MODERN WIRELESS

October

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"THE COASTAL THREE"

By A. JOHNSON-RANDALL

A bigger range of Burndept Standard Precision Condensers

—*obtainable with Super-Vernier Dials*

THE introduction of Burndept Standard Precision Condensers last season met with instant success. Wireless enthusiasts will be pleased to learn that a new type—*Corrected* Square Law pattern—has been added to the range and, further, that these Condensers may be obtained with ordinary dials or with the new Super-Vernier Dial which has attracted so much interest.

Burndept Standard Precision Condenser, fitted with Super-Vernier Dial and with Dust Covers on.

Owing to careful design, the Burndept Condenser absorbs less than 0·05 per cent. of the power applied—a remarkable approach to theoretical perfection. It is ruggedly constructed and the spindle is self-aligning. The upper bearing runs in a flexible steel housing and the lower bearing consists of a metal cone running in gun-metal. Contact is perfect, and the movement is very smooth. These Condensers are absolutely noiseless even when used on waves as low as 40 metres. To protect the plates from dust and to obviate hand capacity effects, metal snap-on covers are provided.

The description, "*Corrected* Square Law," needs a little explanation. Most square law condensers are designed without regard to initial circuit capacity, but the plates of the Burndept Corrected Square Law Condenser are of special shape giving wave changes *truly* proportionate to dial settings.

STANDARD CONDENSERS. All Metal, completely enclosed type.

Model S. V. Fitted with Super-Vernier Dial and Knob.

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No. 918.	Corrected Square Law, .0005 mfd.	1 12 6
No. 919.	Normal Type, .0005 mfd.	1 7 6
No. 920.	Normal Type, .001 mfd.	1 15 0

Model N. Fitted with Black Bakelite Dial and Knob.

No. 921.	Corrected Square Law, .00027 mfd.	£1 2 6
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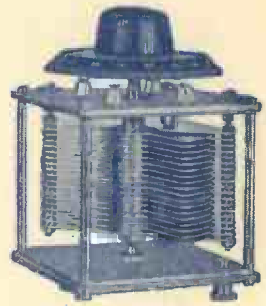
No. 923.	Normal Type, .0005 mfd.	1 2 6
No. 924.	Normal Type, .001 mfd.	1 10 0



Burndept Standard Precision Condenser fitted with ordinary dial, and with Dust Cover removed.

The new Burndept Super-Vernier Dial is ideal for controlling vario-couplers, etc., as well as condensers and enables fine adjustments to be made with ease. It is no larger than an ordinary dial and can be fitted to almost any set without dismantling the instrument. The reduction of about 7:1 is effected by means of a novel friction-driven epicyclic gear, which is perfectly smooth and silent in operation. The gear ratio of 7:1 has been selected after careful trial as the most suitable. There is nothing whatever to go wrong and slight wear is self-compensated. Dials have required no adjustment after an experimental run of half a million revolutions.

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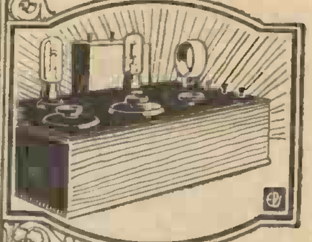

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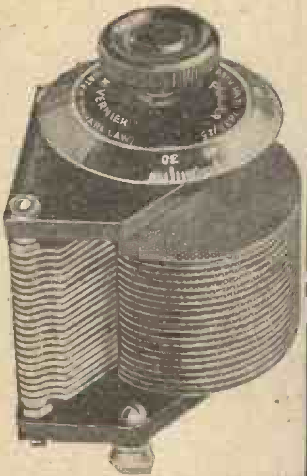
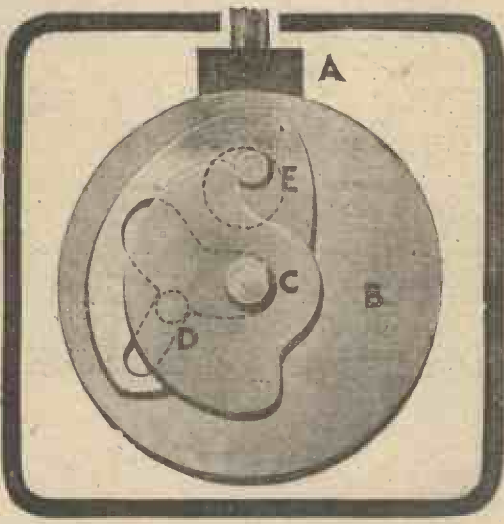
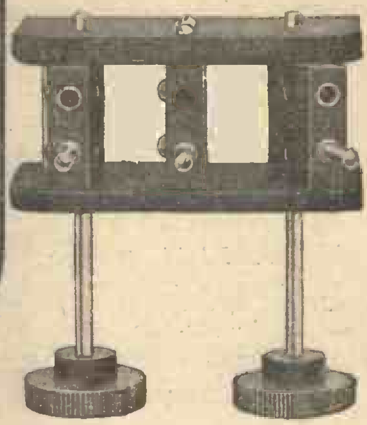
Cam-Vernier—
the master-patent, for efficient fine control.







Since the commencement of the Broadcasting era, no more useful or more popular device has been introduced than the Polar Cam-Vernier principle—which has added infinitely to the simplicitv of fine tuning, and appeals to any listener who appreciates soundness of design.

The Polar Cam-Vernier Device (Patent No. 17838/25) is illustrated diagrammatically above. This diagram shows: (A) the "driven" member—coil-holder or condenser, etc.; (B) the friction disc; (C) the centre spindle and rotating plate carrying pin (D) engaging in slot in intermediate plate; (E) the cam, integral with the intermediate plate, carrying an eccentric pin which engages in slot in driven member A. This device, which occupies less than 3/16 inch in thickness, gives 10 degrees of "vernier" movement (about 1 to 8) at any portion of the sweep—at the end of which the positive movement operates.

The 'Polar' Cam-Vernier Variable Condenser embodies the principle described above—both rough and vernier adjustments being registered on scale. The vanes are designed to give true square-law readings when working with parallel capacities (e.g., self-capacity of inductance coil) and scale readings are continuously proportional to wavelengths. Single-hole fixing: low-loss ebonite end-plates .001 mfd., 12/6; .0005, 11/6; .0003, 10/6.

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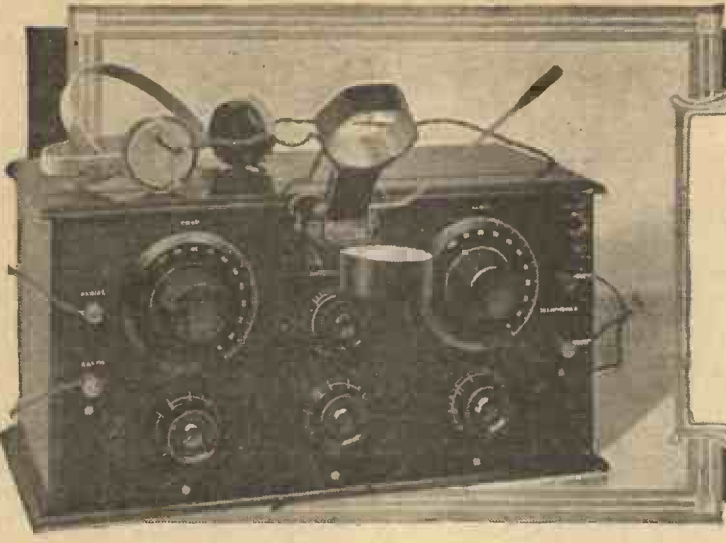


THE COASTAL THREE

by
A. Johnson-Randall,
Staff Editor

"HOW can I cut out interference?" is a question constantly asked. With the progress of broadcasting the problem of selectivity is becoming increasingly important, and the broadcast listener is beginning to realise that it is better to lose a little in signal strength provided a big gain in selectivity is obtained, rather than to receive strong signals together with perhaps even stronger interference.

Effective Signal Strength

In short, the effective strength of a received signal is simply the ratio of signal strength to interference.

It is only necessary to compare the effects of a loud signal accompanied by interference from a multitude of spark stations with a weak signal together with a reasonably silent background, to realise the truth of this statement. Some wish simply to be able to cut out the powerful local station in order to receive other more distant ones, while on the other hand, many are unable to obtain satisfactory results from the nearest station on account of local interference, such as spark jamming from ships. This applies particularly to those listeners living near the coast.

It was with the object of satisfying the requirements of those who desire selectivity combined with simplicity that the receiver described in this article was designed.

Simple Control

I have always been of the opinion that to appeal to the majority the number of controls must be a minimum, and some considerable thought was expended in the choice of a suitable circuit. Since long-distance reception is desirable, in fact, almost essential, it seemed necessary to employ a stage of high-frequency amplification, which, in addition to extending the range, would at the same time tend to increase selectivity. Again, many listeners require loud-speaker reception from at least one station, hence a stage of low-frequency amplification was indicated.

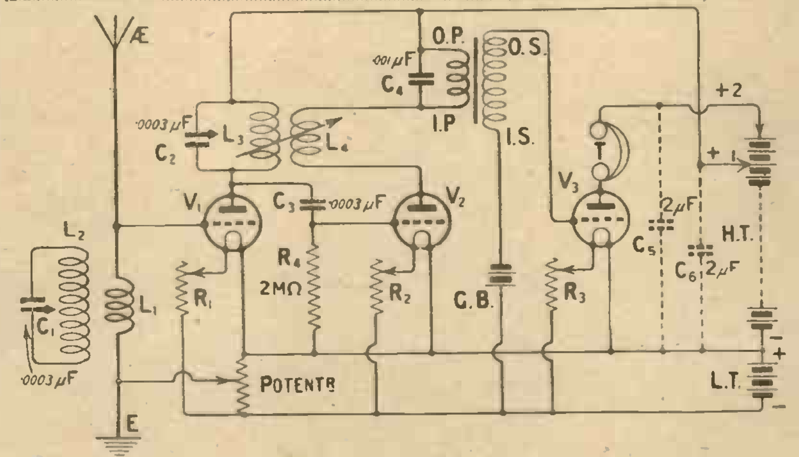


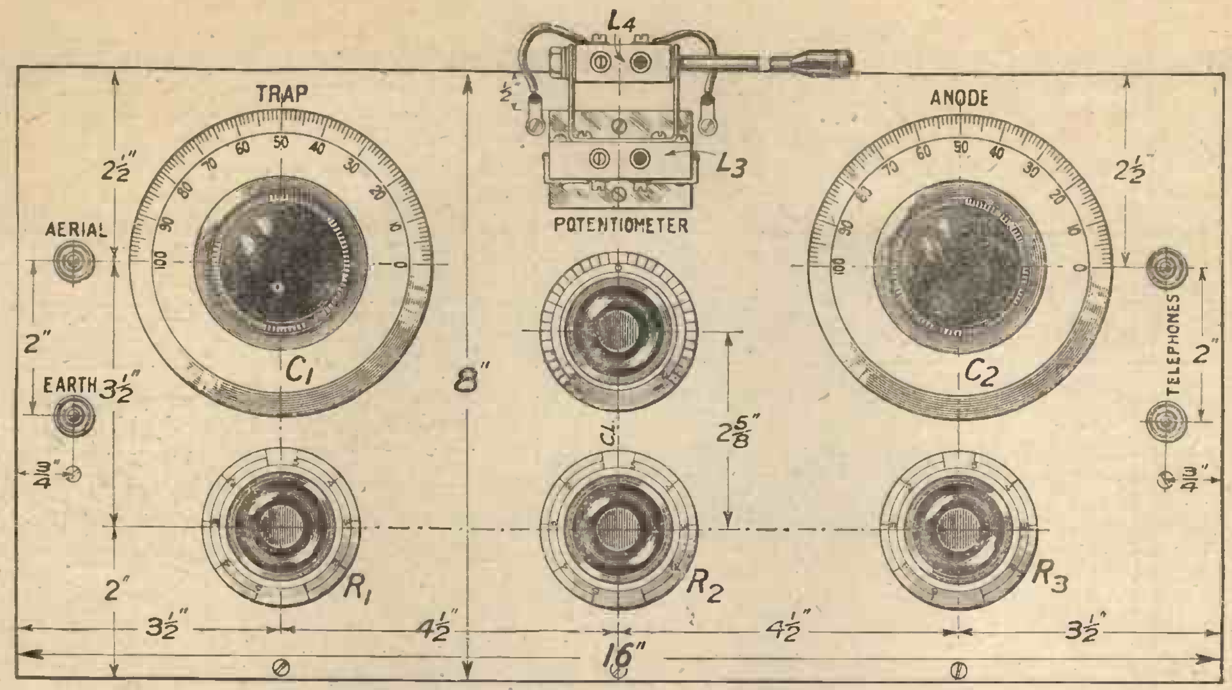
Fig. 1.—The condensers C_5 and C_6 shown dotted should be part of the H.T. unit and are not included in the set.

The Circuit

The circuit finally chosen was one described by Mr. John Scott-Taggart, F.Inst.P., A.M.I.E.E., in an article entitled "Trap Circuits," in the February issue of *Modern Wireless* (Vol. iv., No. 1), and is shown in Fig. 1.

I have called the receiver the "Coastal Three" because I consider it to be eminently suitable for those living at a distance from the coast where interference from ships is bad.

The aerial coil consists of an aperiodic coil of comparatively few turns and has coupled to it a coil L_2 tuned by a .0003 μF variable condenser. The effect of coupling L_2 to L_1 may be regarded as equivalent to turning the aerial circuit into a single tuned circuit, but the net result is a great increase in selectivity, without the disadvantage of an increase in the number of controls. Tuning is therefore precisely the same as in the case of the ordinary conventional three-valve circuit employing one stage of high-frequency amplification but very much more critical. The decrease in signal strength is only slight, and the receiver is very suitable for those who are unfortunate enough to reside in a district where interference is bad. Reaction is employed on to the anode coil and this has the advantage of minimising radiation should the receiver be in an oscillating condition.



Adequate control of oscillation can be obtained by means of the potentiometer.
Blue Print No. 131a, price 1/6, post free.

Constant Tuning

Since the method of tuning is independent of aerial characteristics, any variation in the aerial constants will not appreciably affect the condenser setting, hence the receiver can be calibrated with a practical degree of accuracy by receiving three or four stations, and in this way determining the approximate positions of others, whose wavelengths are known, by interpolation. Plug-in coils are employed so that the set may be used for the reception of 5XX in addition to those stations working on the ordinary broadcast band.

Components Required

One cabinet, mahogany, 16in. by 8in. by 7 in. (inside) with loose baseboard (Camco).

One ebonite panel 16in. by 8 in. by ¼ in. (Paragon).

Two ·0003 μF variable condensers square law pattern (Igranic Electric Co.).

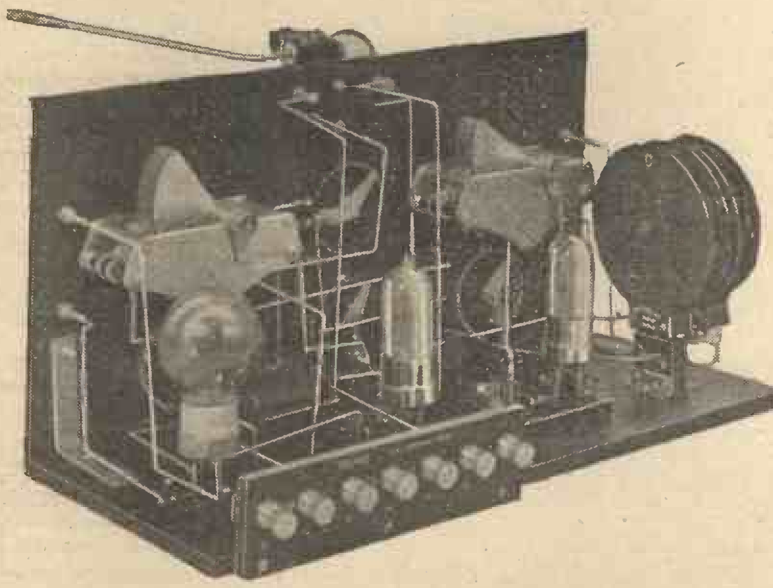
Three dual filament rheostats (L. McMichael, Ltd.).

One potentiometer (L. McMichael, Ltd.).

One two-coil holder, type R Burne-Jones & Co.).

Three "anti-pong" valve holders (Bowyer-Lowe Co., Ltd.).

One ·0003 μF grid condenser and 2 MΩ grid leak (L. McMichael, Ltd.).



All battery leads are taken to the terminal strip at the back of the baseboard.

One terminal strip, No. 1, 7 in. by 2 in. (Burne-Jones & Co., Ltd.).

Four W.O. type nickelled terminals (Burne-Jones & Co., Ltd.).

One C.A.V. L.F. transformer 1st stage (C. A. Vandervell & Co., Ltd.).

One coil plug, baseboard mounting type (Burne-Jones & Co.).

One trap coil, size a/T to clamp on to existing coil, and also one size D/T for 5XX if required (Gambrell Bros., Ltd.).

One ·001 μF fixed condenser (Dorwood Precision).

A quantity of square bus-bar wire (Sparks Radio).

Two angle-brackets, a few 4BA screws and nuts, and a short length of flex.

A set of Radio Press panel transfers.

Mounting the Components

The mounting of the components upon the panel is particularly simple in this receiver, since the filament rheostats and the potentiometer are of the one-hole fixing type. In the case of the two variable condensers, which are secured by means of a three-point suspension, a drilling template is supplied, so that the position of the spindle hole having been marked off, it is only necessary to prick through the centre marks on the cardboard template to determine the points at

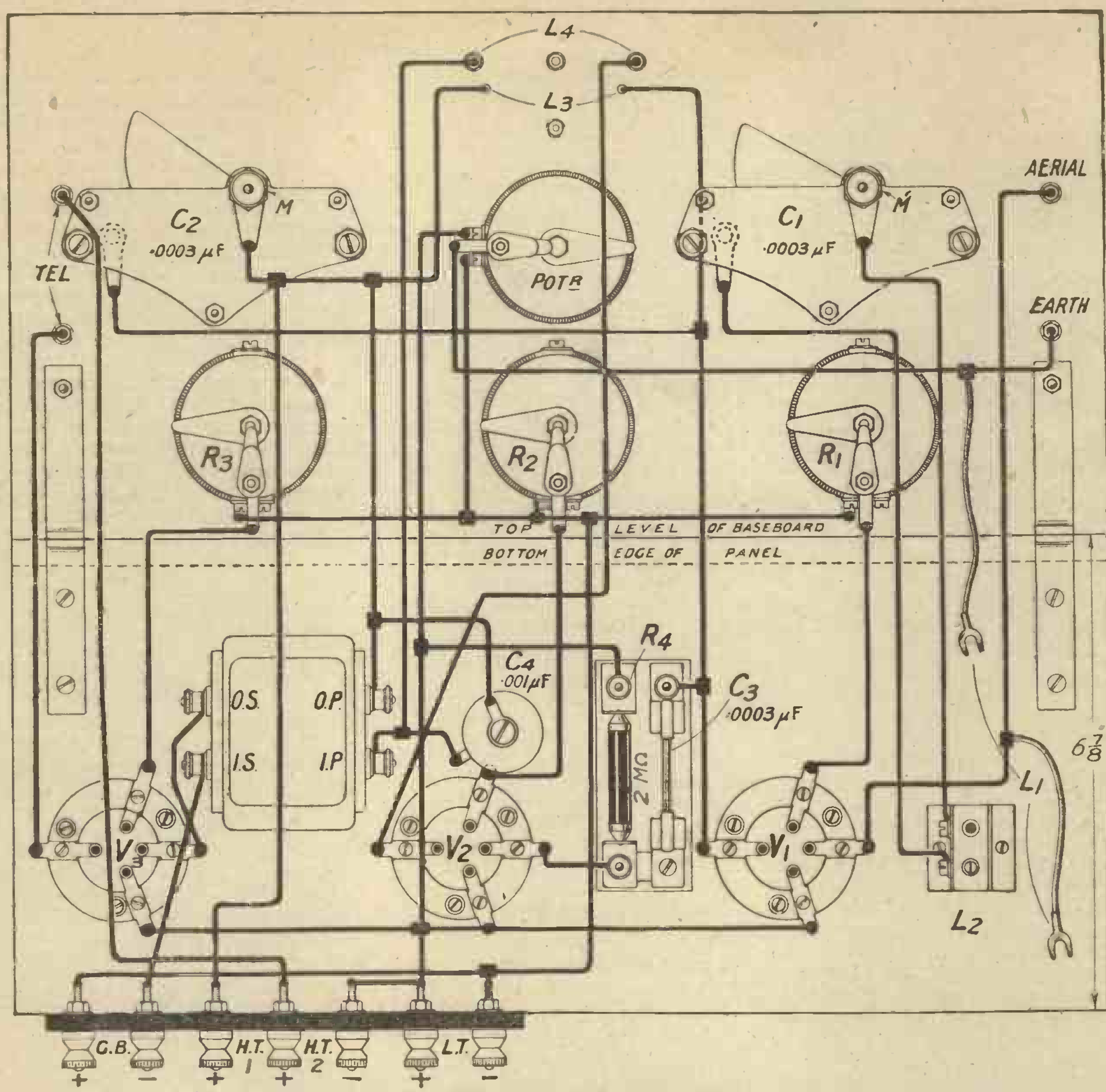


Fig. 3.—The two flexible leads seen on the right should be attached to the terminals on the aperiodic coil. Blue Print, No. 131b, price 1/6, post free.

which the fixing holes are to be drilled. It is as well to mention that this should be carried out with great care, since a slight inaccuracy may render the mounting of the condensers somewhat difficult. The three filament rheostats and the potentiometer require a 3/8 in. drill, and the operation of drilling these large holes is simplified if small pilot holes are run through first. The two-coil holder is placed on the centre line of the panel and may with advantage be used to form its own template.

Baseboard Lay-out

Turning now to the disposition of the components upon the baseboard, these are not placed in position to any fixed dimensions, but the constructor should follow the lay out shown in the wiring diagram Fig. 3, since the general scheme was decided upon after much careful thought.

The terminal strip on the back of the baseboard can be obtained engraved and ready for use, or it can be made by drilling seven holes one inch apart and half an inch from each end of a 7 in. by 2 in. by 1/4 in. ebonite strip.

Wiring up the Set

Having now drilled the panel and mounted the components upon the baseboard, the next operation is to commence wiring up the set. Before securing the panel to the baseboard join up the filament rheostats with a length of square section wire as shown in Fig. 3, this particular lead being rather difficult to solder when once the panel is mounted. A good plan is to solder all the inside leads, working gradually towards the back of the baseboard, and starting with the filament connections to the valve-holders. Always take care to allow ample clearance in the immediate neighbourhood of the valve-holders, for the valves themselves to be inserted. This applies also to the leads near the aerial and trap coils. Lack of care in this respect may cause certain important leads to be damaged in removing the valves or coils while in use. In soldering cleanliness is an essential factor and provided a really hot iron is employed there should be no difficulty.

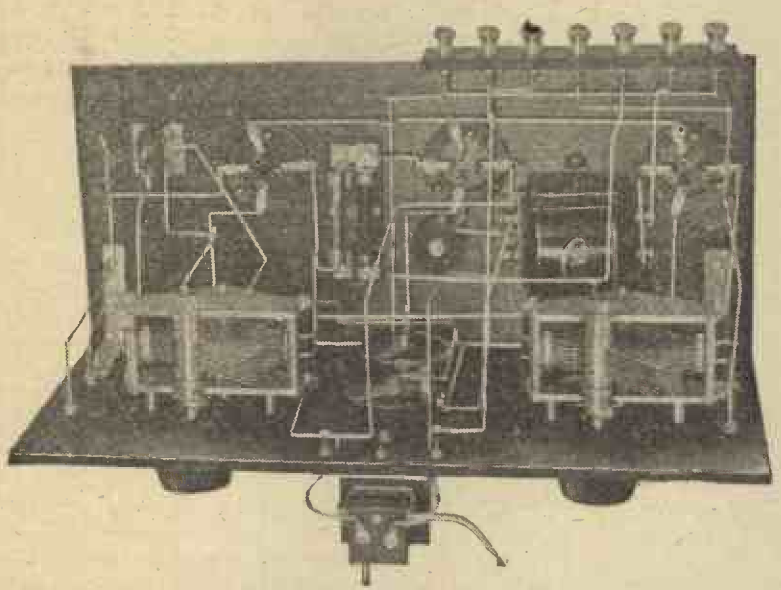
If other than a resin flux is used it is good practice to clean up all joints, in order to prevent corrosion, with methylated spirit.

Operating the Set

First connect the aerial, earth and telephone leads to their respective terminals and join up the L.T. battery. Place the valves in the valve sockets and carefully rotate the filament rheostats. Provided the valves light correctly connect up the H.T. battery, plugging in the H.T. + 1 plug at. say, 45 volts and the H.T. + 2 at about 72 volts. In the preliminary test the grid bias terminals may be joined together with a piece of bare wire. For the broadcast band clamp a "C" coil to the special a/T coil which should be connected by means of two short flexible leads to aerial and earth as shown in the wiring diagram. Insert a No. 50, 60 or 75 coil in the fixed socket of the two-coil holder and a No. 50 or 75 in the moving socket. With these two well apart rotate the two variable condensers very slowly until signals are heard. Then bring the moving coil nearer to the fixed coil and note carefully whether signals increase in strength. If no increase takes place reverse the two flexible leads to the moving coil and perform the same operation again. I have found this to be necessary with a number of coils in my possession.

Practice Necessary

Any tendency to oscillate can be controlled by means of the potentiometer, rotating it anti-clockwise increasing it and vice versa. Tuning will be found very sharp, and some little practice is necessary at first. The best size of reaction coil should be found by experiment, the two sizes mentioned being tried to commence with. Any good general purpose valve can be used in the receiver and that in the H.F. socket might be one specially designed for H.F. amplification. For loud speaker work a small power-valve worked with the H.T. voltage and grid bias which the makers specify will be found an advantage.



There is ample clearance for valves of all types.

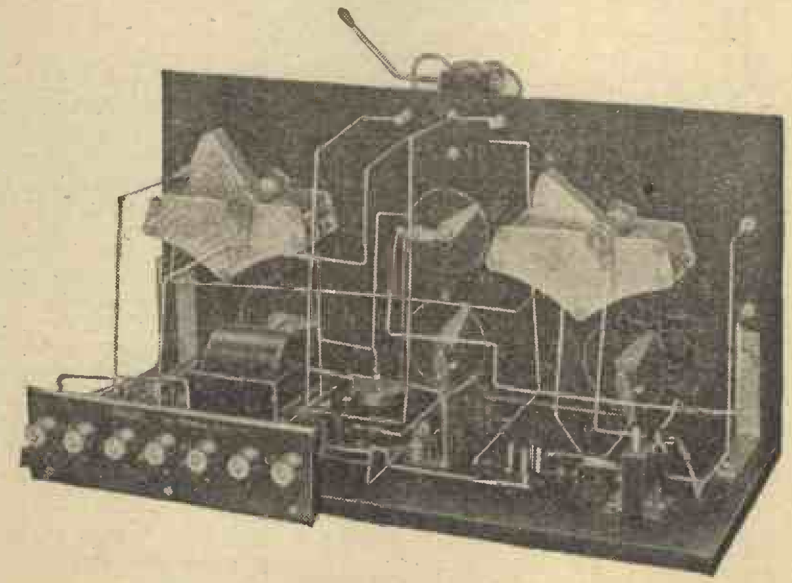
Test Report

The receiver was carefully tested upon an aerial 100ft. in length and 35ft. high (average), at a distance of 15 miles from 2LO. London was full loud-speaker strength and during the ordinary programme Bournemouth, Newcastle, Birmingham, Belfast, Aberdeen and Glasgow, together with a number of Continental stations, were received at full telephone strength. The coils, used were a Gambrell a/T and "C" for the aerial and trap circuits with a "C" in the fixed socket of the two-coil holder and a "B" for reaction. During a test at midnight all of the B.B.C. stations with the exception of Cardiff were logged, Bournemouth on a wavelength of 387 metres (774·7 Kc.) was separable from 2LO on a wavelength of 363·5 metres (824·8 Kc.). Manchester could be heard with 2LO in the background, and the ratios of their respective strengths when tuned to Manchester I should put down as Manchester three and 2LO one. The wavelengths were announced during the test.

Receiving 5XX

In addition to the thorough test on the broadcast band, the receiver was employed upon several occasions for receiving Daventry on the loud speaker. Using a D/T coupled to a G coil for the aerial and trap circuits respectively, with an F as anode coil and an E for reaction 5XX came in at full loud speaker strength, suitable for a large room. Of the numbered coils a No. 250 would be correct in the anode socket and a No. 100 or 150 should suffice for reaction.

It will be noticed that I have not included H.T. shunting condensers in the receiver itself, the reason for this being that I consider these to be essentially part of the H.T. unit.

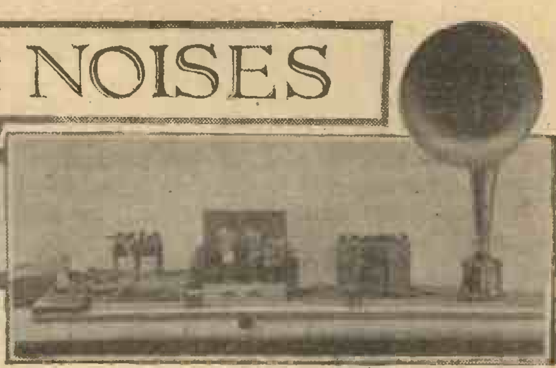


The receiver is suitable both for dull and bright emitter valves.

MICROPHONIC NOISES

INVESTIGATING AN IMPORTANT VALVE PROBLEM

By Major JAMES ROBINSON, D.Sc., Ph.D., F.Inst.P.



MOST people who have used valve receivers and amplifiers in the last three or four years are familiar with a very objectionable feature of some types of valves. Certain disturbing noises are produced under various circumstances. When a valve is "flicked" with the finger a sound is started in the telephones or loudspeaker which may continue for a few seconds. When the amplifier is knocked, again the noise is obtained. Generally when the amplifier is subject to any form of vibration or movement, noises are produced in the loud-speaker or telephones, which tend to destroy the quality of speech or music which is coming through.

Another feature which is noticeable is that sometimes when one speaks loudly or sings in the neighbourhood of the amplifier, again this noise is produced. The banging of a door will also sometimes produce it. Sometimes this noise becomes very bad, and perhaps the worst feature from the broadcasting point of view is that the loudspeaker produces sound waves which are sufficiently powerful to act on the valves and cause vibration, which again produces these microphonic noises. When this happens, a continuous howl is produced which completely washes out any reception of telephony. This is microphonic noise in its worst form. These noises can be produced whenever there is mechanical vibration or direct mechanical shock, and thus for broadcast reception the problem is divided into two parts, either when the mechanical shock is produced direct, or when it is produced by sound waves, particularly from the loudspeaker.

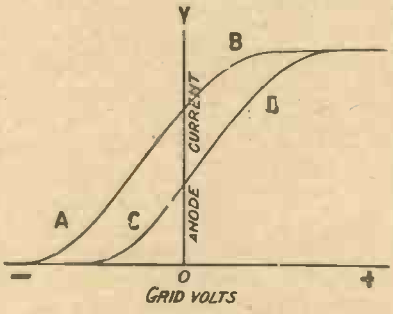


Fig. 1.—Characteristics of two valves with grids (AB) open and (CD) closely meshed.

Dull Emitter Valves

Troubles with microphonic noise have been more pronounced since the introduction of dull emitter valves. Of course, the noises can be obtained with bright emitter valves, but it is due to the introduction of the dull emitter type of valve that the noise has become serious. However, the trouble is not pronounced with all types of dull emitter valves (but depends on the thickness of the filament to a very large extent).

We must now ask ourselves the question why noises are produced when the valve is subject to shock or vibration.

The Cause

We must consider which parts of the valve are set in vibration. This question will be answered in the following paragraphs, but in the meantime supposing that any single part of a valve is subject to vibration, we must consider how this can produce microphonic noises, or, in other words, how this can cause a note to be produced in the telephones or loudspeaker? The reason appears to be as follows:—

The characteristics of valves depend upon the shape and disposition of the various electrodes. It is the function of valve manufacturers to know precisely how the change of electrodes can alter the characteristics of valves, so that they can produce valves with any desired characteristics. We will refer to one example in this connection. This is the case of the influence of the grid mesh.

Spiral Type Grids

We can consider grids of the spiral type. The closeness of this spiral as regards winding controls the lateral position of the characteristics. Referring to Fig. 1, two characteristic curves are shown. The characteristics which are shown are the grid-volt, anode current characteristics. The curves are for a fixed anode voltage and for fixed filament current. The two curves AB and CD are almost identical, except for the fact that one is to the left of the other. The difference is accounted for by the fact that in the case of the curve AB, the mesh of the grid is comparatively open, and in the case of the curve CD, the mesh is comparatively close.

These examples tend to show that the shape of the electrodes controls the characteristics of the valve. Other examples could be given, such as, for instance, where one displaces the filament somewhat, inside the grid. Thus, whenever there is mechanical motion of any part of the electrode, the result is that we move immediately to another characteristic, keeping the anode voltage and the filament current constant. If we move from one characteristic to another, this usually results in giving different anode currents. Changing the anode current suddenly produces a noise in the telephones or loud-speaker. Thus we see that relative mechanical movement of the electrodes will produce noises in the telephones or loud-speaker, and thus we can account for the production of microphonic noises due to the shaking of a valve or to mechanical vibration produced by sound waves.

A Serious Problem

The annoyance produced by microphonic noises is very considerable in private houses, but there are conditions where these noises are very serious indeed. There are many conditions where the amplifier is necessarily subject to a considerable amount of vibration. In my recent capacity as technical head of the Wireless Laboratories of the Royal Air Force, the problem was very serious indeed, for reception in aircraft is by no means under ideal conditions. There is continual vibration of the aircraft, and this must be kept from the amplifier as much as possible.

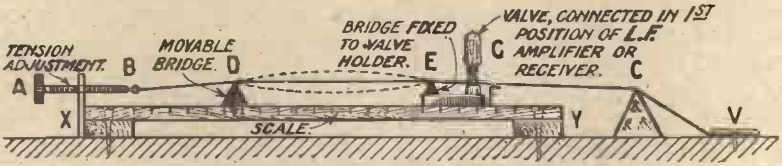


Fig. 2.—A diagram showing the vibrating string or Monochord apparatus referred to in this article.

In the Royal Air Force the problem assumed very serious dimensions, and it was necessary to attack the problem fundamentally. It was necessary to work in close touch with valve manufacturers in order to produce the best type of valve which would be least disturbed by microphonic noises. It was further necessary to perform all types of tests with valves which had been produced.

Apparatus Designed

The members of my staff who were principally engaged on this problem were Captain H. L. Crowther, M.Sc., who is now with Radio Press, Ltd., and Mr. B. Williams, B.Sc. The apparatus about to be described for investigating microphonic noises was suggested and made in the first place by Mr. Williams. This apparatus was designed in order to determine the actual frequencies which produced microphonic noises, and further to discover which portion of the valve was responsible for producing the worst type of noise.

We know that mechanical jars produce the noises. Sometimes the noise produced is of the nature of a "ping," which appears to be of a definite frequency. At other times, the sound appears to be a mere noise without any specific single frequency. It is necessary to determine whether there is any definite frequency of vibration which will give the noises, and thus it is essential to have an instrument whose frequency can be altered continuously so that we can obtain any frequency we desire. We can then make the valve vibrate at any particular frequency to see whether any resonance effect can be obtained. Various musical instruments exist which will give a variable frequency.

The Monochord

The instrument suggested by Mr. Williams consists of a stretched string, which will give frequencies from a low value of about 50 vibrations per second to a high value of the order of 2,000 or 3,000 per second. This instrument is called the Monochord or Sonometer. Many musical instruments depend upon the use of stretched strings. The frequency or pitch of a note produced by a string depends upon three factors: first, the mass of the string per unit length; secondly, on the amount of tension; and, thirdly, on the length of the string.

These principles are well known, and can be readily appreciated by reference to the violin. There are four strings on the violin, the string giving the lowest pitch being the heaviest one, and that giving the highest pitch being the lightest string, and thus the first principle is illustrated where the pitch is controlled by the weight of the string.

Adjusting the Pitch

Again, in order to adjust the pitch of the string, pegs are provided on the violin which can stretch the string to any required tension within limits. In order to raise the pitch of a particular string, it is necessary to stretch it a little more tightly. The third principle is also readily appreciated by reference to the violin, because the fingers of the left hand are used in order to stop the string at any particular point and thus to make the string essentially shorter. By shortening the string in this way a higher note can be obtained. With the violin, of course, a bow is used to produce the sound. With a monochord, however, a bow is usually not used, but the string is usually flicked by the finger.

Description of the Monochord

The Monochord, then, is essentially a string which can be stretched to any required tension, and which can have its length altered to any required amount. Fig. 2 illustrates the essential features of the monochord. There is a baseboard XY, which is screwed down upon a table. The string is fastened rigidly at one end, V, and at the other end there is a tension apparatus, A, so that the string can be stretched as much as required. Bridge pieces C, D and E are shown, each of which is variable in position, so that any required length can be obtained.

Investigating the Noises

In order to investigate the microphonic noises of a valve, all that we require is to place the valve with its valve holder on one of these bridges, and this is shown in the figure at the bridge, EF. Into this small board EF is screwed the valve holder, into which is put the valve G. We thus have a portion of the string DE, which can be altered in length by moving one or both of the bridges. Also the tension of the string can be altered by tension screw A. Thus we can obtain any frequency we require within limits, and by moving the bridge piece E or the bridge piece D, we can get any required length between these two bridge pieces. By suitable adjustments a wide range of frequencies, say, from 50 to 3,000 per second, can be obtained. In order to appreciate the microphonic noises the valve G is made one of the valves of an amplifier. For preference the valve should be in the detector position of the amplifier.

Method of Operating

The method of operation is now to flick the string between the portion DE by the finger and to move one of the bridge pieces D or E until some pronounced microphonic noise is obtained in the loudspeaker. The baseboard XY is calibrated so that the length between the two bridges can be measured, and the actual frequency can then be obtained by adjusting the length between the two bridge pieces to get a note of the same frequency as that of a standard tuning fork whose frequency is known.

Then the length for a standard frequency is known, and thus the frequency for any length between the bridges can be calculated by the use of the formula which determines the frequency n in terms of the length l, the tension T, and the mass per unit length, m. This formula is:—

$$n = \frac{1}{2l}\sqrt{\frac{T}{m}}$$

l being measured in centimetres, m in grams, and T in dynes.

A photograph of the apparatus as used at the Royal Air Force Establishment is shown in Fig. 3.

Instead of flicking the string with the finger it is possible to excite it in a much more convenient manner. This is done by using a string of magnetic material such as iron or steel, and placing the magnets of the telephone head receivers immediately under the string, as shown in the photograph. This telephone headpiece is now excited by the low frequency hummer, which is an oscillating valve circuit arranged to give low frequencies of the order required.

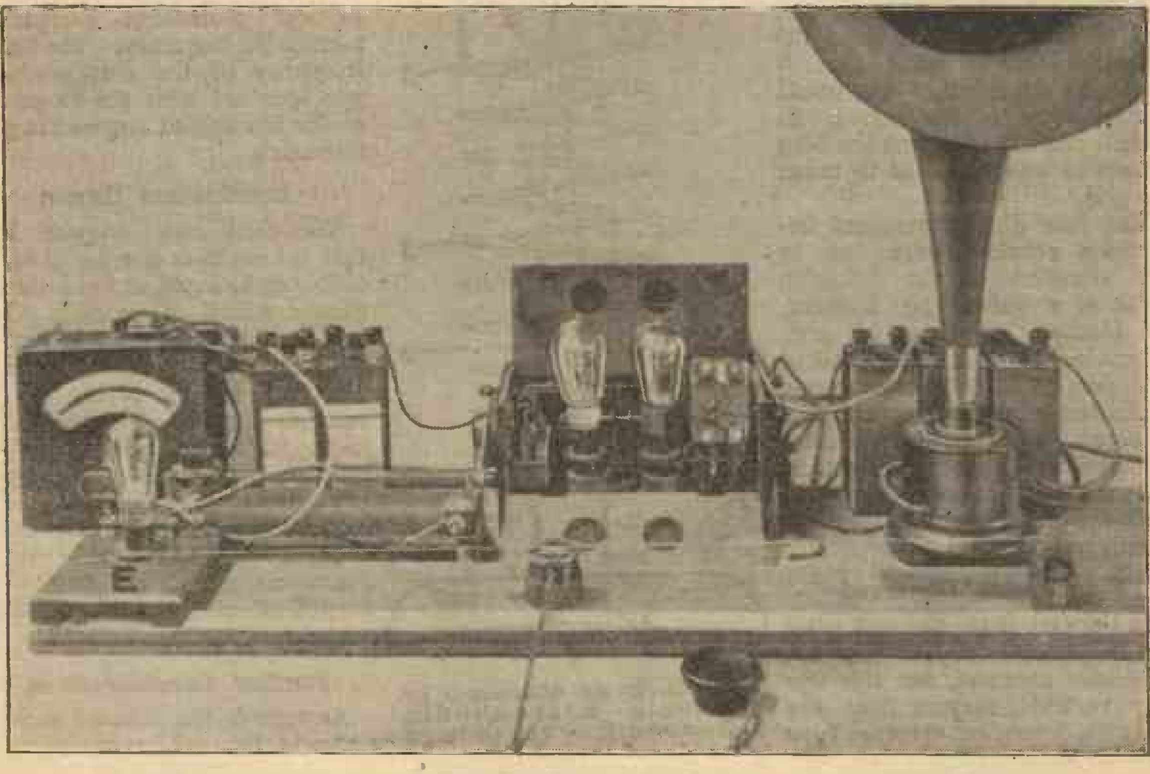


Fig. 3.—The apparatus used at the R.A.F. establishment for investigating microphonic valve noises.

Results

Some most remarkable results have been obtained. It was found that for any particular valve at least four different frequencies combined to give the microphonic noise. For two valves of the same type these frequencies were never the same. The frequencies varied from about 1,000 to about 50 per second. It was found that these notes were also fairly selective, and as the string was altered in length by altering the distance apart of the bridge pieces, the microphonic noise was not appreciated until we were quite close to one of the actual frequencies. Again, the actual amount of microphonic noise depended upon the valve, in some cases being very bad and in others not so bad. The object of the tests was to find what the conditions were which would give microphonic noises of the lowest possible amount at these resonant frequencies.

Very few experiments were required to show that our views as to how the microphonic noise is produced were correct. In addition to observing the effects in the loudspeaker, it was very soon found that the actual mechanical vibration of the various parts of the valve could be seen by eye, and in fact in certain cases the vibration was so great that it made us afraid that we would destroy some of the valves. In certain cases the filament has been caused to vibrate so as to touch the grid.

The four distinct resonant frequencies obtained were due to the vibration of the following parts of a valve: (*a*) filament, (*b*) filament supports, (*c*) grid, (*d*) anode, and with certain valves each part could be seen vibrating mechanically when resonance was obtained. The highest frequencies are obtained with the filament and with the filament supports. With the grid and anode they are usually very much lower.

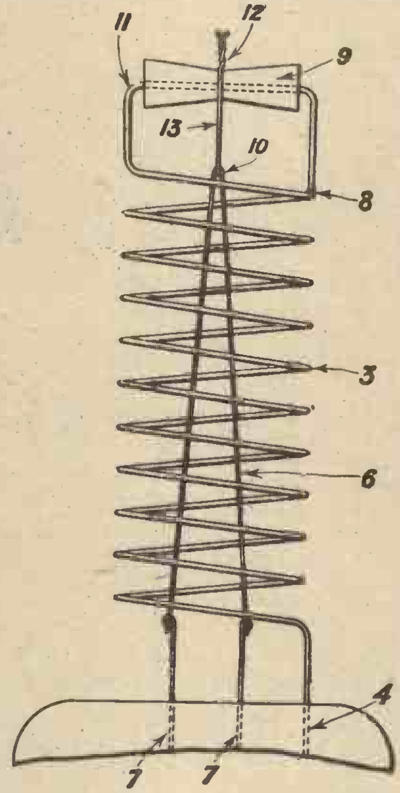


Fig. 4.—In an endeavour to eliminate microphonic effects various suggestions have been made. That due to Capt. S. G. Frost of anchoring the grid and filament rigidly together is shown above. The filament 10 is attached to the grid 11 at 12 but separated electrically by the insulator 9.

Frequencies Observed

In the case of the filament, notes of a frequency as high as 1,000 are sometimes obtained, but this was very variable, varying from 100 to 1,000, depending upon the type of valve and also upon the different valves in a particular type. With filament supports again the note was sometimes fairly high, but usually not so high as with the filament itself. Notes of a frequency of from 50 to 200 could be obtained with the filament supports. With the grid the note obtained was usually low, and with the anode also usually low.

Principal Causes of Noise

It was very soon discovered that the disturbance in the form of microphonic noise came principally from the filament and from the filament supports. This was due to three different causes: First, the pitch of the note produced; secondly, the amplitude of the note; and thirdly, the persistence of the note. In some valves the note persists for many seconds, whereas in others its duration is small. The duration depends on the damping of the vibrations. One of the ways of having considerable damping is to have as little elasticity in the filament and in the support as possible. As regards the filament this depends on the temperature, the higher the temperature the less the elasticity constant. When the note produced is of a frequency below about 100 per second, the influence on speech is not serious, and in fact when below about 30 per second it has no appreciable influence at all. The disturbance becomes serious when the pitch of the note is above 100, and thus the chief feature on which to concentrate are the filament and the filament supports.

Oscillograph records were also taken of the microphonic noise, but this did not add very much to our knowledge except as regards the frequency. The actual frequency of the note produced was identical with the frequency of the Monochord required to give resonance.

Conclusions Drawn

We shall now enquire how this information can be used to enable us to avoid as much microphonic noise as possible. The first conclusion to draw is that it is necessary to prevent as much vibration of the parts of the valve as possible. The anode and its supports should be as rigid as possible, thus tending to prevent any mechanical vibration being conveyed to the anode. The same remarks apply to the grid. Valve manufacturers should pay very careful attention to this point of design.

Further Considerations

As regards the filament and its supports, the problem is not quite so simple. It is, of course, possible to pay some attention to the filament supports, and these should be as rigid as possible. This is a point about which manufacturers may have some doubt, because they think it is necessary to allow the filament supports to have some form of movement in order to allow for the sag and general change of length in the filament due to change of temperature. In fact, patents exist for supports in the form of springs to take up the change in length when the filament is heated. This applies however more particularly to transmitting valves. As regards the filament itself, we shall discuss this in the following. The next point which arises is that it is advisable to design the valves in such a way that any mechanical vibration which can be obtained is of as low frequency as possible. Our investigations show that if the frequency is below 100 the microphonic noises, as a rule, are not serious.

Thick and Thin Filaments

We have seen that the pitch of a note produced by a string depends upon the mass per unit length, and thus if we can have a thick filament the note would be lower provided that the tension were not too great. It is obvious why the microphonic troubles have only become serious within the last three or four years, because some dull emitter filaments are essentially thinner than those of bright emitters. The tendency has been to attempt to obtain filaments which will give the required emission with as low a filament current and filament voltage as possible, and thus to make it possible to use low capacity accumulators or even dry cells to heat the filament. This has led to valves being made with very thin filaments. Some dull emitter filaments are thoriated, and this does not account for the filament being much thicker. Another form of dull emitter filament is the coated type, and this is automatically heavier, as the active material is put on to the metallic filament. In general practice it is found that coated filaments do not produce the same amount of microphonic noise as the thoriated filaments.

Filament Tension

The filament must have some tension in order to guarantee that as it changes in length owing to heating it will not sag on to the grid. Thus the manufacturers have a very difficult problem to solve in order to guarantee that the filament will just have the correct tension to prevent it from sagging on to the grid and at the same time will have small enough tension in order that the pitch of the note shall not be too high. The problem is again made more difficult for the manufacturer because he does not know what the tension will be when the filament is heated.

Elasticity and Temperature

Another point of interest is that the metallic filaments have a considerable amount of elasticity, which quality varies with temperature. At the very high temperatures which are used for bright emitters, the elasticity is considerably less than at ordinary temperature. At the temperatures used for low temperature emitters, or dull emitters, the elasticity is greater than for bright emitters. The temperature for the dull emission filaments of the thoriated type is of the order of 1,300 to 1,400 absolute, and of the bright emitter receiving valve of the order of 2,000 absolute. For transmitting valves the temperature might be of the order of 2,500 and 2,700 absolute.

As regard the question of making the electrodes as rigid as possible, various suggestions have been made from time to time. One suggestion was made by Captain S. G. Frost to keep the filament support and the grid rigidly attached together. In this case, of course, insulation has to be provided between the grid and filament support.

In some cases, again, the filament is supported at the middle in addition to the end supports. This, again, helps to keep the natural frequency of the filament low, as less tension should be necessary in such cases.

Now supposing that we have eliminated the microphonic noise from the grid, the anode, and from the filament supports by rigid construction, we see that it is not so easy to avoid microphonic noise from the filament itself, unless the filament is loaded very heavily, which is not possible in every case. However, if we could now guarantee that the valves were made absolutely constant—that is, that the pitch of the microphonic noise was the same in all valves—something might possibly be done in the way of eliminating the microphonic noise, because a filter could then be used to eliminate a particular frequency. This is, however, an exceptionally difficult problem, and it is not considered to be practicable.

Minimising Existing Defects.

Up to this point we have discussed how microphonic noise can be minimised, by paying careful attention to the design of the valve, and we have seen that a certain amount can be done in this respect though practically impossible at the present moment to eliminate it completely without using very thick filaments, which is not always advisable, as these consume too much current. As so many listeners already have valves which have this microphonic noise, the problem is being attacked from another point of view by various manufacturers. In this case the existence of the microphonic noise is accepted, and attempts are made to prevent mechanical vibration from reaching the valve. In some cases rubber is placed between the valve and the valve cap, and in fact various forms of spring or padding are used in this way. In other cases the valve holder is mounted on a spring, so that the vibration of the amplifier is kept to a considerable extent away from the valve itself. In other cases the whole amplifier is often suspended on springs.

These devices only deal with the type of microphonic noise which is produced by mechanical shock or mechanical vibration. They do not deal with the question of the noise being produced by sound waves from the loud-speaker reaching the valves. Whenever this type of noise is produced, the only remedy at present appears to be to cover up the valve in order to prevent the sound waves from striking it.

We have discussed at some length the objectionable features of microphonic noises. It is possible, however, that these objectionable features from the reception point of view might become of great importance in other ways, and in fact suggestions have been made to use valves as microphones. It is possible to conceive conditions in which valves may be so designed that sound waves impinging on some parts of the valve may cause parts of the valve to vibrate with the sound waves, and thus cause the anode current to vary. This would then give a microphone, which is an instrument for converting sound energy into electrical energy.

The apparatus for testing microphonic noises which has been described here is quite easy to construct, and experiments with it are full of interest.

In Passing

Those Figures

I WONDER why these mathematicians must keep on butting in. Not so long ago wireless was an interesting and straightforward science such as a self-respecting man might study in his leisure moments. But now you are always finding yourself up against the most horrible things. You start an article the first page of which is splendidly interesting. Then you turn over and you find at the top of the next "Hence it is obvious that

$$\frac{Ex}{Ez} = \sqrt{\frac{\frac{nK_1}{1+n^2K^2}}{\sigma^2}} \quad . \quad . \quad . \quad . \quad (1)\text{"}$$

or something of that kind. That "obvious" is insulting. The thing is not obvious. It is far from it, to me at any rate. I have a sort of idea that the fellows who indulge in these rows of figures do so simply in order to get out of some nasty fix in which they find themselves. Having no reasonable explanation on a certain point to offer they simply say "It follows obviously that . . ." and then comes a mass of figures and of mathematical signs. They feel quite sure that they are safe since readers will lack either the ability or the energy to probe deeply into these things. Mathematics are certainly most useful in this way; I find them of the utmost assistance when I want to stave off those who put awkward questions. In case you do not know it, I give you the tip here and now free gratis and for nothing. You make a statement about some wireless phenomenon which one of your hearers immediately contradicts. He goes on arguing at some length to prove that you are utterly wrong. Probably you are; that does not matter in the least. You listen for a while, then smile indulgently and say "yes, but are you not forgetting Bumpelstein's Equation?" If he asks what Bumpelstein's Equation is you simply jot down on a sheet of paper a bewildering mass of figures full of square root signs and even worse things than that. Being unwilling to confess his ignorance your heckler promptly dries up.

What about Bumpelstein's equation?

Pipes and Tanks

I must confess that I have always been suspicious of mathematics ever since my earliest days. I remember with what utter loathing I used to tackle those ridiculous questions about pipes and tanks. Water was flowing into a tank through a pipe of given diameter and leaking out through another rather smaller. How long would it take for the tank to become full? You could and did produce upon paper an answer which showed that the process would be completed in 27 minutes $19\frac{3}{4}$ seconds; but you knew that this was all rot since if the experiment were tried practically, either the Company would turn off the water in the middle of it or else a piece of soap of some other foreign body would become lodged in the wastepipe.

A and B

Then again do you remember the exploits of A and B? How I detested those fellows, who were perpetually running races or swopping investments or playing games of skill. The most perfect example of the utter absurdity of mathematics is to be found in their feats upon the cinder path. A can give B 200 yards start in a mile; by how much will he beat him in a match over 100 yards? Working it out you can prove conclusively that A would win by something over 11 yards whilst actually he would probably be beaten into seven different kinds of cocked hat, for A is obviously a long distance merchant whilst B is a sprinter of prowess. Even if you change A and B into racing motor-cars your mathematics are still as misleading as ever since in one race A's carburetter is probably a little wonky, whilst in the next B's suffers from semi-paralysis of the buffle-shaft or something of that kind.

Calculations

Mathematics would be all right if everything always behaved exactly as it ought to. One of the great joys of wireless is that nothing ever does. You may calculate, with the aid of reams of paper, that in order to receive a certain station to the best advantage your frame aerial must point just so many degrees east of true north whilst for a second station it must be turned a good way from this bearing in one direction or the other. Actually you will find as likely as not that in both cases it has to be pointing towards the fireplace. This may offer an explanation of why it is that wireless reception is so much better in winter than in summer. In warm weather the waves go cavorting about simply anywhere thoroughly enjoying the genial temperature. But in winter they feel the pinch of cold, and seeing a chimney, they say to themselves "Ah, that means a fire and a nice warm room" and

Feats on the cinder path.

so they crowd down it to our great benefit. I will make a free gift of this theory to the mathematicians.

The Slide Rule

It must not be taken from what I have said that I despise mathematicians. On the contrary, I have the utmost respect for their abilities. I have one friend to whom I always go when I require to make some abstruse calculations. I simply give him the data and he produces from his pocket a slide rule. He does a few little conjuring tricks with the thing and at the end of about ten seconds gives me the answer, which he guarantees correct.

Elementary Principles

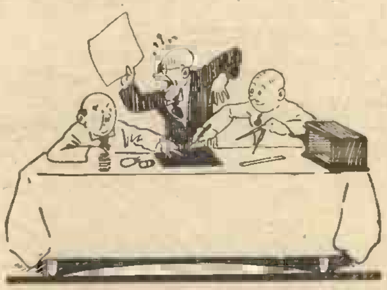
It struck me some time ago, after having watched him make use of it, that the slide rule must be a splendid time-saver. I therefore purchased one at great expense and obtained also a little book of instructions in the art of using it. Having read the booklet through I came to two conclusions: (*a*) that there was something in this slide rule and (*b*) that to master it would entail a lifetime's work. However, I took the thing round to my mathematical friend one night and asked him to tell me all about it. He readily agreed, little realising what he had let himself in for. At the end of a week I had thoroughly grasped the elementary principles of the thing. I could multiply 17 by 42 or divide 195 by 5, not taking more than ten minutes to produce the answer in either case.

Practice Required

At the end of another week I was juggling quite skilfully with decimals and things. My friend was delighted with my progress. He assured me that now I had got the hang of the thing speed was only a matter of practice. I practised so hard that I wore out the first slide rule and had to buy another one. If it had not been that I never could remember whether you read off the answer under the 1 on scale C or over the 1 on scale D, I think that I should have become in time a really expert slide rulist. Even as it was I did not do so badly. I can always get the figures of the answer correct now, though to be quite sure of where the decimal point comes I must either work out the sum with a pencil, or better still run round to see my expert friend.

Mathematics and Design

I need hardly say that my friend Professor Goop is an ardent and convinced mathematician. None of his great inventions ever assumes concrete form until everything has been calculated out mathematically to umpteen places of decimals. If, for example, it is a question of a new circuit, the Professor calculates with the utmost exactitude the position that each of the components must occupy in order that there shall be no interaction between them. He then calls in Poddleby and myself to help him to make up the receiving set. As he is rather short-sighted he leaves the marking out of the panel to us. "Now be very careful over this, my dear fellows," he says beaming at us through his spectacles. "It is essential that these two coil holders should be spaced exactly 3.6123 inches from centre to centre." Perhaps we have been a little careless over the previous lines that we have made, but the fact remains that we find that this measurement will land L2 exactly on the top of V3 or C4. I wink to Poddleby, who, understanding the S.O.S. call, distracts the Professor's attention by treading on his toe or something of that kind, and in the meantime I find a convenient home for L2. And so the set gets built, and it works perfectly as all Professor Goop's sets do, thanks largely to Poddleby and myself. When we test it out the Professor always says "That just shows you the value of mathematics. If we had put that set together in a haphazard way it would squeal or howl or tick, but thanks to the perfect balance assured by my calculations everything is just as it should be."



He distracts the Professor's attention.

Aids to concentration.

New Words

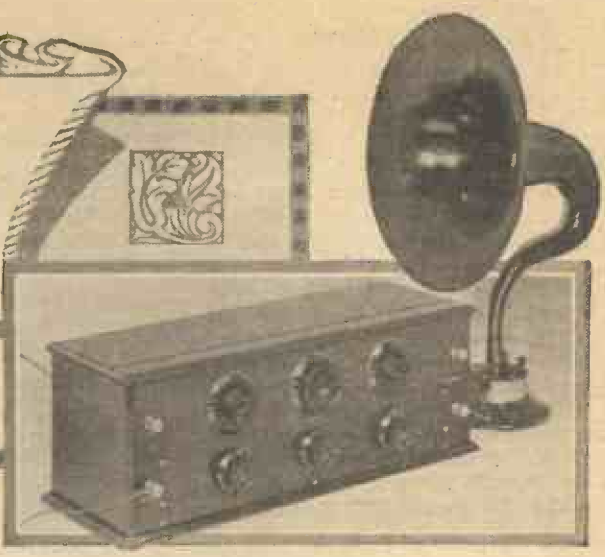
Other fellows that I have no patience with besides mathematicians are those who will keep on introducing new terms for the mental undoing of would-be students of wireless. Here I think we are up against sheer jealousy. These expert fellows see the earnest amateur progressing so rapidly in his knowledge of wireless that they become afraid that he will soon catch them up and know as much about it as they do. Therefore, just as your amateur feels that he is really getting on top of things they invent a lot of new terms which they drag into their writings by the scruff of the neck in order to perplex and bewilder him. They are frightfully fond of things ending in –ance. Provided with a wet towel and other aids to mental concentration you master *reluctance* and *reactance* and *impedance* and *capacitance* and *inductance*. And then one day they hurl *admittance* at you, like the proverbial half-brick at the stranger's head. I suppose that they coined that term just to show that they do not want you and me to enter their sacred precincts; it was doubtless suggested by the well-known notice "No Admittance Except On Business."

The Hero of the Hour

Some day I shall offer to read before one of the learned societies a paper upon The Metagabalous Promulgance of Exonematic Imbulgences. They will accept, of course, for the title of the paper will be sufficient to show them that they are in for something special in the way of a mental feast. I shall lecture to a crowded house using nothing but words like those contained in my title, and they will sit nodding their heads and wagging their beards and applauding loudly whenever a pause in my discourse occurs. And the next day you will see in the papers glowing reports of my remarkable new discovery. No one will be quite sure whether it is a wireless direction finder, or a new constellation, or a safety signal dedevice for railways or a cure for bunions; but that will not matter in the least. I shall become the hero of the hour; smudgy photographs will appear in all the daily papers and I shall receive the first class of the Order of the Bearded Goat from the Emperor of Not-so-Awakia. Meantime I would just like to place on record my own disgustance with those who make still thornier the thorny path of wireless. In case you do not know it, the unit of disgustance is the psha. THE LISTENER-IN.

The DX FOUR

By
D. J. S. HARTT, B.Sc.



This receiver is specially suitable for the long-distance enthusiast. By careful design losses have been kept to a minimum, and the selectivity is such that Bournemouth can be easily separated from 2LO at a distance of 10 miles from the latter station, when using a large and efficient outside aerial.

HOW many amateurs have been requiring a really powerful "DX" set for long-distance reception of stations on the broadcast band? Not a few, I expect; but I doubt whether many have realised their ideal in practice.

Essential Qualities

Let us examine the main essential qualities which such a receiver must possess. First and foremost we must have selectivity of a fairly high order, not merely a "general selectivity" sufficient to separate distant stations operating on fairly close wavelengths, but "special selectivity" which will enable the set to be worked to best advantage on a large outdoor aerial in close proximity to a main broadcasting station, and yet be capable of receiving stations working on wavelengths near to that of the main station.

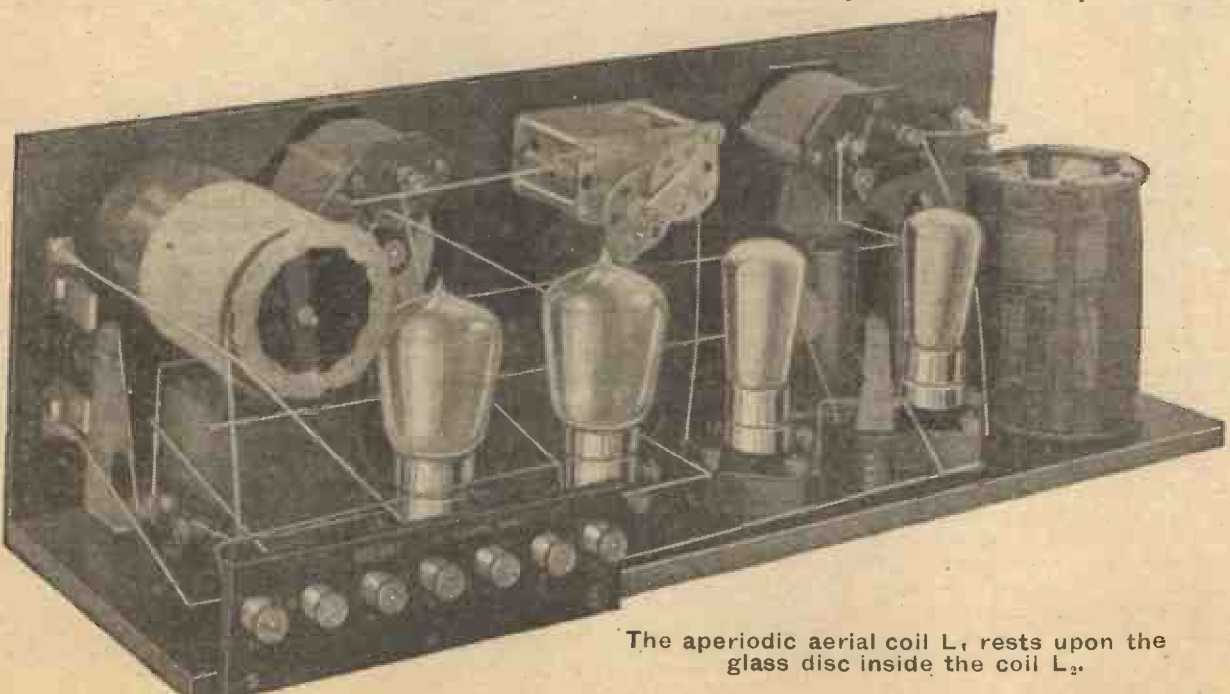
Secondly, the set must be easy to control, tuning controls being limited to not more than two dials.

Thirdly, there *must* be *fine* control of reaction.

Lastly, we must limit the number of valves, say, to three or four, unless it is possible to use the more elaborate equipment of the superheterodyne.

Degree of Selectivity

If, then, we fix an approximate degree of "special selectivity," say, the *complete* elimination of London on full power without the use of a wavetrap, at 10 miles on a large outdoor aerial when receiving Bournemouth on the loud-speaker, we see that to combine all these qualities successfully in one



The aperiodic aerial coil L_1 rests upon the glass disc inside the coil L_2.

receiver we have set ourselves no small task.

Simple to Operate

This task is somewhat simplified if we concentrate solely on a receiver for one band of wavelengths only, in this case the 200 (1499 Kc,) to 600 metre (499·7 Kc.) band.

In this connection I have been carrying out a considerable amount of experiment with various sets and circuits for the purpose, and it is no exaggeration when I say that the receiver illustrated in the photographs is *fully* capable of doing this, and can honestly be said to comply with the conditions specified above.

The set is remarkably stable, simple to operate, and the reaction is delightfully smooth to handle. The receiver should therefore prove extremely popular with those enthusiasts who are keen on long-distance or DX reception of broadcasting stations, unhampered by the working of a powerful local station.

Capabilities

When the set was finally completed in its experimental form I was agreeably surprised at the results, and found no difficulty in tuning in such stations as Bournemouth, Newcastle, Glasgow, Belfast, Birmingham, Brussels, Hamburg, Munster, and other Continental and B.B.C. stations at full loud-speaker strength, on a good night, direct on the loud-speaker without preliminary tuning with the headphones. In its present completed form the set possesses the same capabilities.

The Circuit

Consider the actual circuit diagram shown in Fig. 1. Here we have a "semi-aperiodic" aerial coil consisting of only 25 turns of wire on a small former loosely coupled to the grid inductance of the H.F. valve. Now the grid circuit of the H.F. valve is a circuit where there is little damping and this we can appreciably reduce; so it is an advantage to use here a low-loss single-layer coil with air spaced windings and remove any further damping as far as possible by making the grid adequately negative by means of the grid battery connected as shown.

The H.F. valve must be coupled to the detector valve in such a manner that in these conditions the circuit is perfectly stable, and I have found that the method shown gives the best results. A good high-frequency choke is included in the anode circuit and what would have been an H.F. transformer is turned into another "semi-aperiodic" primary again loosely coupled to a tuned grid circuit of the detector valve. A stopping condenser C_3 is provided to prevent shorting the batteries.

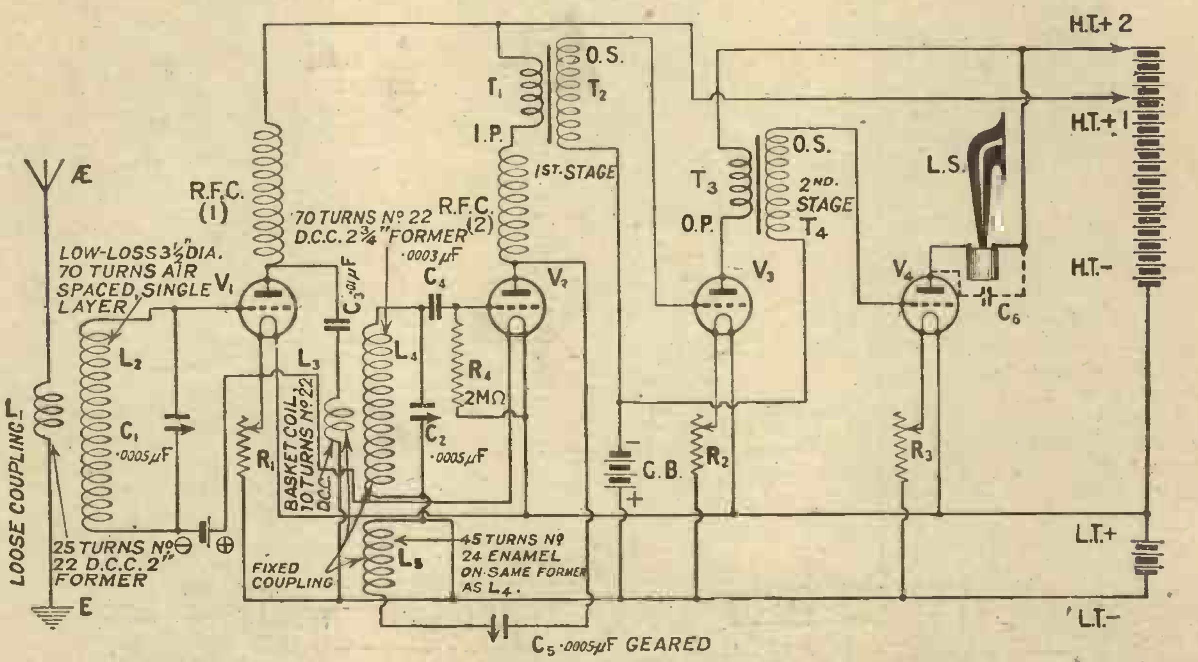


Fig. 1.—The two coils shown at L_4 and L_5 in this circuit diagram are wound upon the same former. The moving plates of the variable condensers are indicated by arrows.

The question now arises as to what form of inductance to use in the grid circuit of the detector valve. In *Wireless Weekly*, Vol. VI., No. 17, Mr. A. D. Cowper, M.Sc., has shown that the grid circuit damping of a detector valve operating on the leaky grid condenser method of rectification is of a fairly high order, equivalent in fact to an H.F. resistance of around 50 to 60 ohms.

Coil Considerations

Thus, apart from any other considerations, it does not seem worth while to go to the extent of using a low-loss coil here, and a plain single layer solenoid wound on a dry cardboard or ebonite tube is indicated. The great point is to avoid capacitative coupling between L_3 and L_4. I have tried several forms of inductance for L_3 and find that a small basket coil of few turns placed at the end of L_4 gives the best results.

Reaction

Where shall we provide reaction is the next question to be settled. We have seen that the damping in the grid circuit of the H.F. valve is fairly low, and full advantage is taken of this fact to obtain selective tuning. In the grid circuit of the detector valve the damping is fairly high, and this is a convenient place to apply reaction. This is done by a combination of magnetic

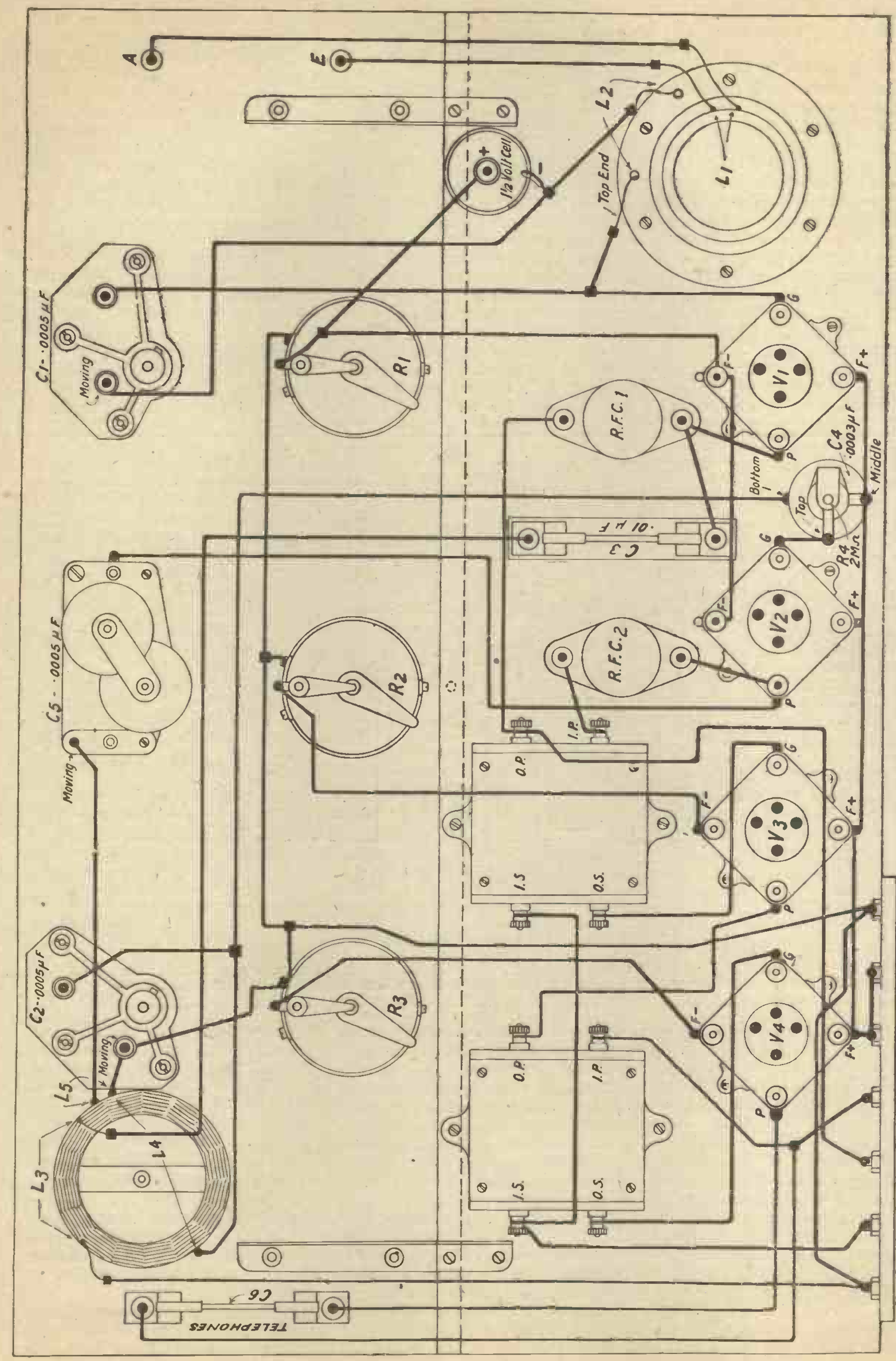


Fig. 2.—This wiring diagram may be obtained as a full-sized blue print, price 1s. 6d. post free (Blue Print No. 130b).

and capacity coupling as shown in the diagram.

Arranging the Coils

We now encounter a further difficulty, for we have two inductances to mount in the same set,

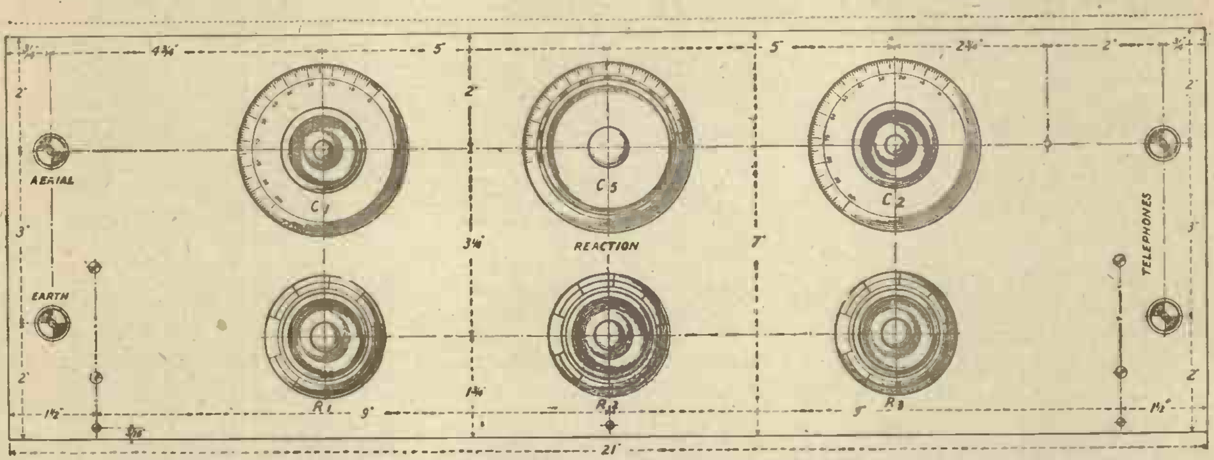


Fig. 3.—The filament rheostat R_1 controls the H.F. and detector valves. Ask for blue-print No. 130a price 1/6d. post free.

and to obtain the necessary selectivity we must obviously mount them as far apart as possible. One of these inductances is a low-loss coil with a somewhat extensive field which still further increases the difficulty. I have tried using some of the special coils for the second grid inductance which have little exterior field, but in this direction I have not met with sufficient success to justify the making of such coils. A simple single layer solenoid for the second grid inductance, placed at least 18 in. from, and at right angles to, the first grid inductance was found to give the desired effect.

So much, then, for this part of the circuit, which is the essence of the whole arrangement. The remainder consists simply of two transformer-coupled low-frequency valves. There are two H.T. tappings, one for the first two valves and one for the last two, and, further, I have cut down the number of rheostats to three, using one for controlling the first two valves. This arrangement is quite convenient in practice.

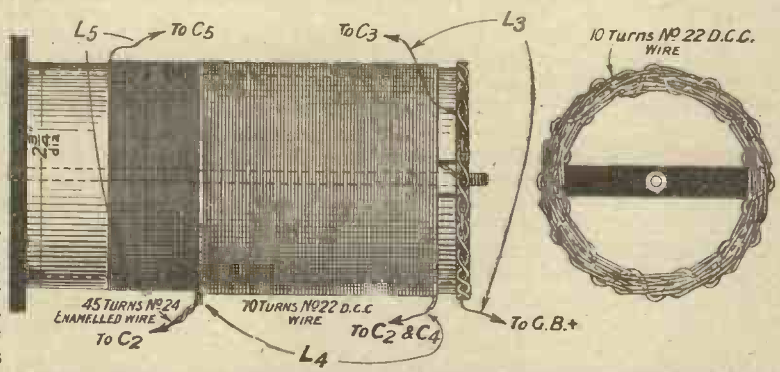


Fig. 4.—Details of the second grid inductance and the reaction coil L_5. The small basket coil L_3 is shown separately on the right.

Stability a Feature

The whole circuit is so stable that I have put 100 volts on the first H.F. valve with more than 1½ volts negative grid bias, and the control is still quite normal.

Tuning Range

Now a word as to tuning ranges. In *Wireless Weekly*, Vol. VI., No. 23, and in previous articles in the same journal, I discussed the effects of stray capacities in relation to tuning ranges and gave practical details of experiments carried out with a view to showing the order of the *maximum* range possible, using only one fixed coil and a variable condenser. The values of inductances and condensers specified here are based on these experiments, and there will be no difficulty in covering the whole of the 200 (1499 Kc.) to 600 metre (499.7 Kc.) band with sufficient working overlap. I have also erred on the side of generosity in the number of reaction turns and the size of the reaction condenser, so that, while still giving the fine control necessary, there will be no difficulty in securing oscillation of the detector valve. It is interesting to note that the method of obtaining reaction and the design of the circuit largely preclude the possibility of much radiation from the aerial due to self-oscillation.

Further, if the sizes and numbers of turns in the coils L_2 and L_4 are carefully followed, the condenser readings on the tuning dials will be substantially the same on each for any given wavelength so that it is only necessary to rotate the dials of C_1 and C_2 simultaneously from 0 to 100 degrees at the same rate for tuning purposes.

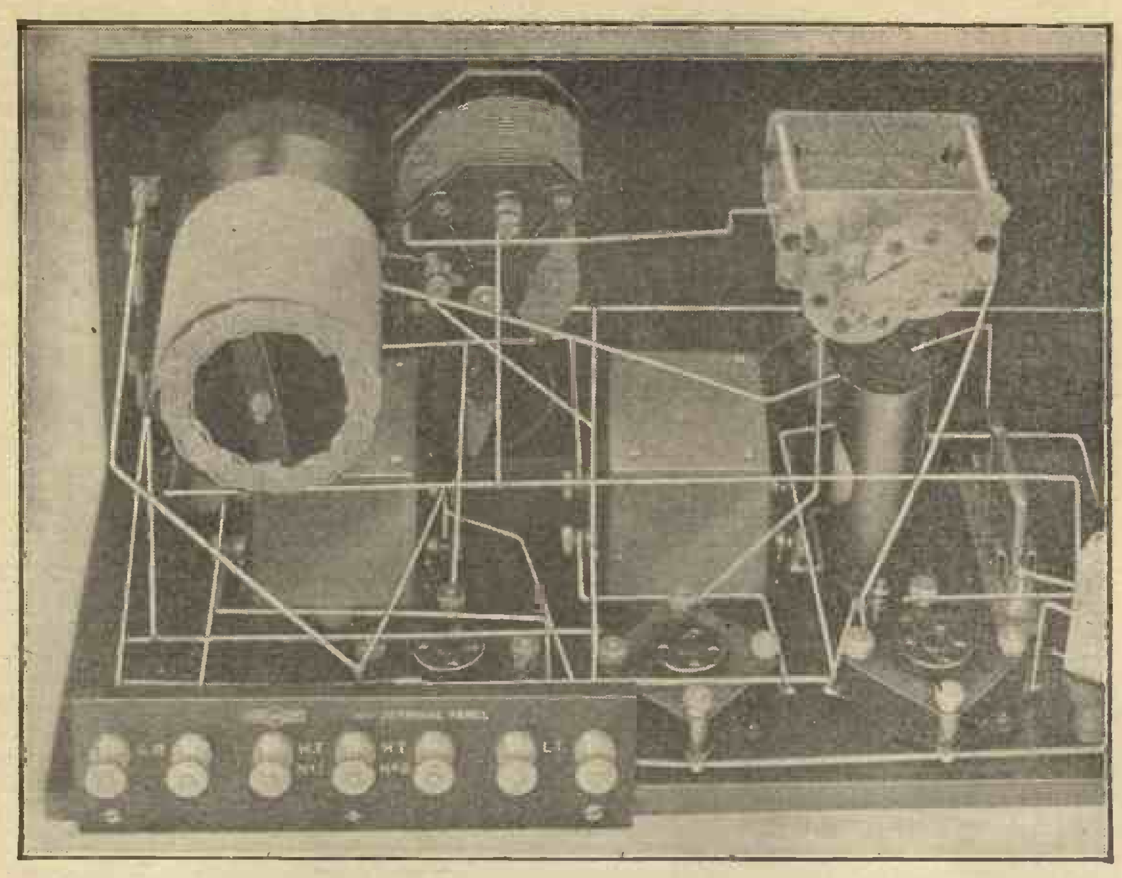
Panel Layout

As to the layout of the actual set I have followed the conventional American practice now very popular in this country, with the result that a symmetrical and pleasing panel layout is possible. The three dual type rheostats are along the bottom of the panel, and the first grid tuning condenser, reaction and second grid condenser dials along the top, reading from left to right. The aerial and the earth terminals are on the left, telephone terminals on the right; while the battery terminals are carried on a strip at the back of the baseboard.

Below a complete list of components required is given, and if you have not had much experience in set building and operation, I would strongly advise you to adhere strictly to these components. More experienced and discriminating constructosı have ample selection in the choice of compo nents

Components Required

One ebonite panel, 21 by 7 by 3/16 in. ("Radion," American Hard Rubber Co.).



The terminal strip at the back of the baseboard eliminates unsightly battery leads from the front of the set.

One Collinson low-loss former, 5 by $3\frac{1}{2}$ in. diameter.

Two ·0005 μF variable square law condensers (Collinson Precision Screw Co., Ltd.).

One ·0005 μF variable (square law) condenser, geared (G.E.C.).

Two H.F. chokes (Lissen, Ltd.).

Four "Clearer tone" valve holders (Benjamin Electric, Ltd.).

Two L.F. transformers, 1st and 2nd stage (Gambrell Bros., Ltd.).

Three dual-type filament rheostats (L. McMichael, Ltd.).

One grid condenser, and grid leak mounting (Dorwood Precision).

One grid leak 2M Ω (Dubilier Condenser Co., Ltd.)

Two clip-in condensers, ·01 μF mounted, and ·002–·006 μF with clips (for L.S.) (L. McMichael, Ltd.).

$1\frac{1}{2}$ in. ebonite tube, 2 in. diam., and 5 in. ebonite tube, $2\frac{3}{4}$ in. diam. (both as thin as possible, say, $\frac{1}{8}$ in.). Four large terminals and one No. 1 terminal strip. Small strip of ebonite, $2\frac{3}{4}$ in. by $\frac{3}{8}$ in. by $\frac{1}{4}$ in., wood screws, angle brackets; square wire for wiring; 2 oz. No. 22 d.c.c.; 1 oz. No. 24 enamel and $\frac{1}{4}$ lb. No. 20 enamel.

One suitable cabinet (Carrington Mfg. Co.).

One $1\frac{1}{2}$-volt dry cell (Ever-Ready, type UW 1).

Radio Press Panel Transfers.

Construction.

In the construction of the set no great difficulty should be experienced; the actual set took about a day or a couple of evenings to make after all the preliminary experimental work and the design had been completed.

The coils are, perhaps, best made first. When the Collinson former has been assembled, secure one end of the No. 20 enamel in the two small holes provided in one end ring and wind on 70 turns, having previously inserted the glass disc supplied with the former in the centre of same. The windings should be put on tightly, and the wire carefully straightened as the winding is proceeded with. Finally secure the other end of the wire in the second end ring.

Twenty-five turns of No. 22 D.C.C. are then put on the $1\frac{1}{2}$ inch length of 2-inch ebonite tube, the ends of the wire being simply secured through a pair of small holes at each end of the tube. This constitutes the coil L_1, and is simply placed on the glass disc inside the low-loss coil L_2, which has just been made.

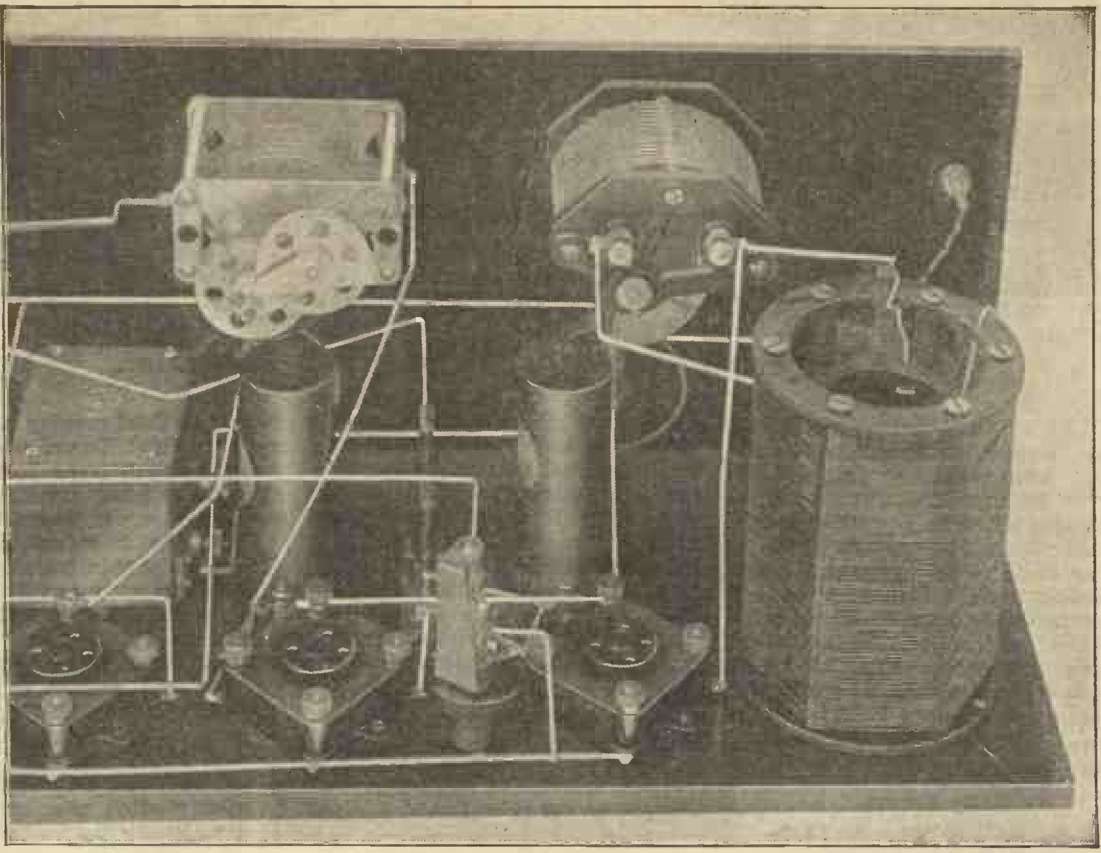
The second grid inductance, L_4, consists of 70 turns of No. 22 D.C.C. wire on the $2\frac{3}{4}$-inch tube. When this has been put on, 45 turns of the No. 24 enamel are wound continuously with this first winding, and in the same direction. This constitutes the reaction coil, L_5.

Mounting the Coils

The small basket coil L_3 has ten turns of No. 22 D.C.C., and is wound on a former 2 inches in diameter.

The L_4 winding is started about $\frac{3}{8}$ inch from one end of the $2\frac{3}{4}$-inch former, and the other end of same is bared and twisted round the bared end of the wire which forms the beginning of the reaction coil, for about $1\frac{1}{2}$ inches, and finally soldered. This constitutes the tapping point, which is connected to LT negative.

This whole coil is secured behind



The use of a geared condenser enables a delicate control of reaction to be obtained.

the panel by means of a 5¼-inch length of 4 B.A. screwed rod and a small piece of ebonite 2¾ inch by ⅜ inch by ¼ inch, with a hole drilled into the centre. This strip is let into notches at one end of the ebonite tube. The photographs should, I think, make these points clear. The small basket coil is simply secured to the end of the former by binding in two places with string to the ends of the small ebonite strip.

The larger low-loss coil is secured to the panel by means of wood screws through one of the end rings.

When these coils have been completed, the panel should be carefully drilled in accordance with the drilling diagram. This is a simple matter and mistakes can hardly be made, since the lay-out is symmetrical.

Finally secure the panel to the baseboard and mount the remainder of the components on the baseboard in the positions indicated in the photographs and in the wiring diagram.

The main point in the wiring is to space each wire from its neighbours sufficiently without making the leads too long.

After a final clean up of all the wiring and components, the transfers may be affixed to the panel where desired.

Preliminary Tests

There is ample choice in the selection of valves, and I would recommend two of the dull-emitter ·06 type for the H.F. and detector, such as the D.E. 3 or B.T.H. B 5, type, and two small power valves, such as the B.T.H. B6 type, if dull-emitters are used for V_3 and V_4, in the two L.F. stages.

As high an H.T. voltage as possible within the limits specified by the makers should be used on the first valves (H.T. + 1), such as 80 volts.

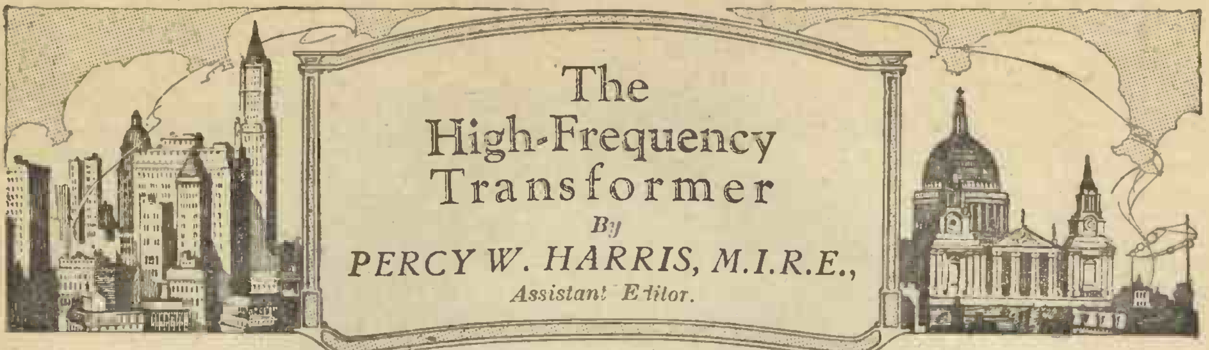
During the preliminary tests, first see that the set oscillates (you can tell this by the rushing sound and the faint "plonk" in the phones when the dial of the centre condenser is turned to the right). There should be no "backlash," *i.e.*, when the set just starts oscillating it should stop when the condenser is moved back just a degree or so and not require the dial to be rotated back very much. Suitable adjustment of the H.T. + 1 voltage and the filament current of V_2 will ensure that this is so.

Do not expect to tune in stations by swinging the dials; this is fatal, as tuning is remarkably sharp. A little practice will soon enable you to acquire this fine sense of tuning.

In conclusion, I should very much like you to write me if you try this set, as it will give a good indication of the popularity of sets of this description and be helpful in the design of future receivers.

Test Report

I shall not say much about the test report, since I have already given an indication of the capabilities of the set. I do not want to give any false impressions as to its possibilities, since conditions vary to such a large extent in various localities, but would rather that readers judge the receiver on its own merits.



The High-Frequency Transformer

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

A talk on the Design of an Important Component.

THE high - frequency transformer, as a popular instrument in amateur design, dates from the introduction of the plug-in type by Mr. Burbury, of Criggleston, near Wakefield, an enthusiastic and experienced amateur. Mr. Burbury sent a number of his own make of plug-in transformers to Mr. A. A. Campbell Swinton, who, after confirming many of Mr. Burbury's experimental results, presented a paper before the Radio Society of Great Britain in 1921.

Early Forms

Prior to this time the high-frequency transformer had not proved very popular, and probably the most efficient design existing at that time was the type used in Army apparatus during the war—an ebonite barrel with a number of slots cut in it and with the slots filled alternately with primary and secondary windings. All the primary windings and all the secondary windings were respectively in series. By adopting this form of construction a good tight electro-magnetic coupling between primary and secondary was secured without too much trouble from capacity effects.

The Plug-in Type

Mr. Burbury's high - frequency transformers were ingeniously adapted to plug-in to an ordinary valve socket, a method of fitting which has been very widely copied. In form, they were of the disc type, similar to that shown in Fig. 1, the primary of the secondary being tuned with a variable condenser. It must not be forgotten that at the time of the introduction of these transformers, short waves such as we know them to-day, were rarely used and broadcasting was but a vague possibility. Amateurs devoted most of their time to the study of longer waves, and it was very rarely that any wavelengths below 600 metres (499·7 Kc.) were considered of interest. For this reason it was possible to market a number of tapped transformers designed to work without any variable condenser across primary or secondary winding, and arranged to have tappings on wavelengths which were popular at that time.

An excellent transformer which I used with considerable satisfaction in those days, is that illustrated in Fig. 2, and made by Messrs. H. W. Sullivan. There were four tappings connected to a stud switch. The first stud covered on 600 metres (499·7 Kc.), and when so used the transformer gave excellent amplification for ship signals. On the second stud the Hague concert could be heard, the third tapping had a peak on the Eiffel Tower wavelength, and the fourth (very flatly tuned), gave quite good amplification on even the longest waves.

Fig. 1.—A disc type of plug-in H.F. transformer.

Fig. 2.—A disc type of tapped transformer.

With the introduction of Mr. Burbury's plug-in transformers experimenters soon found that here was a way of getting excellent high-frequency amplification on the amateur band, which was then a thousand metres (299·8 Kc.). When Croydon started, however, on 900 metres (333·1 Kc.), it was found that the thousand metre (299.8 Kc.) amateur telephony often gave considerable interference, particularly on Sunday afternoons. A drop was then made to 440 metres (681.4 Kc.), and here also the plug-in transformer proved very serviceable.

The Barrel Type

The next step forward was probably the introduction of the plug-in transformer of the barrel type, suggesting in its appearance a combination of the Burbury type with the older Army design. This type of transformer was brought out by Mr. Hesketh, and had as a distinctive feature the "staggering" of the slots, the slots for the primary winding being much deeper than those for the secondary winding. In this way the capacity effects between windings were still further reduced. I think I can claim to be the first to popularise this type of transformer, for it was an essential part of the first of the "Transatlantic" designs, which I described in this magazine about two years ago. This type of transformer has been very extensively reproduced by other manufacturers, but it is only right that Messrs. McMichael should be given the credit of first introducing it.

An interesting modification of this design was described in *Wireless Weekly* some time ago by Mr. Donald Straker (see fig. 6). Distinctly improved results, both in sharpness of tuning and general efficiency, were obtained with this type of transformer, for as the illustration shows, there is a minimum of solid dielectric in the field, and the windings are not in any way bunched together. This transformer is, as Mr. Straker pointed out, a modification of my X coil design, which was first described in *Wireless Weekly*.

The Honeycomb Type

Before leaving this branch of the subject it would be a serious omission if I did not mention the plug-in transformer made by the Igranic Electric Co., and illustrated in Fig. 7. This was probably the first high-frequency transformer sold in this country to have a fairly thick wire for its winding. It is wound in the honeycomb fashion, similar to this Company's coils.

Available Components

In this brief survey of the history of the high-frequency transformer I have purposely omitted reference to anything other than the components generally available to the home constructor. Many commercial sets have, of course, special transformers wound to suit the particular instruments; and, of course, the tapped transformer, another means of covering a wide wavelength with variable condenser, is still available in a number of commercial forms.

American Lessons

My visit to America proved to me conclusively that if we are to equal with British apparatus the selectivity obtainable with the

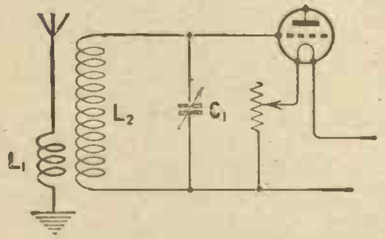


Fig. 4.—This circuit was used to test an H.F. transformer as a coupler.

American, we must at once turn our attention to the re-designing of the high-frequency side of our apparatus. The detector and note-magnifying portions of our receivers need cause us no heart-burning; for they are distinctly superior to the majority available to the American amateur. There are, indeed, very few low-frequency transformers sold in America which are comparable in quality of reproduction to the majority of those sold here, and as to valves, there is greater uniformity in the British product than in the American, quite apart from the fact that we here have a much greater variety to choose from.

A Useful Instrument

The plug-in high-frequency transformer, as it is available to-day,

Fig. 3.—The original plug-in barrel type of H.F. transformer.

has proved a most excellent and helpful instrument in the development of the art. Without it I doubt whether the average experimenter would have had any appreciable success in high-frequency amplification. But with the rapid multiplying of stations, and the fact that many of us have to do our work near a station of much higher power than that of the average American Broadcasting Station, makes it necessary to have the highest selectivity if we are to enjoy long distance reception. Before proceeding further in this article, I would like to direct attention to one or two aspects of high-frequency amplification which we must bear in mind in considering transformer design.

The Main Problem

In an efficiently-designed receiver, if both grid and anode circuits are tuned to the same frequency, and no special form of damping is introduced into one or the other, then self-oscillation will occur. If, by connecting the aerial to the grid circuit (or the anode circuit, for that matter), we bring into action the damping of the aerial, then this will serve to check oscillation and in many cases to stop self-oscillation entirely. A second way to check self-oscillation is by losses set up by grid current. The best known method of effecting this is to connect a potentiometer into the grid circuit so that a varying degree of positive bias may be placed on the grid. Another method is to introduce resistance in the plate circuit or the grid circuit (often unconsciously done by the home builder in winding coils of very fine wire, or by placing them in such a position that eddy currents set up in adjacent metal work give the equivalent of resistance in circuit). All these methods are what may be termed "loss" methods, and every one of them has the effect of considerably reducing the selectivity of the set; while the sensitivity of the set suffers far more than most home constructors, and even commercial builders, imagine. It is, of course, useless to utilise low-loss coils in these circuits when we are deliberately introducing losses in other directions.

Inefficiency

Some high-frequency transformers, wound with fine wire in multi-layer formation, are very inefficient. I carried out an interesting test the other day with a commercial type of plug-in transformer, using it as a "coupler" (aerial and grid coils). The circuit used is shown in Fig. 4. Compared with a good quality plug-in coil (commercial make), the signal

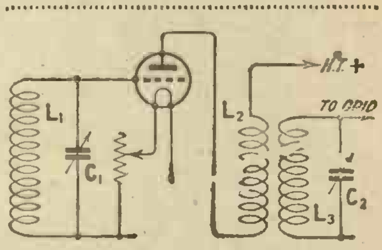


Fig 5.—The coupling between L 2 and L 3 is usually too tight.

strength obtainable was only about one-third, which shows how far we can go in improving our high-frequency transformers, both in sensitivity as well as selectivity.

I have come to the conclusion that efficient high-frequency transformers can be developed with the secondary wound as a single layer, the wire for this winding being of fairly heavy gauge compared with that now used. In short, we short make low-loss high-frequency transformers. A further important point is the coupling between the primary and secondary. The tighter the coupling within limits, the greater the tendency for feed-back between circuits. The coupling can, as a matter of fact, be loosened to such a degree that practically all tendency to feed-back disappears. When this point has been reached, however, there is considerable loss in signal strength. By tightening the coupling and getting better signal strength, we increase the tendency

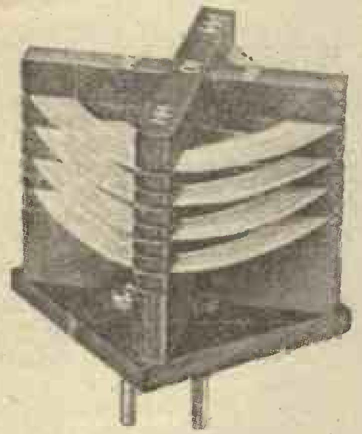


Fig. 6.—A modification suggested by Mr. D. Straker.

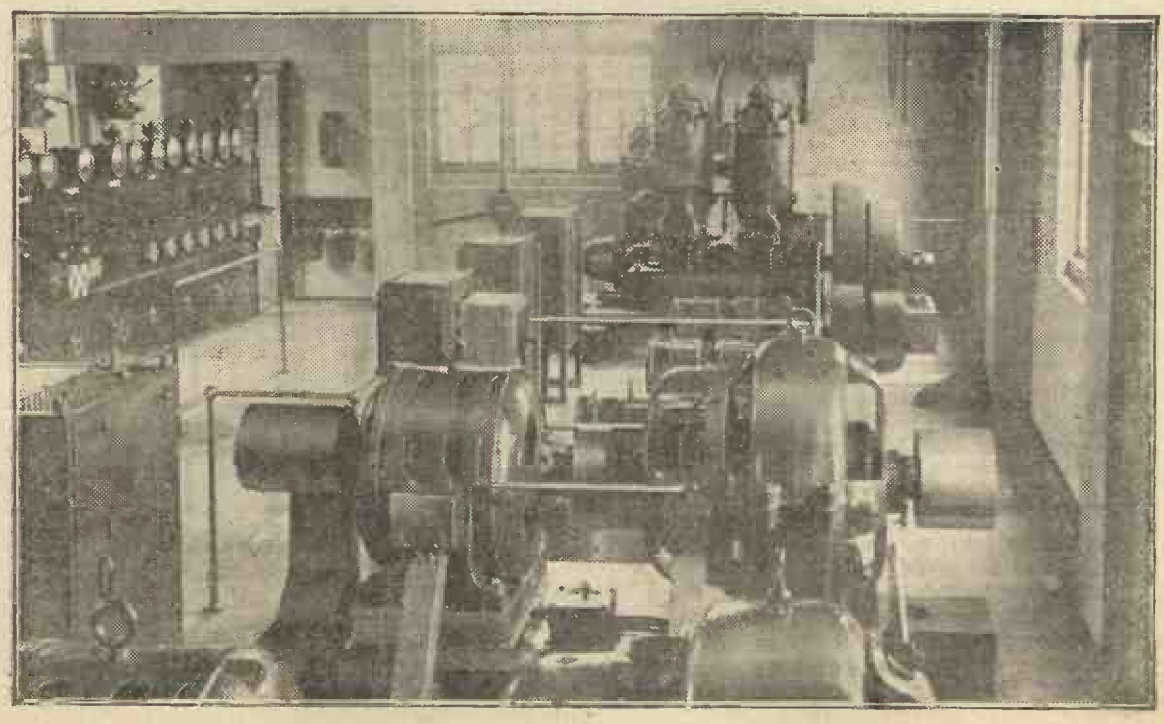
to self-oscillation; but this again can be checked by one of the several neutralising methods now available. Many neutrodyne sets neutralise on the Hazeltine principle, which is so well-known in the United States; but most of them have the disadvantage that the neutralisation has to be carried out very accurately to suit the particular valve supplied.

In working out neutralising arrangements, do not forget that the less capacity shunted across the transformer windings, the greater the tendency to self oscillation. For this reason a set with the ordinary form of Hazeltine neutrodyning is generally less sensitive on the upper part of the tuning scale than on the lower.

A Suggestion

In my opinion the best method is one which enables the user to change valves if necessary without upsetting the whole design, and the neutralising portion should be made adjustable for this purpose. Another very important point in high-frequency transformer design is the question of capacity coupling between primary and secondary. Great improvements will be found by making the primary winding geometrically small compared with that of the secondary. The capacity coupling between primary and secondary windings in high-frequency transformers in this country is one of their chief disadvantages, and I am at present carrying out experiments with a new type of transformer which will be even simpler to manufacture than the present kind, and in which the chief difficulties are overcome. Meanwhile this article is intended to be suggestive to experimenters by pointing out the way in which developments are likely to take place.

Fig. 7.—The honeycomb type.



The switchboard and some of the generators at the well-known Post Office station at Northolt.

AN ACCEPTOR WAVE-TRAP

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

ONE hears a good deal of discussion at the present time of the "selectivity problem," but it does not seem to be generally realised that from the practical point of view it is convenient to regard this problem as being divided into two parts.

Two Classes

First, there is the question of what is sometimes described as "general selectivity." By this phrase is meant the power to separate distant stations from one another, and further, the power to receive any given distant station with a relatively small amount of spark and other miscellaneous interference. Secondly, there is "special selectivity," by which is meant the power to shut out a single powerful local interfering station, in order to receive more distant stations transmitting on near-by frequencies.

"Special Selectivity"

At first sight this would appear to be a "distinction without a difference," but as a matter of fact it is very convenient to regard the problem as being divided in this way. To achieve the degree of "general selectivity" needed to separate fairly distant stations whose frequency difference is more than the usually accepted minimum value of 10 kilocycles is not a very difficult matter, and it is fairly easy to design a set which will do this, but to achieve the amount of "special selectivity" which will suffice to shut out a powerful local transmitter such as a broadcasting station, to so effective an extent as will permit of the reception of quite distant stations on near-by frequencies, is a problem of a very different order of difficulty.

The Wave-Trap Method

It is, therefore, natural that there should be a considerable attractiveness about the wave-trap method of obtaining "special selectivity," although perhaps it is not quite correct to describe this as a method of obtaining selectivity at all, since it is really purely a matter of shutting out one particular station. Most experimenters no doubt have tried the various types of wave-traps, as they have been described in the past, and with varying success, since there can be no doubt that the behaviour of any one of the majority of such traps varies considerably on different aerials and earths. The particular type of tuner incorporated in the receiving set with which the trap is used also appears to have some influence.

An Effective Type

The type of trap which is to be described in this article appears to be one of a degree of effectiveness and reliability very much above that of most of the well-known ones, and I would strongly commend it to the notice of all those who desire to achieve what has been called "special selectivity."

A spring clip is provided for the purpose of varying the number of turns.

Now, one of the most effective of the simple circuits for obtaining a good degree of "general selectivity" is that in which what is known as the "aperiodic aerial" arrangement exists. The aerial circuit in this scheme consists merely of the aerial, a coil of some suitable number of turns, and the earth, no means of actually varying the tuning being provided. More or less closely coupled to this primary circuit is a sharply tuned secondary circuit, in which a fairly good degree of selectivity is usually obtainable.

Simplicity

A special type of wave-trap has been developed by Mr. A. D. Cowper for

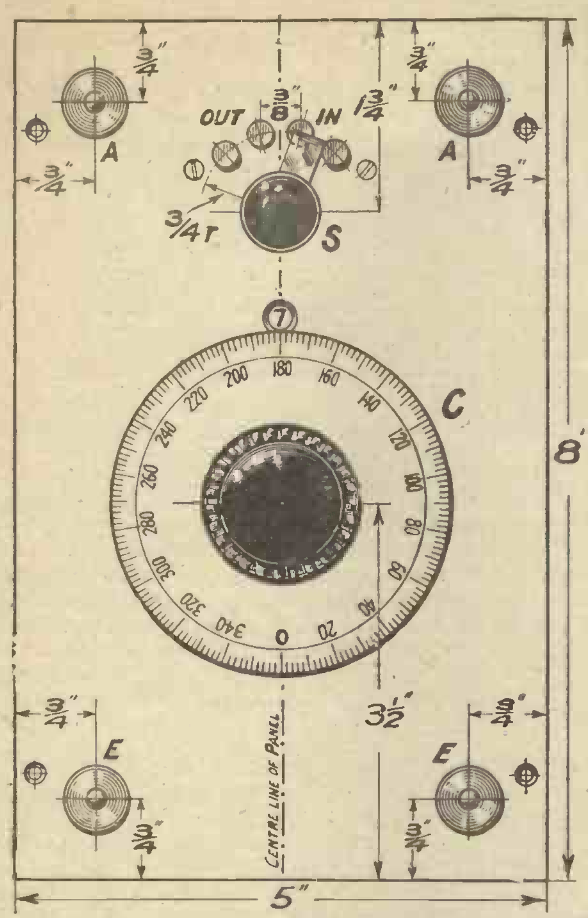


Fig. 1.—The wave-trap may be cut in and out of circuit by means of the switch S.

use in conjunction with all such circuits, including under this heading the aperiodic aerial type, the auto-coupled circuit, and the Reinartz arrangement. This trap I have found extremely effective and dependable with a great variety of arrangements, in addition to which advantages it possesses the very great one of notable simplicity of construction and operation. The trap arrangement consists simply in placing in parallel with the primary winding to which reference has been made a coil and condenser in series with each other, constituting what is known as an "acceptor" circuit.

Theoretical Considerations

When this acceptor circuit is tuned to resonance with the frequency of the in-coming oscillations, these undesired oscillations will pass through the acceptor without producing any difference of potential across its ends, so that, *in theory*, no current can pass through the primary winding of the tuning arrangement, and nothing can be transferred to the secondary. I have emphasised the words "in theory," because to achieve such a desirable end the acceptor circuit must possess zero resistance, and this, of course, is not obtainable in practice. However, by using a good condenser and low-loss coil, the resistance can be kept low, and a good degree of interference elimination achieved. It is, of course, to be understood that this trap can be set to eliminate only one station at a time, and, therefore, it can only give selectivity of the "special" type.

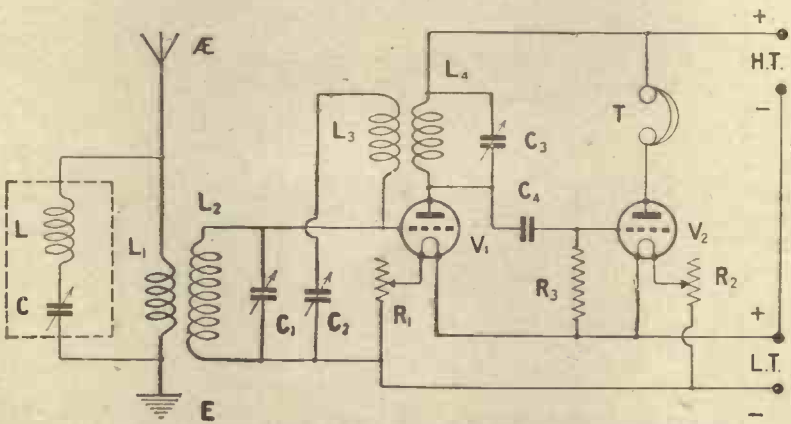


Fig. 3.—Showing theoretically how the instrument would be connected to a simple neutrodyne circuit.

Components

To construct the instrument the reader will need the following components or their equivalents of similar good make :—

1 Ebonite Panel, 5in. by 8in. by ¼in.

1 Cabinet to take the above panel, arranged vertically, with a space of 8in. available inside from back to front. (Burne-Jones & Co., Ltd.)

1 Two-way Switch (Bowyer-Lowe Co., Ltd.)

4 Brass terminals.

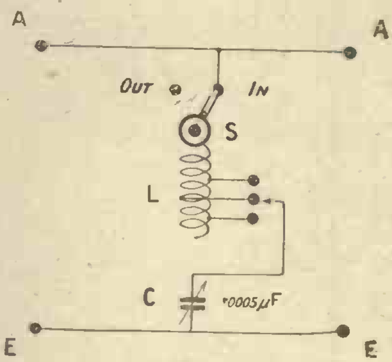


Fig. 2.—With the switch arm to the right the trap is in circuit.

1 Standard Collinson low-loss former, 7in. long.

1 .0005 μF Variable Condenser (Collinson's geared type). If a geared condenser is not used here, one of the vernier plate type, or alternatively one provided with some other form of fine adjustment is recommended.

1 Piece of ebonite, 2in. by 7in. by ¼in.

2 Brass brackets.

¼-lb. No. 20 enamelled wire.

1 Burndept spring clip.

Radio Press panel transfers.

The Coil

The coil is wound with a total of ninety-five turns, and provision is made for varying the number of turns in circuit, by the following arrangement. At turns 70, 75, 80, 85, and 90, a point upon the wire is bared and to this is soldered a short piece of tinned copper wire with the end left projecting about half-an-inch. To any one of these ends the tapping clip mentioned in the list of components can be attached.

and this clip is carried on the end of a piece of flexible wire, whose other extremity is soldered to the moving plate terminal of the variable condenser. After the coil has been wound, it is mounted upon the 7in. by 2in. strip of ebonite, which is in turn attached to the upper part of the panel by means of the two brass brackets, in the manner illustrated in one of the diagrams.

Operation

The wiring-up of the trap will be found a very simple matter, and

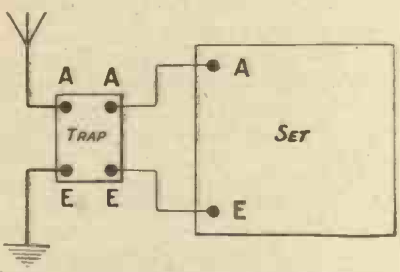


Fig. 4.—The method of connecting the wave-trap.

the usual tinned square wire and carefully-made soldered joints are, of course, essential.

To connect the trap up to the set, the procedure is as follows: Place it upon the side of the set whereon the aerial and earth terminals are located, remove the aerial and earth leads from the set, and connect them instead to the A and E terminals upon one side of the wave-trap. Take two leads from the A and E terminals on the other side of the wave-trap to the aerial and earth terminals of the set respectively, and the instrument is ready for use.

To use the trap, first turn the switch to the "on" position, place the tapping clip upon the first tapping point and slowly turn the trap condenser, first adjusting the tuning of the receiver to some point at which the interference from the local station is heard fairly strongly. You will probably presently find a point upon the dial of the wave-trap condenser at which the signals of the local station die down almost to nothing, and upon either side of which they reappear quite sharply. Then proceed to try all the tapping points until you find the one at which the extinction point seems to be sharpest and most definite. This will probably give you the best results in practice, but it is as well to carry out the test very carefully again when some distant station has been tuned in, which is normally badly interfered with by the local station, noticing upon which tapping point the best results seem to be obtained. It is, of course, understood that any alteration of the tapping point and consequently of adjustment of the trap condenser may slightly upset the calibration of the receiver itself. In general, the best results will be obtained by using as large a number of turns as possible in the trap coil, with a fairly small setting of the trap condenser.

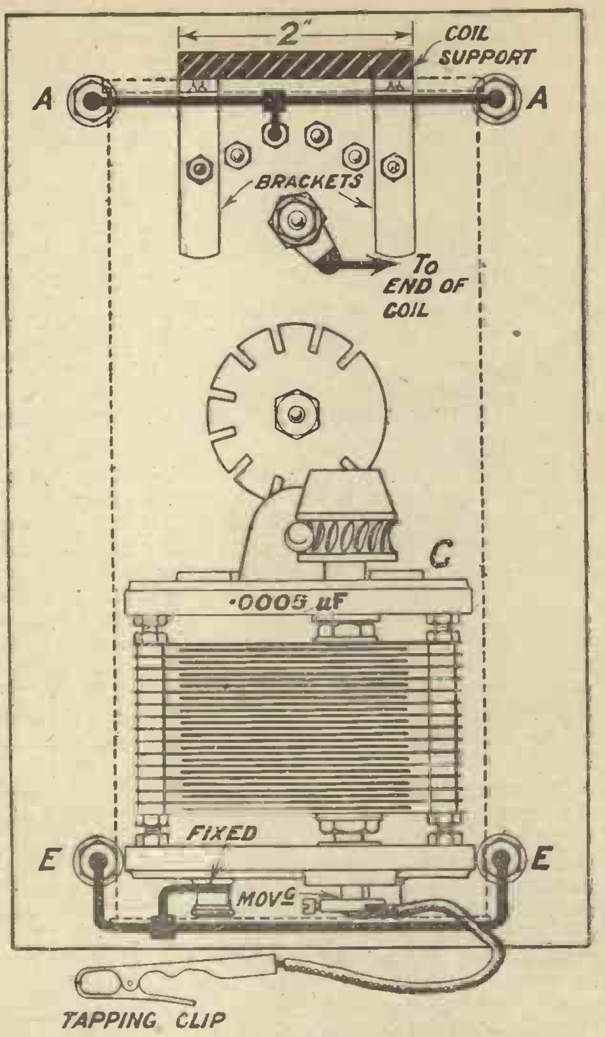


Fig. 5.—A geared condenser is used to facilitate fine adjustments.

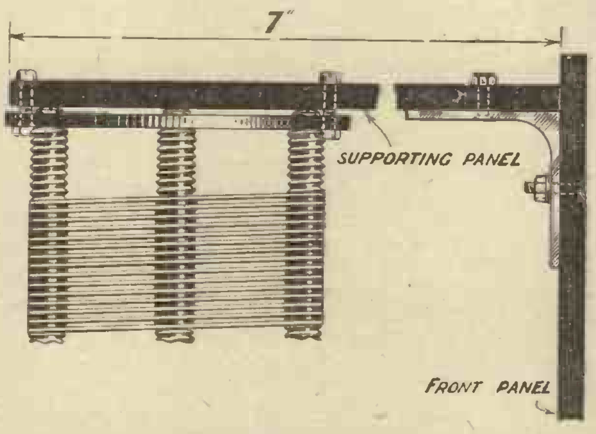


Fig. 6.—The coil is supported by a 7 in. by 2 in. ebonite strip.

Results

As regards the actual results which can be obtained with a trap of this type, it is, of course, impossible to speak very definitely, since they will depend to some extent on the locality and the efficiency of the aerial with which the instrument is used, and, of course, upon the actual degree of selectivity possessed by the receiving set. With a set of quite indifferent general selectivity, at a distance of only seven miles from the new 2LO station, I find it quite an easy matter to obtain good signals from Bournemouth without any interference from London, and also, I think, without any loss of signal strength. With a set of fairly high general selectivity it is possible to obtain clear and undisturbed signals from Manchester, without very much difficulty in operation.

The Valve as a Rectifier

by JOHN SCOTT-TAGGART, F.Inst.P., A.M.I.E.E.

There are innumerable valve users who have only the most remote ideas as to how a valve acts as a detector. It can act in two or three different ways, and each is explained in this article.

In almost every valve set a valve detector is used, and even when a crystal is used as a detector instead of a valve, one or other of the valves of a receiver is often acting unintentionally as a rectifier. This rectification is the cause of much distortion and unless it is eliminated it is not possible to get pure reception, hence the great importance of the whole problem of rectification in a wireless receiver.

Little Progress Made

I have previously expressed my views regarding the inefficiency of the valve as a detector. It has hardly progressed for the last 20 years since Fleming first used a two-electrode valve containing a filament and a plate as a means of obtaining rectification.

Not only has the problem of rectification never been seriously tackled by investigators, who have been far more concerned with amplifying methods, but there have been practically no published facts regarding any efforts in this direction.

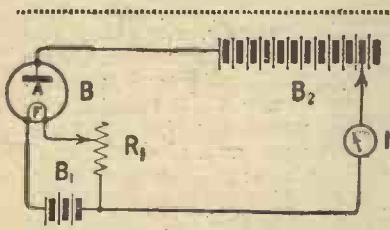


Fig. 2. Increasing the value of B_2 increases the current through the galvanometer I.

The Grid Condenser Method

To-day we use the grid condenser method of rectification which, as a matter of fact, was invented by Dr. Lee de Forest in 1907. He used a grid condenser, and it is said that he obtained the leak effect by making the condenser leaky by moistening across its terminals with the aid of his finger. Whether this story is true or not I cannot say. The chance of the "leak" drying up seems very great! Whether de Forest really understood what he was doing is very doubtful, but it is interesting to recall that the grid condenser made its appearance in the first three-electrode valve patent in this country. At any rate, the honours of the grid condenser and leak go to America in any case, because there is a patent dating back to October 29th, 1913, by Alexanderson of the Radio Corporation of America which not only specifies the grid condenser and leak but also gives an explanation of its operation.

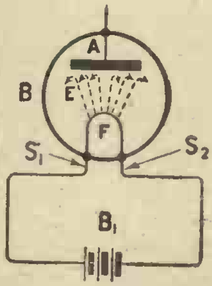


Fig. 1. An explanatory diagram of a two-electrode valve.

A Neglected Subject

During the last year I have probably interviewed at least 500 applicants personally for staff appointments in the Radio Press, and of these only an extremely small fraction could explain how a valve acts as a detector; "I know how it does, but I cannot explain it," is the usual reply. As a matter of fact, the question is the first one which is put to an applicant for a post in my organisation, so that those who have any ambitions in that direction may care to study this brief résumé of the subject!

The fact of the matter is, that detectors are taken for granted, always have been, but will not be in the future, if our new Elstree laboratories have anything to say in the matter. The rectifier valve is the weakest link in the reception chain. We can amplify high-frequency currents relatively easily and we can amplify low-frequency currents to any extent we desire, but we can use normally only one detector and a bad detector will spoil the whole reception.

The Fleming Valve

The incandescent filament valve using two electrodes is generally recognised as being the first commercial valve detector.

The Fleming valve was used by the Marconi Company and at the beginning of the war numerous sets used this method of rectification.

Although it might appear that a discussion of the ordinary two-electrode valve as a detector is dealing with an obsolete subject, yet on the contrary it is vital to enable us to understand the action of the common form of detection used to-day. The whole question of rectification may be dealt with assuming certain broad facts which are quite sufficient for the purpose of a simple, easy and fairly accurate explanation of the valve acting as a detector. I propose to adopt this plan in the present article and

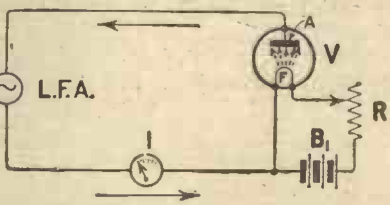


Fig. 3. When alternating potentials are applied across A and F the resultant current through I is in the direction of the arrows.

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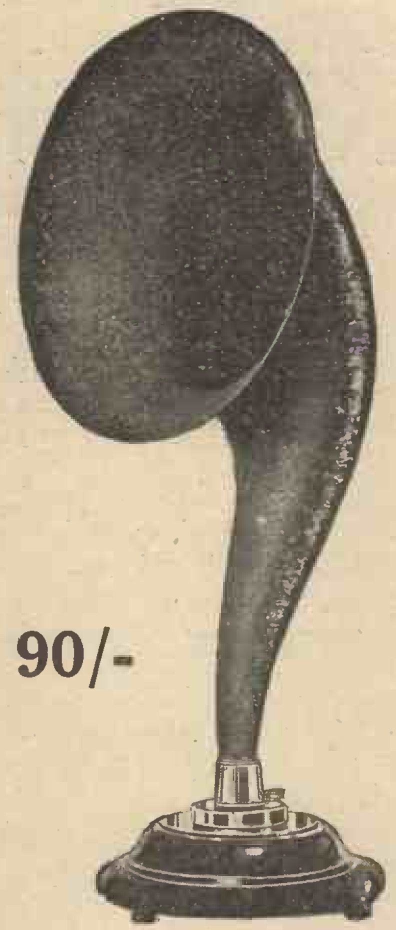

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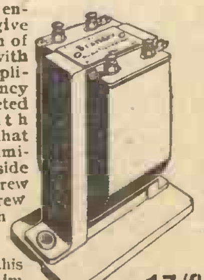

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to follow it at some future time by a more detailed examination of what I might call the special refinement. An extremely full explanation of valve rectification from several angles, both in two-electrode valves and three-electrode valves, is given in my book: "Thermionic Tubes in Radio Telegraphy and Telephony." Although this book gives a very detailed account, yet I propose to draw on a method of explaining which is given in my "Elementary Text-Book on Wireless Vacuum Tubes," a work of a much simpler character.

A Two-Electrode Valve as a Detector

Fig. 1 shows diagrammatically a filament F and an anode A which constitute the simple two-electrode valve. Within the bulb are two leading-in wires S_1 and S_2 between which is stretched the tungsten filament F. Near to F is a plate A, from which is taken a wire which passes through the bulb B. The filament is shown heated by an accumulator B_1. If the plate A were left disconnected, the electrons E from the filament would simply float around near to the filament and then return to their source. If, however, we connect (as in Fig. 2) a battery B_2 and a galvanometer or other measuring instrument I across the plate A and filament F, electrons from the filament F will pass across the space to the plate A and so round the external circuit which is usually termed the plate or anode circuit. In the figure the resistance R_1 is connected in series with the filament to enable the current through it to be varied; by this means we can vary the temperature of the filament and, therefore, the number of electrons emitted from it per second. The plate A is given a positive potential by means of the battery B_2, and it is this positive potential which attracts the negative electrons given off by F. The plate A is called an electrode, and since it is given a positive potential it is called an anode; the term anode is preferable and is becoming more common than the word plate, which really means a disc, whereas anode is applicable to cylinders. The external circuit is usually called the anode circuit. The filament F is sometimes called the cathode, since it is negative with respect to the anode.

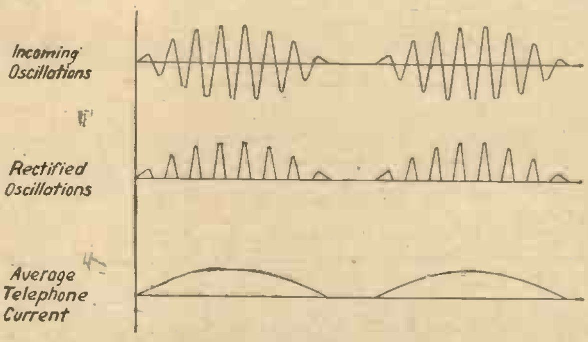

Fig. 5.—Illustrating how the incoming oscillations produce audible signals.

A Comparison

The flow of current through a vacuum tube and round the anode circuit has been compared to the dripping of water into a reservoir, which has an outlet pipe. The drops represent the current passing through the tube in the form of electrons which travel right across the space in the tube. The outlet pipe and reservoir represents the external anode circuit.

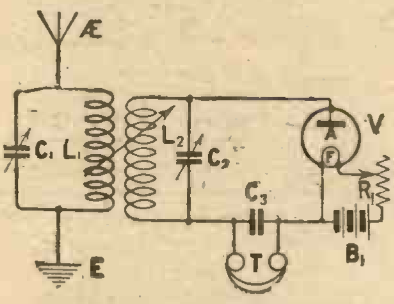

Fig. 4.—A simple coupled receiving circuit.

A Simple Explanation

If we vary the voltage of B_2 we will vary the potential of the anode with respect of the filament F. An increase of positive potential on the anode A will cause an increase in the number of electrons passing to A and so increase the current through the galvanometer I. If, however, we were to reverse the battery B_2 so that the anode A were given a negative potential with respect to the filament, we would obtain no current in the anode circuit at all. This is because there will be no anode current unless electrons pass from the filament F to the anode A, and this will only happen when the anode A is positive. When A is negative, the negative electrons emitted from F are repelled according to the well-known law which declares that electrical charges of similar character repel each other, whereas they attract each other if of opposite sign. Since there is no anode current whatever when the anode is made negative, we call the arrangement a valve. The valve only allows electricity to pass from the filament to the anode. No electron current can pass from the anode to the filament, since the anode is cold and does not emit electrons. The two-electrode valve is a device which is said to have unilateral conductivity since it conducts only in one direction.

The Effect of Alternating Potentials

Fig. 3 shows a circuit which demonstrates very clearly the valve action of a two-electrode vacuum tube. Across the plate A and filament F of the tube is connected a source L.F.A. of alternating current and a measuring instrument such as a galvanometer I. The source L.F.A. may be an alternator. Whatever the nature of the source may be, it will make the anode A alternately positive and negative with respect to the filament F. When the anode A becomes positive, electrons pass from F to A round through L.F.A. and I back to the filament. When the next half-alternation is supplied by L.F.A, the anode A is made negative and no current whatever flows through the valve. We thus see that positive half-cycles will produce a current through the valve but negative half-cycles will produce no current. The current through I will consequently take the form of a series of impulses of direct current always flowing in the direction of the arrow head; thus, whereas we started with alternating current we have now obtained a direct, although fluctuating, current by means of the valve.

A Practical Case

Looking at Fig. 3, we may imagine the source of alternating current L.F.A to be the receiving circuit of a wireless station. The incoming currents will be of an alternating nature, but instead of being of low-frequency they will usually be of a frequency of the order of a million. Nevertheless, the action of the Fig. 3 circuit remains exactly the same whatever the frequency of the alternating currents applied across the anode and filament. The current passing through the galvanometer I will always be a direct one. Since the galvanometer will not respond to each impulse, it registers the average current.

Actual Reception

Fig. 4 illustrates a wireless receiving circuit in which we use the circuit of Fig 3 with incoming signals acting in place of L.F.A., and a pair of telephone receivers taking the place of I. The usual form of coupled circuit is shown. The aerial contains an inductance L_1 shunted by a variable condenser C_1. To the coil L_1 is coupled the inductance L_2 which is shunted by a condenser C_2.

The Circuit

The closed receiving circuit L_2 C_2 is connected across the anode A and filament F of the two-electrode valve, the filament of which is heated by current from the accumulator B_1, which has in series with it a variable resistance. Between the negative side of the accumulator B_1 and the lower end of the inductance L_2 is connected a pair of telephones T of high resistance (usually about 4,000). Shunted across these telephones is a fixed condenser C_3.

The Telephone Condenser

The action of this circuit is briefly as follows: When spark signals are being received, the oscillations in the circuit L_2 C_2 take the form shown in the top line of Fig. 5. Each spark produces a group of waves which increase in amplitude up to a certain point and then die down again. The oscillations are called damped oscillations, and it will be seen that these currents apply alternating potentials to the anode A of the two-electrode vacuum tube or valve. The half-alternations (or half-cycles) above the line, make the anode A positive with respect to the filament; consequently, a flow of current takes place round the anode circuit at each positive half-cycle. The negative half-cycles (those beneath the line) make the anode A negative with respect to the filament; as a result, the anode repels electrons and no current flows round the anode circuit. The action of the condenser C_3 must now be explained. If the telephones were disconnected entirely, the high-frequency potentials supplied by the oscillatory circuit L_2 C_2 would still be communicated to the anode and filament of the valve, since condensers, while acting as insulators to direct current, will allow alternating currents,

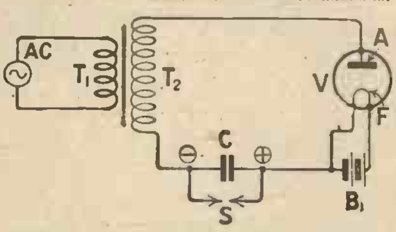

Fig. 6.—The condenser C will build up and ultimately discharge across the spark gap S.

particularly if they are of high-frequency, to pass through them. For each positive half-cycle on the anode there will be a flow of electrons to the anode round the anode circuit, through L_2 and on to the left-hand plate of the condenser C_3, but the second positive half-cycle may again make the anode positive and cause a further flow of electrons round the anode circuit and into the condenser C_3. We will thus see that during each wave-train or group of oscillations the condenser C_3 will gradually get charged up to a high voltage owing to an accumulation of electrons on the left-hand plate. Since, however, the telephones T are connected across the condenser C_3, the store of electricity in C_3 flows round through the telephones thus discharging the condenser C_3 and giving a signal in the telephones.

A Reservoir Action

Since the telephones, connected across the condenser C_3 are of high resistance, it is not likely that much current passes through them except when the wave-train is finished. While the condenser C_3 is being charged up, it is, however, also being discharged to a certain extent by the telephones T. The action of the condenser C_3 is, therefore, somewhat similar to that of a reservoir which is being filled up by a stream and which has water taken from it through the main outlet pipes. Even if we eliminate the condenser C_3, the telephones will be shunted by the self-capacity of the windings and leads.

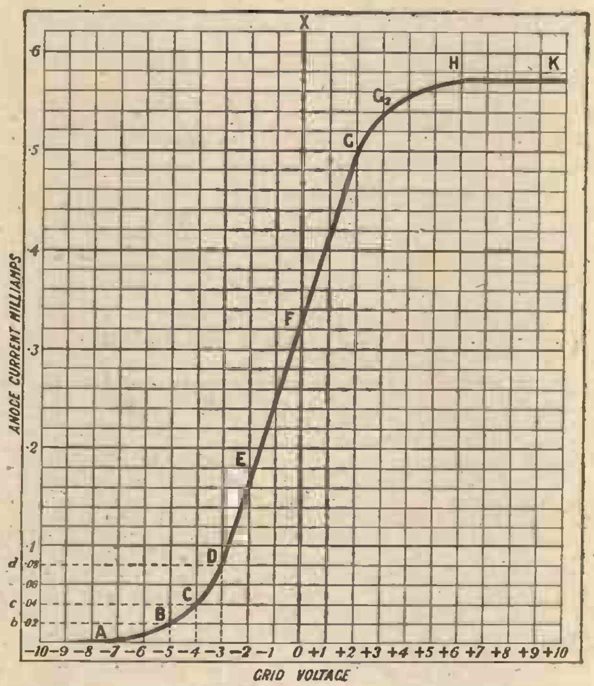

Fig. 7.—Showing how the increase C to D in anode current, due to a positive half-cycle, is greater than the decrease C to B due to a negative half-cycle.

Diagrammatical Representation of Rectification

Fig. 5 illustrates very clearly how the circuit of Fig 4 operates. The top line shows two groups of incoming waves which produce similar oscillations in the aerial and the closed receiving circuits. The second line shows how the negative half-cycles are ineffective since only the positive half-cycles produce high-frequency impulses of direct current which charge the condenser C_3. The bottom line of Fig. 5 shows the impulses of fairly steady direct current which pass through the telephones T. The impulses of direct current shown here are really the average effect of the high-frequency direct impulses of the second line.

If we removed the telephones out of the Fig. 4 circuit the condenser C_3 would continue being charged up so that the left-hand side became negative and the right-hand side relatively positive. When the voltage across C_3 equals the amplitude of the signals in the circuit L_2 C_2 the condenser C_3 will no longer charge up but will remain in its charged condition. Under these circumstances

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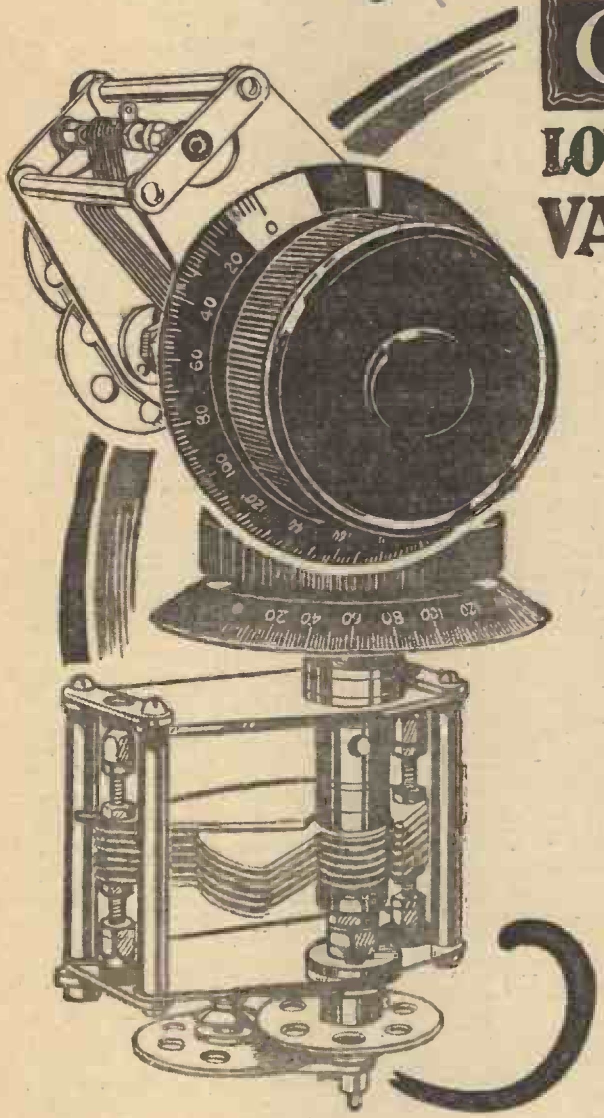

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the bulb B would no longer take part in any rectifying action. This, of course, assumes that the condenser C_3 and the rest of the apparatus is so highly insulated that a leakage of the charge in C_3 is impossible.

Experimental Illustration

An interesting experiment which has been proposed to show the charging-up action of a condenser in a two-electrode valve circuit is illustrated in Fig. 6. We have here the primary T_1 of a transformer T_1 T_2 connected to a source of alternating current A C. The secondary T_2 is connected on the one hand to the anode of the two-electrode valve V and on the other side to one plate of the condenser C. The right-hand plate of C is connected to the negative side of the filament accumulator B_1. Across the condenser C is connected a spark gap S, which may be adjusted to such a separation that a spark will take place when the voltage across the terminals reaches, say, 50 volts. The voltage across the secondary T_2 may be, say, 100 volts, while the condenser C may have a capacity of 2 or 3 microfarads. If this arrangement is connected up, the following action takes place. The currents in T_2 will be alternating, which means that the anode will alternately become positive and negative with respect to the filament F. When the anode A is positive electrons will be attracted from the filament to the anode A round through T_2 and charge up the left-hand side of the condenser C. The electrons cannot pass through the condenser C, but remain on the left-hand plate. The negative half-cycle now makes the anode A negative, and no current passes through the valve V. The charge of the condenser C is consequently not varied. It might be asked at this stage why the condenser C passes the alternating current at all, but the beginner must remember that alternating potentials are readily communicated through a condenser, especially if the condenser is large. The flow of the electrons amounts to direct current and consequently stops on the left-hand side of the condenser C. Advanced readers will appreciate that to make the explanation of valve rectification simple, it is necessary to talk in very broad terms, and I propose doing this in the present article.

Sparking Point

The second positive half-cycle draws up more electrons from the filament which go to charge the left-hand plate of C still more negatively. This process goes on until the potential difference across the condenser C is 50 volts when a spark immediately occurs at the spark gap.

The Point at which Rectification Stops

If there were no spark at all, the condenser C would charge up to the full voltage of T_2, *i.e.*, 100 volts. Afterwards the valve would no longer be carrying out any useful function as a rectifier because the voltage across T_2 which tends to make the anode A + 100 volts is counteracted by the voltage across C which is trying to make the anode A − 100 volts. These two voltages therefore oppose each other and, in fact, the voltage across the condenser C is all the time opposing T_2 and gradually becomes equal to the voltage applied by T_2.

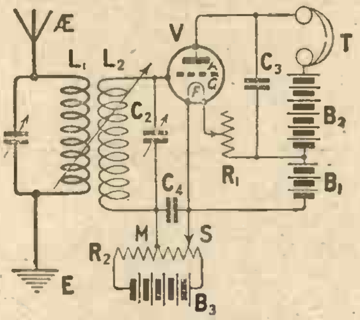


Fig. 8.—By means of the potentiometer R_2, the operating point may be suitably adjusted for maximum results.

H.F. Currents most Important

In actual practice, of course, we are not particularly anxious, in the ordinary wireless receiving circuit, to rectify low-frequency alternating currents, but we are interested in rectifying high-frequency currents because they cannot directly operate telephone receivers or similar instruments.

I now propose to discuss the question of the three-electrode valve as a detector and use the explanations I have already given in connection with the two-electrode valve.

The Three-Electrode Valve as a Detector

There are three essential methods whereby a three-electrode valve may be used as a detector. These are :—

1. By working the valve at a bend in its characteristic curve.
2. By taking advantage of grid currents in the valve.
3. By the use of the grid condenser and leak method which is a development of the second method.

I will deal with these three methods in turn.

Anode Current Rectification

This is the name given to the method of rectification which depends upon a non-symmetrical change in the anode current for equal changes of grid voltage. When receiving wireless signals we can assume that negative and positive half-cycles of oscillating current are of equal amplitude. These, if applied to a valve which is acting simply as a perfect amplifier would result in a similar high-frequency output current which, however, would be of greater amplitude. It is not generally realised that the grid condenser method of rectification depends upon the valve acting as a perfect amplifier, *i.e.*, a non-distorting amplifier in which positive and negative half-cycles of equal strength are equally amplified. When using anode current rectification, however, we assume that the input positive and negative half-cycles are of similar values, and that rectification is obtained by an alteration in their effect on the anode current passing through the telephones. If, for example, we arrange that + 1 volt

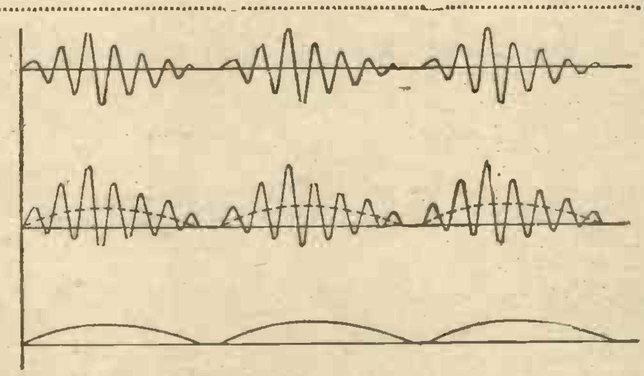


Fig. 9.—A graphical representation of one method of three-electrode valve rectification, i.e., anode current rectification.

produces a bigger anode current change than – 1 volt, then by applying our oscillating current to the grid of a three-electrode valve we can produce a low-frequency variation of current through our telephones. We talk about valves acting as rectifiers on the incoming oscillations. To be exact, however, a three-electrode valve as a whole never does actually act as a rectifier of the original currents, as is the case with a crystal detector. In the latter case the crystal itself actually rectifies the high-frequency alternating currents and the resulting direct currents are used to work the telephones, or other apparatus. In the case of a valve operating on the anode current rectification principle, the anode circuit is quite distinct from the grid circuit and the oscillations in the grid circuit may not be altered in any way whatsoever when using this method. The grid is really acting as a means of controlling the anode current, the grid circuit and the anode circuit being absolutely distinct. The best explanation is obtainable by looking at the characteristic curve of a three-electrode valve.

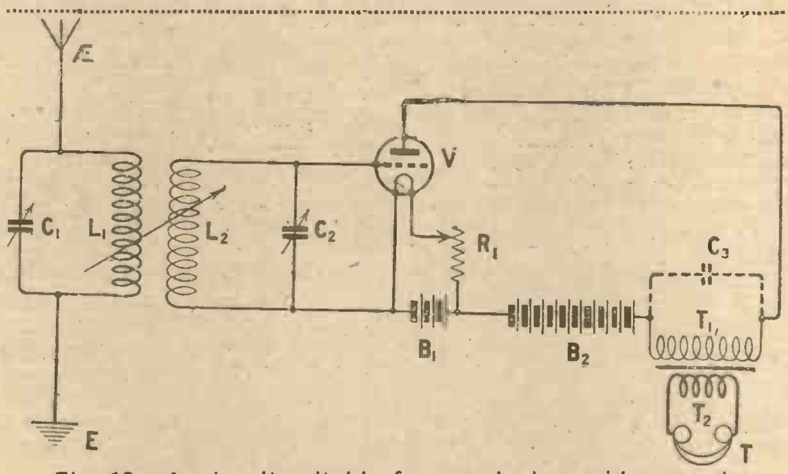


Fig. 10.—A circuit suitable for employing grid current rectification, which is the least effective method.

Working on the Bottom Bend

Fig. 7 shows a typical characteristic curve, and we know that there is a bend near the point C, and a bend near the point G. If now we work the valve at the point C by placing – 4 volts on the grid, incoming positive half-cycles will move the representative point up to D and produce a large increase of anode current, whereas negative half-cycles will produce small decreases of anode current. A positive half-cycle of 1 volt would cause the anode current to increase from C (0·04 milliamp.) to D (0.08 milliamp.), whereas a negative half-cycle of 1 volt will cause the anode current to decrease from C (0·04 milliamp.) to B (0.02 milliamp.). The increase for every positive half-cycle is, therefore, 0·04 milliamp., while the decrease for each negative half-cycle is 0·02 milliamp. The result is that, as the high-frequency alternating currents are super-imposed on the fixed potential of – 4 volts on the grid, the mean or average change in the anode current will be an increase. When signals cease, the anode current, of course, returns to its normal value of 0·04 milliamp. During the reception of signals the average current rises to some value between the points C and D. These increases will be produced during each group of incoming waves and a click will be produced in the telephone receivers if they are connected in the anode circuit of the valve.

A Simple Receiving Circuit

Fig. 8 shows a simple receiving circuit in which the closed circuit L_2 C_2 is connected across the grid G and filament F of the valve. In the grid circuit of this valve is a potentiometer circuit R_2 B_3, which is connected next to the filament. If the resistance of the potentiometer is high, it is usual, although not always essential, to connect a small condenser C_4 of, say, 0·001 microfarad across the fixed and variable contacts on the resistance R_2. The sliding contact shown by the arrow head is capable of moving along the whole length of R_2, so that the grid may be made positive or negative with respect to the filament. By means of this potentiometer, which may take various forms, we are able to work our valve at any point on its characteristic curve, and, since we usually operate the valve at the lower bend, we adjust the potentiometer so as to give the grid a potential which brings the operating point to this bend. In the anode circuit of the valve are the telephones T, which should be of high-resistance if connected directly in the circuit (or low-resistance if used in conjunction with a telephone transformer), and the anode battery B_2. A fixed by-pass condenser C_3 may be connected across the telephones or across the negative side of B_2, and the anode side of T. This condenser is not essential.

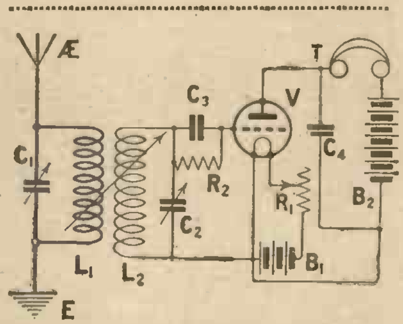


Fig. 11.—A practical receiving circuit employing the grid leak and condenser method of rectification.

Unwanted Rectification

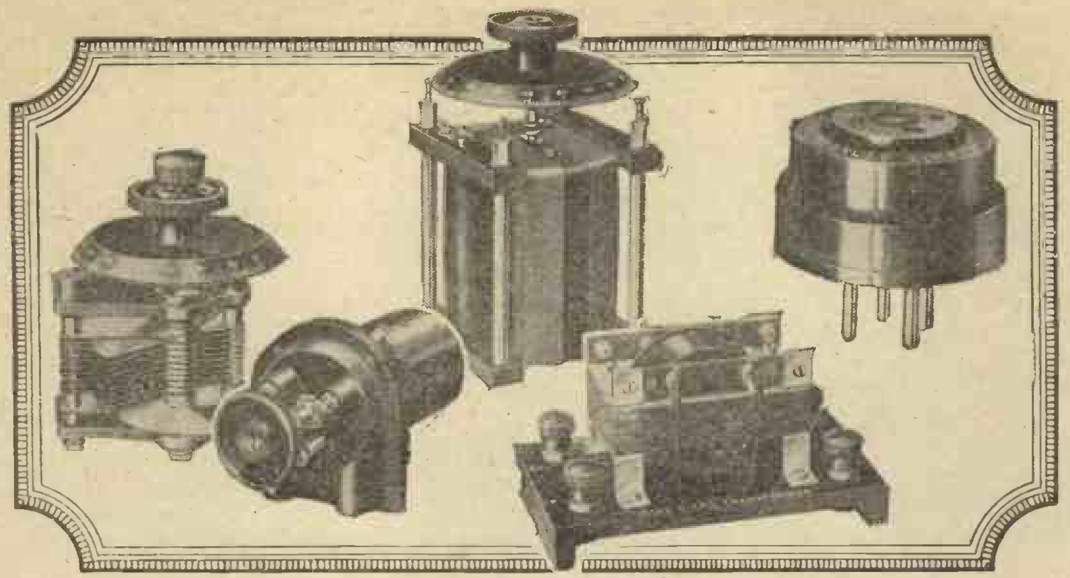
It is important to bear in mind that rectification with a three-electrode valve will take place under almost any conceivable circumstances, and the beginner will be puzzled by this fact. As long as you have telephones in the anode circuit of a valve, you are almost bound to get signals of greater or lesser strength.

A Point to Note

Any of the above-mentioned methods may be taking place, and sometimes all three are taking place at the same time! There is only one set of conditions when rectification would not take place. This place would be somewhere between the points E and F on the curve of Fig. 7. At this point it is possible to obtain practically no rectification at all, and this point is really the ideal one for low-frequency amplification where distortion is to be avoided.

The Condition for no Grid Current

An advantage of anode current rectification is that when the operating point of a characteristic curve is produced by a negative potential on the grid, there is roughly speaking no grid current flowing, and in these circumstances the damping of the circuit L_2 C_2 in Fig. 8 is very small. In the case of a crystal detector, the damping introduced into the circuit by the crystal detector is very considerable and affects both selectivity and signal strength. To a certain extent the same effect is obtained when using grid current methods



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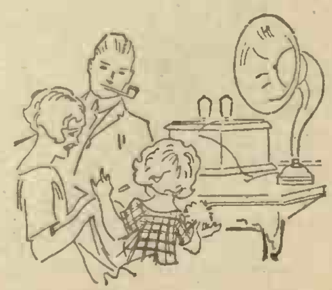

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of rectification which come under the headings 2 and 3.

A Bend not Essential

Another point in connection with this method of rectification is that an actual bend in the curve, as most people understand it, is not essential. Any curvature, even of a regular nature, will cause rectification. For example, if part of the characteristic curve were shaped like a portion of the circumference of a circle, rectification effects would be obtained. It is not necessary, as many people imagine, that there should be a change in the curvature, although a big change in curvature at a certain specified point is undoubtedly going to give excellent rectification effects, and various attempts have been made to produce such rapid changes in curvature, although without much success. I have, however, heard of a recent valve which possesses distinct advantages over the ordinary type in this respect.

Graphical Representation of Rectification

Fig. 9 shows very clearly what happens in the Fig. 8 circuit, the top line showing two or three groups of incoming waves such as would be produced by a spark at the transmitting station. The oscillations produced in the circuit L_2 C_2 will vary the grid potential above and below the normal negative value given to it by the potentiometer. The second line shows how the positive half-cycles produce increases of anode current greater than the decreases due to the negative half-cycles. The anode current variations are, therefore, of a high-frequency character and resemble more or less the received oscillations. The average effect of each group of oscillations, however, will be to produce an increase in the steady anode current. This increase is shown by a dotted line in the second line of Fig. 9, and the effect on the telephones will be as though direct current pulses were passed through them. This is shown in the third line of the figure.

Using the Upper Bend

Instead of working the valve at a point C of Fig. 7, we can work at the point G or thereabouts. In this case positive half-cycles will produce small increases in the anode current, whereas negative half-cycles will produce large decreases. The effect of a whole cycle or alternation will be an average decrease in the anode current and this will affect the telephones in the same way as in our previous case.

Grid Current Rectification

We now come to another method of detecting wireless signals. In the first method we did not alter the incoming oscillations, but caused them to produce unequal changes of current in a separate anode circuit. To do this, we utilised the change in curvature of the anode current curve. In the method to be described, we work the valve on the straight portion of its curve, but achieve our object by causing the grid potential variations to differ. The positive half-cycles have their amplitude lessened while the negative half-cycles remain the same. This is done by taking advantage of the fact that when the grid is made positive with respect to the negative end of the filament, electrons are drawn up from a portion of the filament, are attracted to the grid, and flow round the external grid circuit back to the filament. At zero volts on the grid, that is to say when the grid is connected through the receiving circuit to the negative side of the accumulator, the grid current can be taken as being zero. If the grid is given a negative potential, the current to the grid remains zero since electrons are repelled by the negative charge on the grid. If, however, the grid potential is raised to a positive value above zero, it will immediately begin to draw electrons which will flow round the receiving circuit to the filament. The greater the positive potential on the grid the greater will be the grid current. If we were to leave out the anode of the three-electrode valve, the grid current curve would resemble the anode current curve of a simple two-electrode valve. Now if we connect a conducting circuit across an oscillatory circuit we will lessen the oscillating potentials across the latter; for example, if we connected a resistance across a closed receiving circuit the resistance would take current from the receiving circuit and would have a "damping" effect; the potentials across the oscillatory circuit would be less than if the resistance were absent. Now, the effect of a grid current is to damp out to a certain extent the positive half-cycles of oscillating potential applied to the grid of the valve.

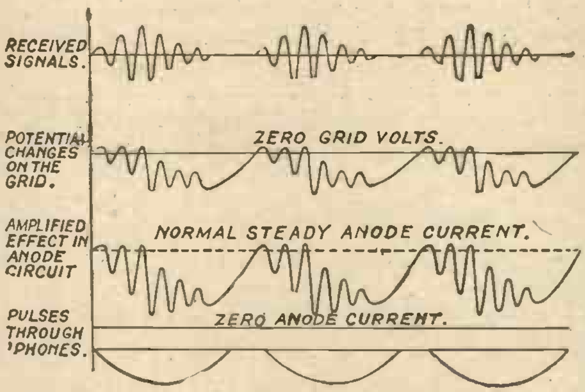

Fig. 12.—A graphical representation of the process of grid condenser rectification.

An Analogy

A somewhat similar effect is obtained when we connect a lamp, for example, across a battery of dry cells; when a current flows through the lamp the voltage across the cells immediately drops. Since the grid current only flows when the grid is made positive, the positive half-cycles never reach their full amplitude; whereas the negative half-cycles are unaffected. We do what is equivalent to partially short-circuiting the positive half-cycle. The conductive path between filament and grid acts as a shunt resistance to the oscillatory circuit L_2 C_2 (Fig. 10), which only affects the positive half-cycles. The grid potential, when using this circuit, should be kept in the neighbourhood of zero volts, and the filament current and anode voltage should have such values that the valve is being operated at such a point of the characteristic curve that the representative point travels down a steep straight portion. Such a point is F in Fig. 7.

The Least Effective Method

Positive half-cycles now produce only a small increase in the anode current, whereas negative half-cycles produce a large decrease. The result is an average decrease in the anode current, and this affects the telephones T. A small fixed condenser is usually connected across the primary T_1 of the telephone transformer T_1T_2, and may be connected so as to shunt both the anode battery B_1 and the winding T_1. This method of rectification is the least effective.

Grid Condenser Rectification

The commonest form of a detector circuit works on a rather more complicated principle than the arrangements already described.

The receiving circuit is similar to that of Fig. 10, but between the grid and the top of the inductance L_2 is a small fixed condenser C_3 usually having a capacity of about $0{\cdot}0003\mu F$, or less. Across this grid condenser, as it is called, is connected a high resistance R_2 (see Fig. 11). The resistance R_2 has in practice a value of between 1 megohm and 5 megohms, a value of 2 megohms usually giving good results.

Action of Condenser

Let us first of all consider the action of this circuit without the high resistance or leak. The condenser C_3 acts as an insulator to steady currents which might otherwise flow in the grid circuit. The potential of the grid is usually in the neighbourhood of zero volts, or slightly negative. Electrons on their way to the anode pass to a certain extent to the grid which collects them. These electrons charge up the grid, but since they cannot flow through the condenser C_3 the grid acquires a slightly negative charge which prevents more electrons from going to it. The effect, then, of putting a condenser in the grid circuit is to give the grid a normal potential which is just sufficient to prevent the flow of any current round the grid circuit. We may say that the normal steady potential of the grid will be equal to that potential which, when connected in the grid circuit (C_3 being shorted) would just prevent the flow of a grid current. This potential is usually between zero volts and -1 volt; it is that voltage which, if slightly raised in a positive direction, would start a flow of electrons to the grid. We will assume, for the sake of the following explanation, that the grid potential is normally zero volts, and that if its voltage is raised above the value it begins to attract electrons.

The Grid

When incoming signals produce oscillations in the closed circuit L_2C_2, the grid will become positive and negative alternately with respect to the filament. This is because the condenser C_3, although acting as an insulator to direct currents, will act as a conductor to high-frequency or pulsating impulses. When the grid is given a positive potential with respect to the filament, it immediately begins to attract electrons from the filament, but these electrons remain on the grid and on the right-hand side of C_3. These electrons give the grid a small steady negative potential, which remains after the end of the positive half-cycle. The negative half-cycle of oscillating current makes the grid momentarily still more negative, but since no electrons are drawn to the grid, the change in grid potential only lasts during the short period of the negative half-cycle. The next positive half-cycle comes along, overcomes the small steady negative potential on the grid, and raises the grid potential once more above zero. The grid, becoming momentary positive, attracts a further supply of electrons, which, since they cannot escape, increase still further the negative potential on the grid. At the end of the second positive half-cycle, the steady grid potential will have become still more negative. The process repeats itself a number of times, the grid potential gradually becoming more and more negative.

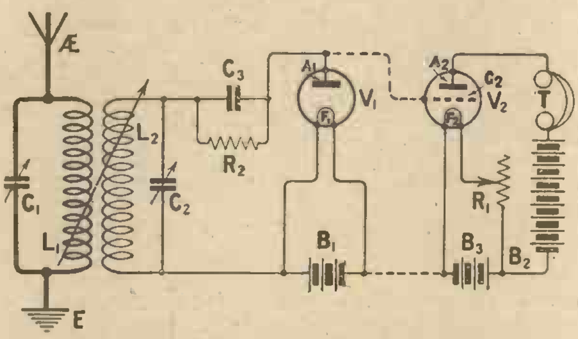

Fig. 13.—A circuit which helps to explain how a three-electrode valve amplifies as well as detects when being used as a rectifier.

The Effect of the Grid Leak

At the end of a wave-train the grid would normally still be at a negative potential. The anode current which has meanwhile been decreasing, owing to the increasing negative potential on the grid, would also remain at a steady decreased value. Subsequent wave-trains would produce no effect, and consequently the circuit would be useless for receiving wireless signals. It is essential that at the end of each wave-train the valve should be restored to its former sensitive condition ready for the next group of waves. In order to restore the original conditions, we provide a high resistance which we connect so that the electrons stored up on the grid can leak away back to the filament in time before the next wave-train comes along; we usually connect a grid-leak across the grid condenser. The electrons thus flow through R_2 and L_2 back to the filament. During the very short period of the wave-train the leak R_2 has practically no effect, since its resistance is so high that it takes a very much longer time than the duration of a wave-train for the electrons on the grid to leak away through it.

Decrease of Anode Current

At the end of the wave-train, however, there is a comparatively long interval (actually about 1-1,000th of a second) for the accumulation of electrons on the grid to leak away through the resistance R_2. When they have all leaked away, the grid is once more at about zero potential, and the process is repeated at each subsequent wave-train. During each spark at the transmitting station the grid potential gradually drops, and the anode current at the same time decreases. There is, therefore, a click in the telephones for each spark, a note being thus produced when signals are received. Most British valves detect best when the grid circuit is connected to the *positive* side of the accumulator.

An Alternative Connection

Instead of having the grid leak across the grid condenser, it may be connected directly across grid and filament without altering the action in any way. The bottom end of the resistance is conneeted either to the negative or positive side of the accumulator, whichever gives the best results with the valve used.

A Graphical Representation

Fig. 12 shows graphically the process of grid condenser or "cumulative" rectification. The first line shows three groups of damped waves (waves from a station, such as a spark station). The second line shows how at the end of each positive half-cycle the grid potential has gradually fallen. The lowest mean negative potential reached by the grid is always less and cannot be greater than the amplitude of the largest positive half-cycle; a point is therefore reached somewhere between the largest positive half-cycle and the end of the wave-train where the average grid potential ceases to fall. Since it takes a comparatively long time for the electrons to leak away through the grid resistance, the grid

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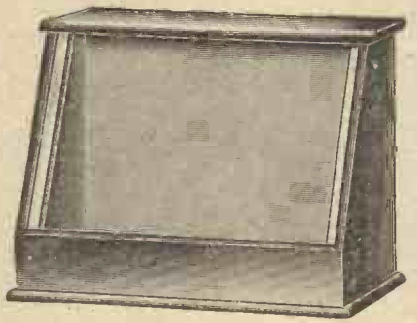

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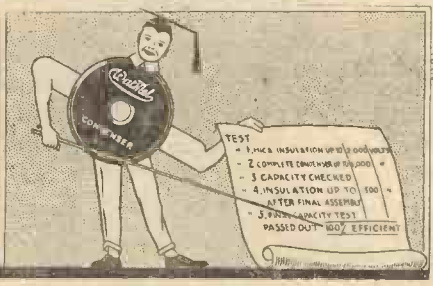

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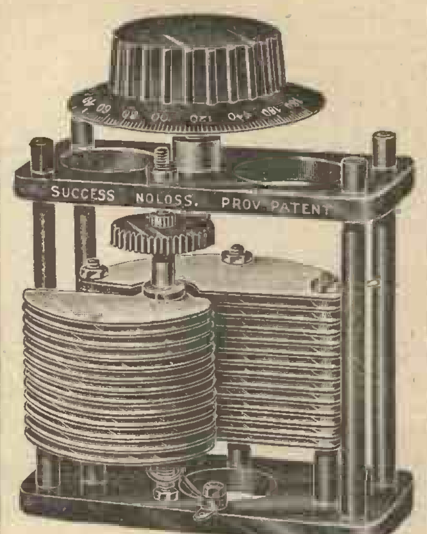

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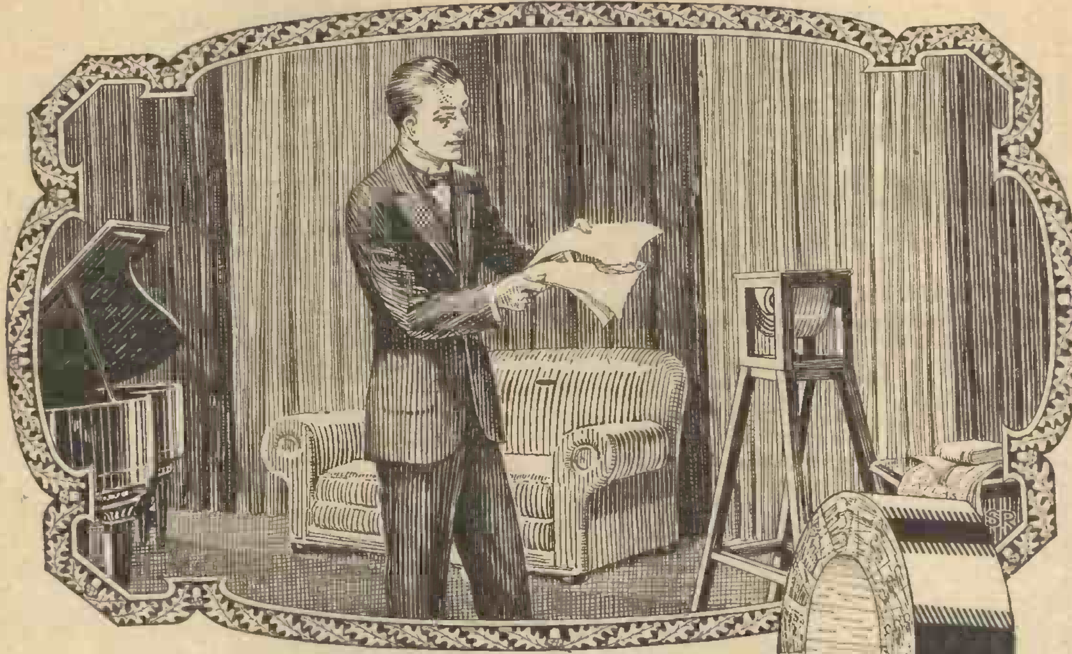

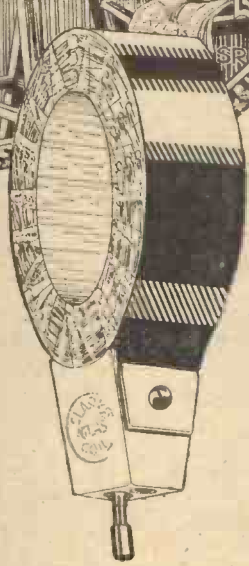

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potential remains at its negative potential for some considerable time. The value of the leak should be such that the electrons on the grid have sufficient time to leak back to the filament before the next wave-train arrives. In line 2 of Fig. 12 will be seen how the grid potential rises slowly from its negative value to zero volts. All the time that the grid is kept at a negative value the anode current will be reduced, and since the anode current is kept reduced for an appreciable period and to an appreciable extent, the response in the telephones is greater than in the methods of rectification which have been previously described. The fourth line shows the average pulses of current which flow through the telephone receivers.

The Best Working Point

Since we desire to get the maximum decreases of anode current for the average decrease in the grid potential we must work our valve somewhere on the steep straight portion of its characteristic curve. The point F of Fig. 7 would be suitable. To obtain the best results with cumulative (or grid condenser) rectification circuits the filament current of the valves should be variable.

High and Low Frequency Variations

The grid potential of the valve in Fig. 11 varies in two ways, when signals are received. In the first place, the grid potential is varied at a high-frequency ; the frequency of the impulses on the grid is equal to that of the incoming signals. At the same time, however, the average potential of the grid gradually becomes more and more negative during a wave-train. These average decreases in potential occur at each wave-train and, therefore, take place at audio-frequency. Since the anode current variations respond exactly in time with the grid potential variations, we get radio-frequency current variations in the anode circuit; but while these are taking place we are getting audio-frequency decreases in the anode current which take place every time the grid falls to a steady negative potential. The high-frequency variations are called the "radio-frequency component" of the anode current, while the low-frequency variations are usually called the "audio-frequency component" of the anode current.

An Example

It may at first be a little difficult to understand how the two current variations take place at the same time. We may, however, take the analogy of a swinging pendulum. The pendulum may be swinging to and fro very rapidly, but at the same time it may be gradually lowered towards the ground. The rapid sideways movement of the pendulum represents the radio-frequency component, while the slow movement of the pendulum towards the ground is analogous to the audio-frequency component of the anode current. We may also be helped to understand the problem by considering a variable resistance in series with a delicate ammeter which, instead of being supplied with current from a battery, is supplied from direct-current mains. The current supplied by the mains, while being fairly steady, usually varies very slightly at a frequency of, say, 50 times per second. The slight periodic variation is due to the commutator of the dynamo. The ammeter needle, while remaining comparatively steady, will tremble perceptibly. By gradually increasing the resistance the current through the ammeter will gradually decrease, but whatever the current through the ammeter may be, there will always be slight commutator variations which will make the needle tremble.

The commutator "ripple" represents the radio-frequency component, while the slow steady drop in the current through the ammeter represents the audio-frequency component.

Use of the High-Frequency Component

In the simple detector circuits which we have so far considered, only the audio-frequency component is used to operate the telephones, which are unaffected by the radio-frequency current variations. In Fig. 11 these latter pass through the condenser C_4 and are not utilised in any way. But there are many more circuits in which use is made of these radio-frequency currents.

An Explanatory Circuit

A circuit which may help to explain the fundamental action of the "leaky grid condenser" circuit of Fig. 11 is shown in Fig. 13. A two-electrode valve V_1 is connected across the oscillatory circuit L_2 C_2, a condenser C_3 shunted by resistance R_2 being connected in the position shown. A three-electrode valve V_2 may be connected across the anode and filament of V_1 as shown ; but for the moment we will leave out of consideration the valve V_2. Incoming signals make the anode of V_1 positive and negative alternately. Negative impulses have no effect, but positive half-cycles cause the anode A to draw up electrons from F_1, and these electrons accumulate on the anode and on the right-hand side of C_3. At the end of each group of oscillations the right-hand side of C_3 and the anode A will have acquired a negative potential with respect to the filament F. In order that this negative potential may leak away before the next train of waves arrives, the high resistance R_2 is connected across C_3. We can now connect up a second valve V_2 to amplify the negative potential on the anode A_1. This may be done as shown in Fig. 13. At each wave-train the anode A_1 becomes negative, and, therefore causes the grid G_2 to become negative. The anode current of V_2 consequently decreases, and produces a click in the telephones. This circuit is really the same as Fig. 11, except that instead of having a separate anode A_1 and a separate filament F_1, the grid G_2 acts not only as a means of controlling the current through V_2 but also as an anode which draws up electrons from the filament. The valve of Fig. 11 acts as a combination of a two-electrode rectifier and a three-electrode amplifier.

The Self-contained Three-Valve Receiver

SIR,—It may interest you to know that I have just completed the "Self-contained Three-Valve Receiver," described by Mr. John Underdown in the August issue of MODERN WIRELESS.

I have altered the layout slightly in order to put it in a portable form, the size of the panel being 11¼ in. by 10½ in. I also altered the wiring of the H.F. transformer to take an Igranic Honeycomb Duo-lateral transformer.

Using three 1·8 v. ·3 amp. valves, the last being a power valve with 70 volts on the first two valves and 100 on the L.F., 5XX comes in at loud-speaker strength and Radio Paris at good 'phone strength in daylight. I have not yet obtained a transformer for the lower broadcast wavelengths, so I do not know what the results will be on the lower wavelengths. My aerial is 30 ft. high and 50 ft. long, badly screened, the earth 100 ft. of copper wire buried beneath the aerial. Wishing your papers every success.
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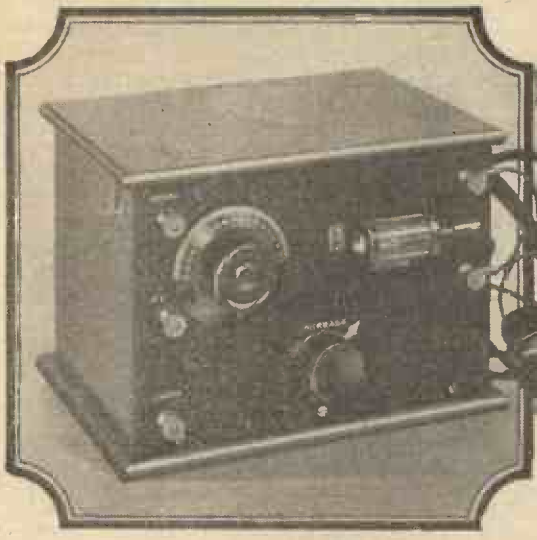

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Morse Interference

There are, however, several thousands of listeners who are so unfortunate as to reside in areas near the sea or a river, where the reception of local broadcast is very often spoiled by interference from ships.

These people need a selective receiver even to listen to their local station, and it is for them more especially that the set to be described was designed.

Daventry transmissions, I know, offer one solution, but the local programme is often preferred.

The Circuit

The circuit used in this set may be seen in Fig. 1. It will be observed that the aerial circuit is aperiodic, and variably coupled to the secondary coil, which is of the low-loss type, tuned by a ·0003μF. condenser.

The crystal and telephones may be connected across the whole or part of the secondary coil, which is tapped at seven points along its 72 turns. Provision for adding a loading coil for the reception of 5XX has been made in the secondary circuit, and a further position to which the crystal lead may be connected is seen indicated at X. The loading coil plug is placed in this position, and not on the earth side of the coil, in order that when receiving 5XX the effect of tapping the crystal across the low-loss coil alone may be tried.

Three terminals appear on the left-hand side, these being Aerial, A_1, and Earth respectively.

The centre terminal, A_1, is used when it is desired to receive Daventry, the aerial now being directly coupled to the tuned circuit.

Components

The general arrangement of the panel is simple, and lends itself to easy operation of the three adjustments on it.

In order to construct this receiver you will require the following components, and whilst actual names are given, it is not to be understood that the special makes used are essential for successful results; any good quality components will do equally as well, but the quality must be good. Their size, however, will have to be considered if the same size panel is used with them:

Ebonite panel, 9 in. by 6 in. (Paragon).

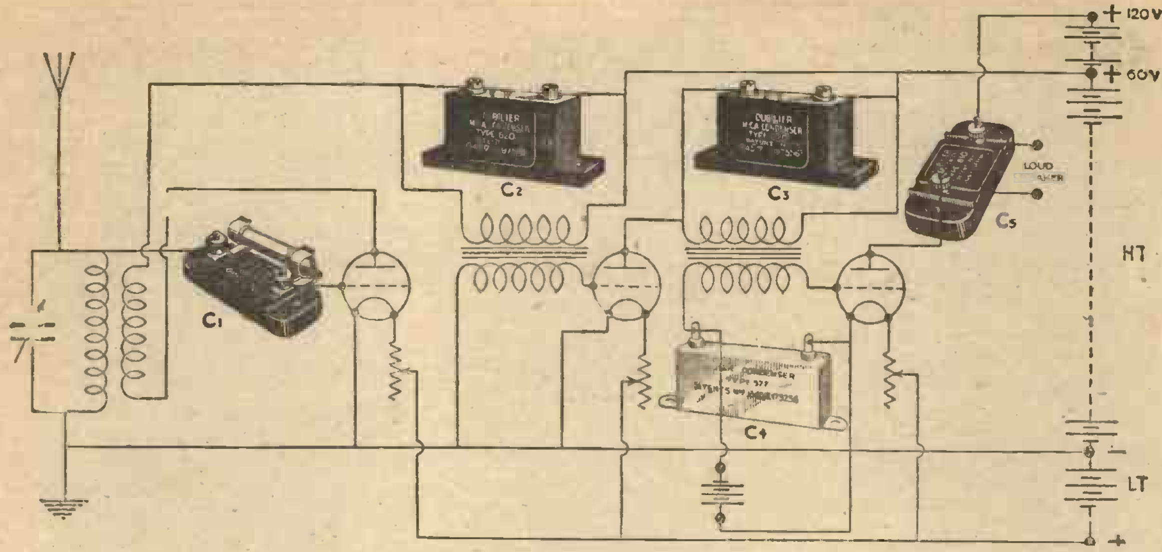
Mahogany cabinet to take panel. (Camco.)

5 Nickelled terminals.

1 Shorting plug. (Burne-Jones & Co., Ltd.)

1 ·0003μF. variable square-law condenser (low-loss type). (Jackson Bros.)

The connections to the telephones are clearly shown here.



THE RIGHT THING in THE RIGHT PLACE

ALTHOUGH the experience of the average man with wireless matters has been comparatively short, it has certainly been intensive. In the summer of 1922 an aerial outside a house was a rarity. In 1925, on the other hand, it is the house without one that is the exception. Literally millions of people nowadays know quite a lot about the theoretical and practical sides of wireless. Above all they now realise that a successful set must be fitted with good condensers, and in every case the name Dubilier is generally recognised as the hall mark of condensers both fixed and variable, Anode Resistances, and Grid Leaks, and other similar products.

In the illustration above, we show some examples of the right thing in the right place :—

at C1 a Dubilier Type 610 Mica Condenser (from 3/-)
with Grid Leak (2/6)
at C2 & C3 Dubilier Type 620 Mica Condensers (from 3/-)
at C4 a Dubilier Type 600a Mica Condenser (from 2/6)
at C5 a Dubilier Type 610 Mica Condenser (from 3/-)

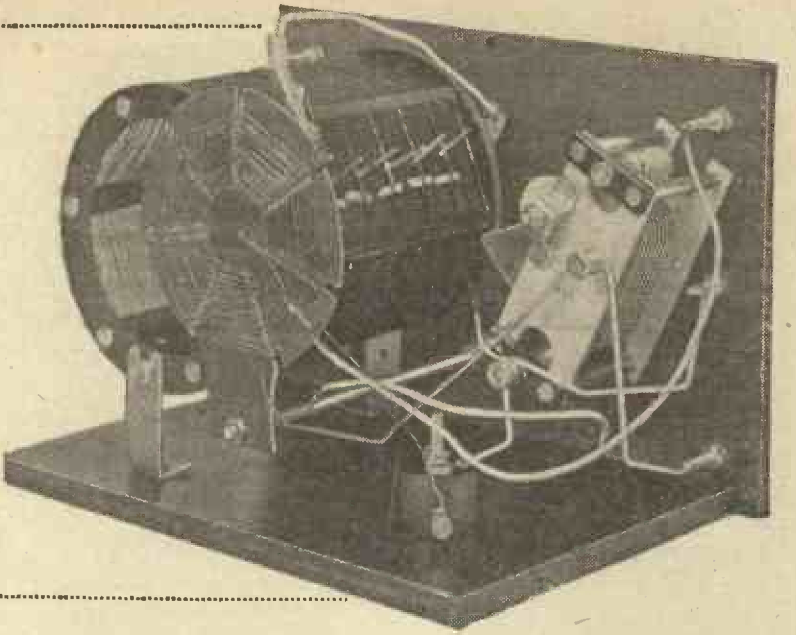
Dubilier Condensers are made in a very wide range of capacities, and the Grid Leaks in several values. Every wireless Dealer stocks Dubilier products, and they are used in every good wireless set.

Always remember that quality tells, and make sure you *specify*—

TRADE DUBILIER MARK

DUBILIER
CONDENSER CO (1925) LTD

1 Burndept micrometer crystal detector. (Burndept Wireless, Ltd.)
1 4 in. diameter low-loss coil former $4\frac{1}{2}$ in. long (I actually cut down one 6 in. in length). (Collinson Precision Screw Co., Ltd.)
1 Board mounting coil socket. (L. McMichael, Ltd.)
1 Spring clip. (S. H. Collett.)
1 Ebonite knob with pointer.
$6\frac{1}{2}$-in. 2 B.A. screwed rod, with nuts and washers.
1 brass bush and
1 Spring washer (2 B.A.).
$\frac{1}{2}$ lb. No. 22 enamelled copper wire.
Flexible rubber-covered wire.
Square section tinned-copper wire; screws, etc.
Radio Press panel transfers.



A general back of panel view. Note the tappings on the low-loss coil and on the fixed plates condenser terminal.

Drilling the Panel

Mark out and drill the panel according to the drilling diagram shown in Fig. 2. Since all necessary dimensions are given, this will not be found a difficult matter. Now take the baseboard and temporarily affix the panel to it.

Winding the Coils

The coil former, with the two brass angle-pieces fixed, should now be placed in position on the baseboard, care being taken that it does not foul the telephone terminals. When its position is decided, mark the positions for its fixing screws.

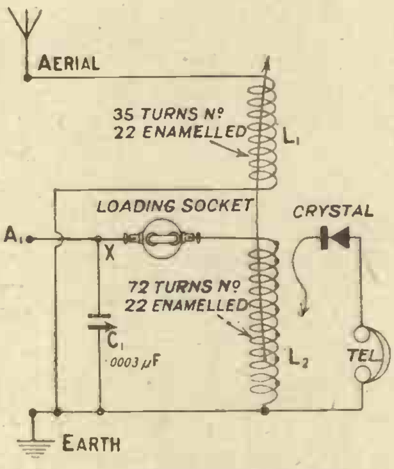


Fig 1.—The long wave tap is indicated at X.

The panel may now be removed from the baseboard and the condenser, crystal detector, terminals and 2 B.A. brass bush mounted.

The winding of the coils must next receive attention. As stated in the list of components, the low-loss former should be $4\frac{1}{2}$ in. long, but if a longer one is obtained, then it will not be found a difficult matter to cut it down to the desired length. As there are 16 threads to one inch, a $4\frac{1}{2}$ in. former will be of sufficient length for 72 turns of wire to be wound on it.

A Point to Note

The circular disc of ebonite supplied with the former should be fixed inside the latter before wiring is commenced. One end of the No. 22 enamelled wire must be secured by passing it through the two small holes provided in the end ring, leaving about 6 in. free for connecting later. Now the winding may be proceeded with, and when completed this end of the wire must be secured in a similar manner to the last, 6 in. being left free.

The Aerial Coil

For the aerial aperiodic coil former I have used an ordinary piece of stiff, dry cardboard. Its exact size is immaterial, and about 35 turns are wound on in the usual basket-coil manner. The photo makes this clear. Two or three inches must be left free at either end of the winding.

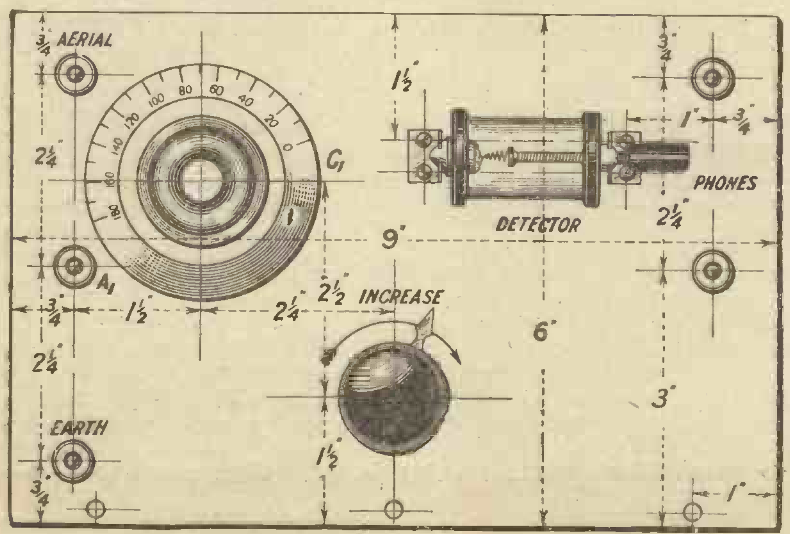


Fig. 2.—The knob in the centre of the panel is for the purpose of adjusting the aerial coupling.

A sufficiently large hole to take the 2 B.A. rod must be drilled through the former in the position shown.

Soldering the Crystal Taps

Having progressed thus far, take the low-loss coil and fix it temporarily on to the baseboard in its correct position. The small lengths of square tinned-copper wire must now be soldered to the various turns as shown in the diagram. The first is to be soldered to the end turn furthest away from the panel, 10 turns separating each tap, with 12 being left between the seventh and the coil end.

If the following instructions are carried out this soldering will be greatly facilitated.

Force up the turn to be soldered and push a small piece of a matchstick underneath it, but above the adjacent windings. It is now an easy matter to scrape the enamel off, and, after tinning the wire solder the small piece of square section wire to it.

The two connections, one from the upper telephone terminal to the detector, the other, a flexible lead (with clip attached) from the other side of the detector, should be soldered in their correct positions before fixing the panel and baseboard together. When this is completed, screw the panel to the baseboard and fix the loading coil plug in position, so that any coil to be used will not foul the condenser or low-loss coil when plugged in.

Wiring Up

In Fig. 3 the wiring diagram will be seen. It is perfectly simple, and with its aid the actual wiring up should present no difficulty. It will be noticed that a projecting length of wire is secured under the fixed plates terminal on the condenser. Being in this position, when the clip connects to it, it places the crystal across the whole of the loading coil, plus the low-loss coil, when receiving 5XX. At the same time, if it is desired, the crystal can be tapped across the low-loss coil alone or only part of it.

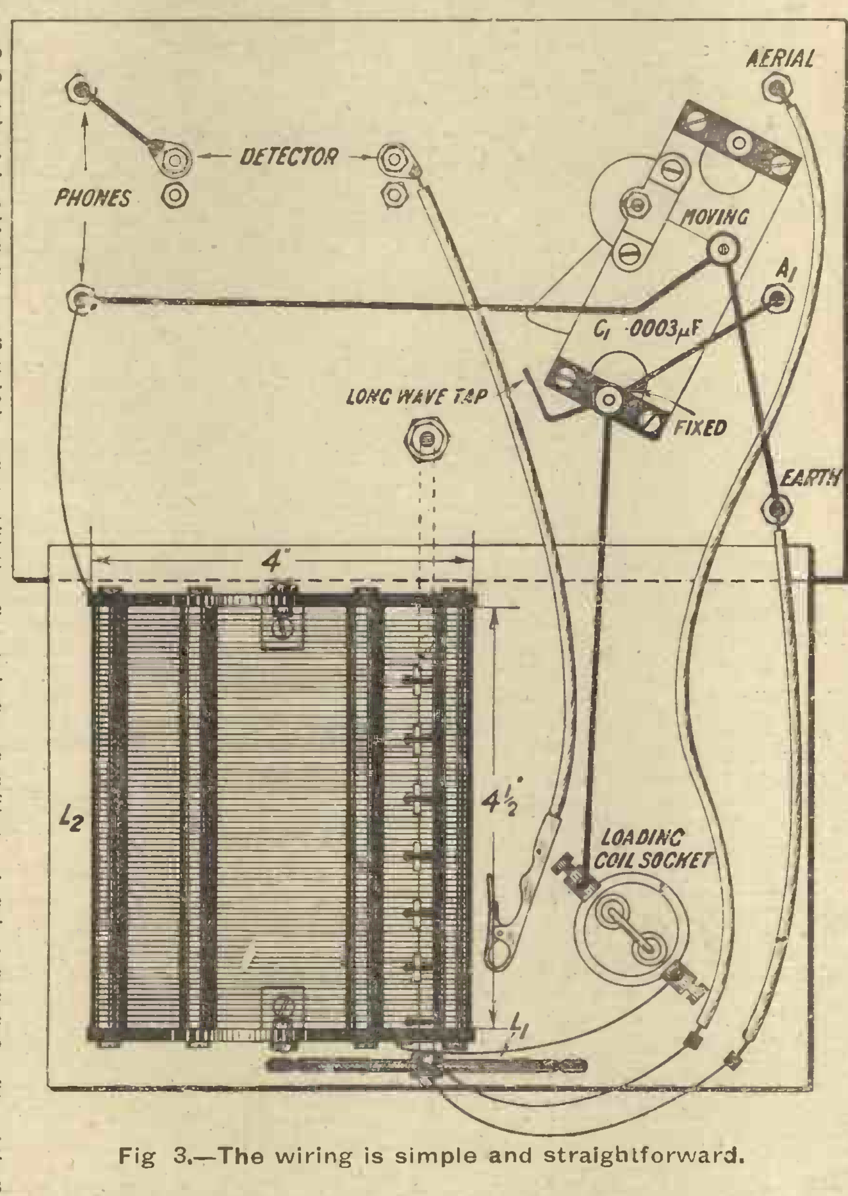


Fig 3.—The wiring is simple and straightforward.

The 2 B.A. rod, together with the pointer and ebonite knob, must be secured in the correct position, the aperiodic coil being mounted on the end of the rod and held fast by two nuts.

The actual distance of this coil from the panel must be such as to allow it, when swung, to pass as near as possible, without fouling, to the low-loss coil end, and flexible leads are connected from the aerial and earth terminals to it.

Testing Out

When the wiring up is complete the set may be tested out.

First short the loading-coil socket then connect the aerial to the top left-hand terminal and earth to the bottom terminal, the telephones, of course, also being connected to the correct terminals. The detector lead must be clipped on to the tap furthest from the panel. Swing the coupling to its maximum position, and after adjusting the crystal to what is thought to be a good spot, adjust the condenser slowly from minimum to maximum. If local broadcasting is going on, it is almost certain that something will be heard.

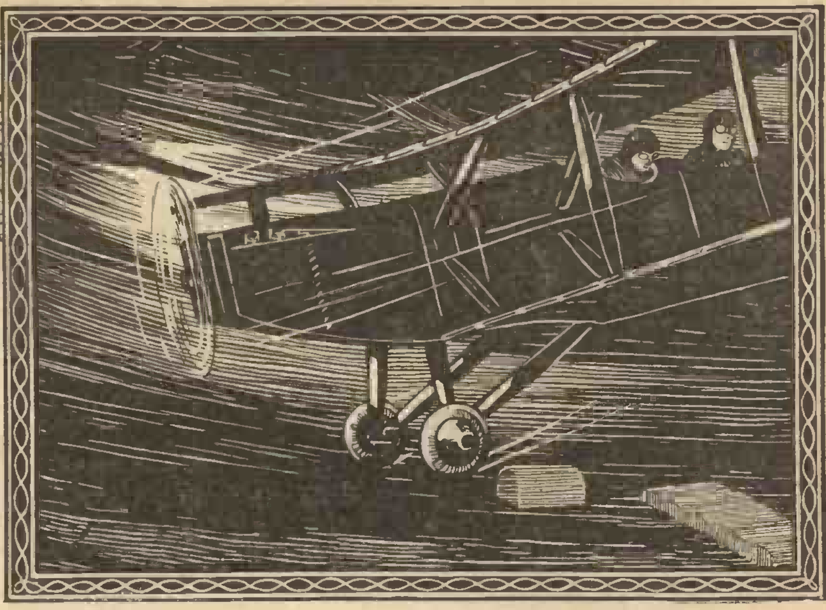
However weak the signals heard may be, the condenser can be adjusted to its correct position by their aid, and a really good crystal setting found.

The effect of varying the coupling and the crystal tap should be tried, and in some cases it may be found that signal strength increases to a certain extent if the crystal is tapped across only part of the coil.

Receiving 5XX

To receive the long-wave station a No. 150 coil must be plugged into the socket provided, and the flex lead clipped on to the wire projecting from the variable condenser terminal. When signals have been heard and the condenser and crystal correctly adjusted, try the effect of tapping the crystal across the low-loss coil. (*Continued on page* 67.)

QRB?



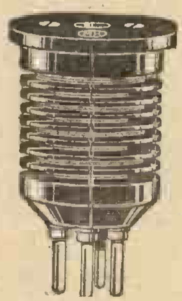
What is your distance?

In radio working the letters "Q.R.B." followed by the interrogation mark mean "What is your distance?"

Station replying sends "Q.R.B....... miles." (no interrogation mark) meaning "My distance is......miles."

Night flying! Illimitable and impenetrable space, the objective unseen and, to the uninitiated, unattainable, but by keen judgment and the aid of scientifically designed apparatus, the pilot, without fuss or worry, quickly attains to it. "Q.R.B. 100 miles" soon becomes "Q.R.B. 50 miles," and finally "Arrived O.K."

Use *your* judgment, obtain scientifically designed apparatus, and you will reach to distant stations hitherto considered unattainable.



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No. 1	300 „ 600 „	10/–	No. 4	2,500 „ 7,000 „	10/–

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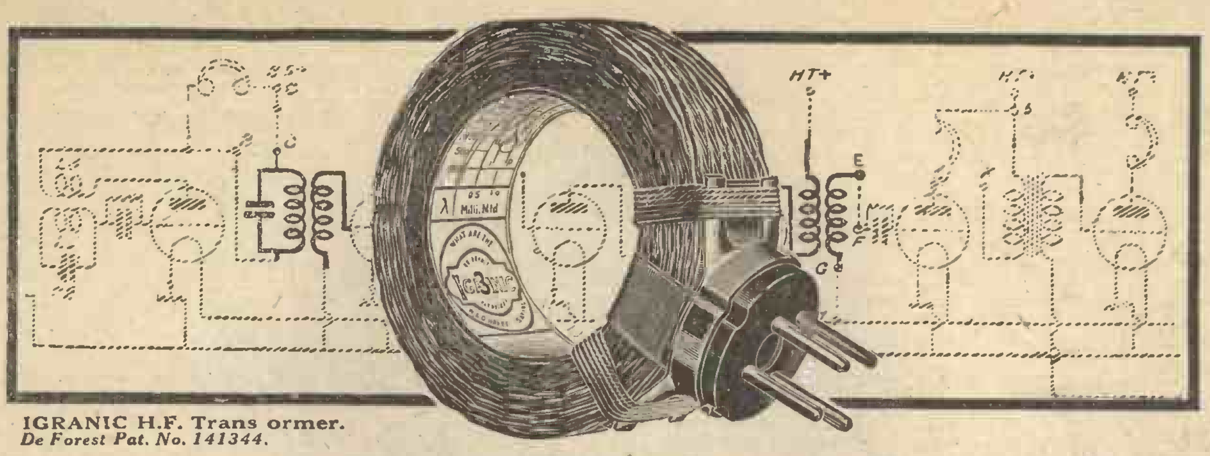

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Working Your Set from the D.C. Mains

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

In this interesting article the well-known Chief Research Engineer of the Marconi Company describes how the H.T. and L.T. supply may be obtained from the house-lighting mains.

A VERY large number of people are supplied with direct current for lighting purposes and it is now quite easy to use this for working a two or three-valve set, thus avoiding the expense of accumulators and of high-tension batteries, and, incidentally, giving more reliable power for loud-speaker work.

The mains are usually 220 or 240 volts, and one side or the other of these mains is much nearer earth potential than the other. It does not really matter whether the positive or negative is near earth potential except for the following point. If the positive is near earth potential, then if one's set is in a room with a slightly conducting floor, touching terminals on the set will give a shock, but this can be guarded against by care in placing the set.

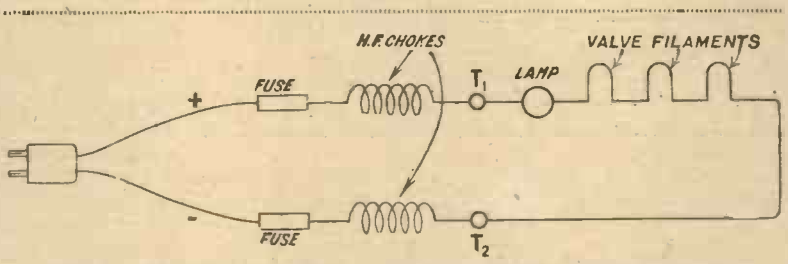

Fig. 1.—The H.F. chokes may be suitable plug-in coils.

Filament Current

Lighting the filaments is the most troublesome portion of the experiment.

As our filaments only consume at the most 6 volts the remaining voltage of the mains is wasted, consequently we must keep our current down to a minimum to save expense.

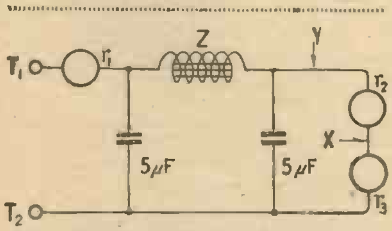

Fig. 2.—The method used for obtaining H.T. from the mains.

Suppose we consider a 3-valve set, using 3 D.E.5 valves. Each of these valves takes .25 amperes, so that if we place them as usual in parallel we shall be taking .75 amperes at 240 v. from the mains, and this will cost on an average 8d. for every six hours, which would not be very economical.

We can, however, run these three valves in series quite easily, and the cost will then only be ½d. per hour.

It will be advisable to keep to the same type of valve right through as this makes the adjustment of current through the valves much easier. Those who care to go to the expense of a rheostat will require one to stand .25 amperes, and with a resistance of $\frac{240-15}{.25}$ ohms. = 900 ohms.

Where 240 = voltage of mains,
15 = voltage of 3 valves in series. .25 = current.

A Lamp Resistance Preferable

Another way and much cheaper is to choose a lamp which takes .25 amperes at the particular voltage, which will be the mains voltage minus three times the valve voltage.

Or, still a third way is to choose a lamp which takes a little more than .25 amperes and put a resistance across the 3 valves as a regulator.

If you have an ammeter or voltmeter you will be able to judge exactly either by current or voltage.

The lamp or rheostat must be put in on the positive side of the mains, and I would recommend a fine thin fuse to be put in on the negative side in case during the test an accidental earth is put on the set.

It is nearly always necessary to choke the mains with high-frequency chokes. For the ordinary broadcast range two 50 coils are enough, but for Daventry two 150 coils will be necessary. There seems to be quite a lot of H.F. mush coming from D.C. mains. It is preferable to put chokes in right at the main switch-board if possible, but in this case special chokes must be used, plug-in coils being unsuitable, and an electrician should be employed for the job. Suppose, however, we incorporate the chokes in the set, the filament lighting system will be like Fig. 1.

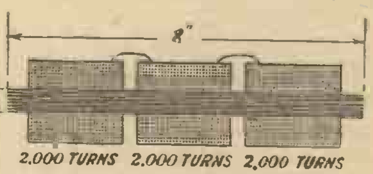

Fig. 3.—Details of the smoothing choke Z.

I will show a little later how you can tell which is positive and which is negative. The high-tension supply has to be well smoothed out, but it was not difficult to do this in all cases I have tried.

The terminals T_1 and T_2 have the full mains voltage on them, say, 240 volts.

We shall seldom need quite as much as this. The connections to be made are as in Fig. 2; r, r_2, r_3 are three 16 c.p. 240-volt carbon lamps.

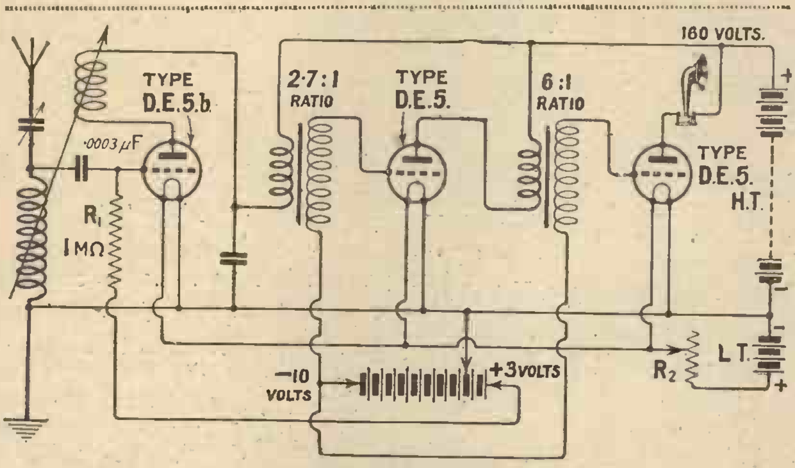

Fig. 4.—A conventional three-valve circuit, using accumulator L.T. and dry cell H.T.

Z is a choke which can be made by winding in three longitudinal sections, 6,000 turns of No. 28 D.C.C. wire on a straight iron wire core of about ½ in. diameter and 8 in. long (Fig. 3). The two condensers should be 400 volt condensers to prevent chances of breakdown. We now have available 80 volts from T_2 to X and 160 volts from T to Y, and of course 240 volts across the set.

Grid Bias

If a greater splitting of voltage is required 3 or 4 lamps can be put in instead of r_2 and r_3, all of course in series, noting that a condenser of large value must go across from the tapping to the negative end. The only voltage which it is better to supply from a battery is the grid bias, and I will represent this in the set as dry cells, but of course it can quite easily also be supplied by providing a variable resistance of small value in the negative side of the mains. If dry cells are used it saves a lot of trouble and they last a very long time.

In Fig. 4 I show an ordinary 3-valve set working off accumulators and dry cell H.T. for comparison purposes with Fig. 5, the same set running completely off the mains.

A Safety Measure

If the whole set is connected up as shown, but without regard to which is positive and which is negative on the mains—and then the mains plug is inserted—no signals or clicks on making and breaking the loud-speaker will be obtained if the plug is in the wrong way round.

It will be noted that I have put a $2\mu F$. 400-v. Mansbridge type condenser in series with earth lead.

This should be put in the earth lead near where it enters the house, so as to avoid possibilities of earthing the mains and blowing fuses.

A Further Precaution

I have indicated a leak across it to relieve static discharges. Those who are anxious to prevent any chance of this main earthing happening under any circumstances, can insert in the system a large 240-volt carbon lamp on the negative side at M. This, of course, will alter current and voltage values. The larger it is the less the alteration, but now if the negative side of the system is accidentally earthed, instead of a fuse blowing the lamp M will light up to full brilliancy.

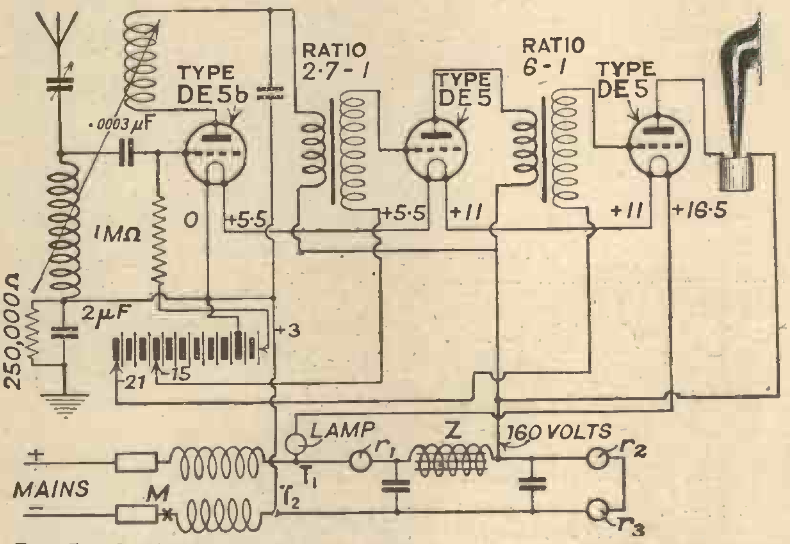

Fig. 5.—A similar circuit to Fig. 4, in which both H.T. and L.T. are obtained from the mains. A common H.T. tapping at 160 volts is shown for simplicity.

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The above-mentioned results were obtained on the ordinary £18 18s. 0d. Model of your manufacture.

Hope I am not boring you with this long account of results, but anyone wishing to receive long-distance broadcasting—specify the Duodyne V, and extreme satisfaction and many hours of enjoyment will result.

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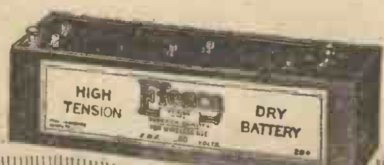

EFESCA HEADPHONES

Are Neutrodyne Circuits Worth While?

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

An interesting article, dealing with the necessity for neutralising the effect of the inter-electrode capacity in high-frequency amplifiers and illustrating some useful methods of accomplishing this.

QUITE a number of home-built high-frequency amplifiers made nowadays are fitted with a neutrodyne control, or some other method of neutralising the effect of the inter-electrode capacity of the valves employed. The question as to whether this extra trouble and expense is justified by the results which are obtained is one which must have occurred by now to every serious enthusiast.

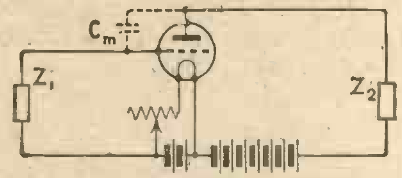

Fig. 1.—An elementary circuit in which the inter-electrode capacity of the valve is represented by C_m.

High-frequency amplifiers could be, and were, constructed before the days of neutrodyning, and the circuits which are employed to-day do not differ in any fundamental principles from those originally employed, except for the addition of this neutralising condenser. What, then, is the advantage to be gained by this additional control?

Effect of Inter-Electrode Capacity

Let us consider for a moment what happens in a high-frequency amplifier associated with any one valve: we have firstly an input circuit, and secondly an output circuit. These circuits may be represented as in Fig. 1. The input circuit may be the secondary of an intervalve (H.F.) transformer, or it may be a tuned circuit, either applied directly to the grid, or tapped from the previous valve through a condenser. In any case we may represent it, for the time being, as an impedance of some sort which we will call Z_1. The output circuit, similarly, may be either an inductance, a resistance, or a tuned circuit, and we will represent this by an impedance Z_2.

Now the incoming signal will apply a certain voltage between the grid and filament of this valve, which will cause amplified currents to flow in the anode circuit. These currents in turn will develop voltages across the external impedance of the anode circuit, and due to the amplification of the valve, these voltages will be considerably greater than those originally applied across the grid and filament.

Feed Back

Now, theoretically, one would expect to obtain an amplification of something like 5 or 6 for each stage of high-frequency amplification, and in practice one finds that it requires very considerable skill in construction to obtain an overall amplification of as much as 2. If the amplification is increased any more than this the whole amplifier bursts into oscillation.

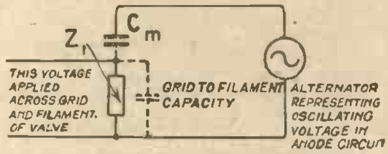

Fig. 2.—A diagrammatic representation of Fig. 1.

The reason for this lies in the inter-electrode capacity. The voltages which are developed across the external impedance Z_2 in the anode circuit produce currents which flow through the capacity between the anode and grid of the valve, which is shown as C in Fig. 1, and complete a circuit back to the filament through the grid impedance Z_1.

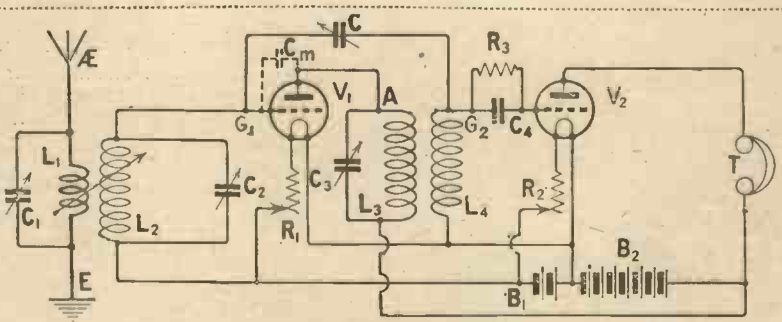

Fig. 3.—The original form of Hazeltine circuit.

Fig. 2 shows this part of the circuit re-drawn in somewhat simpler fashion. From this figure it will be seen that the voltage really splits up into two portions, one of which is dropped on the internal capacity C_m, and the other is developed across the external impedance Z_1. This latter voltage is, of course, applied across the grid and filament of the valve, and will be amplified as if it were an incoming signal.

Now it is easy to show that under the conditions which normally apply in a high-frequency amplifier, these voltages which are developed by this shunting effect through the capacity of the valve are in such a direction as to cause reaction or

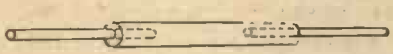

Fig. 4.—The original Neutrodyne condenser consisted of two short pieces of wire sliding within a length of insulating sleeving.

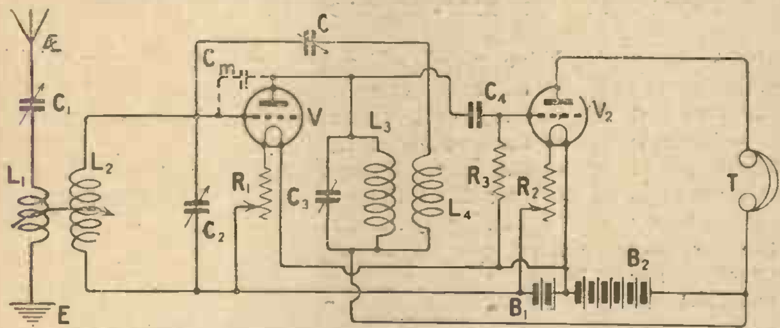

Fig. 5.—The Cowper modification of the Hazeltine circuit using the tuned anode principle.

feed-back. That is to say they will tend to produce oscillation, and if they are sufficient in quantity they will actually do so. It is this feed-back which, causing oscillation as it does, limits the amplification which is obtainable in a high-frequency amplifier.

The Neutrodyne

Professor Hazeltine, in America, proposed an ingenious method of overcoming this difficulty, which in one form or another has since come into very general use. He suggested that, in addition to the existing shunt path through the internal capacity of the valve, we should supply, external to the valve, another shunt path arranged in such a way that it would produce voltages across the grid and filament exactly equal and opposite to the voltages produced through the valve itself.

If this were done, it is obvious that the two effects would neutralise each other and the feed-back which causes the oscillation would be neutralised. One would then expect that the amplification of the valve could be increased to a figure somewhat more in keeping with the theoretical estimate, and in practice this anticipation was justified.

Increased Amplification Obtained

In an ordinary high-frequency amplifier, without any neutrodyne control, one finds that, as the potentiometer or other control is moved more and more towards the sensitive position, so the amplification rapidly increases, but that this increase is very soon cut short by the set bursting into oscillation. With a neutrodyned amplifier, however, the amplification continues to increase for a considerable distance past this point, and one is able to obtain a really effective amplification from the valve. There is no doubt, therefore, that neutrodyning is very distinctly worth the trouble, for it enables one to obtain more amplification from each valve, and therefore in the long run saves an additional valve, and possibly more.

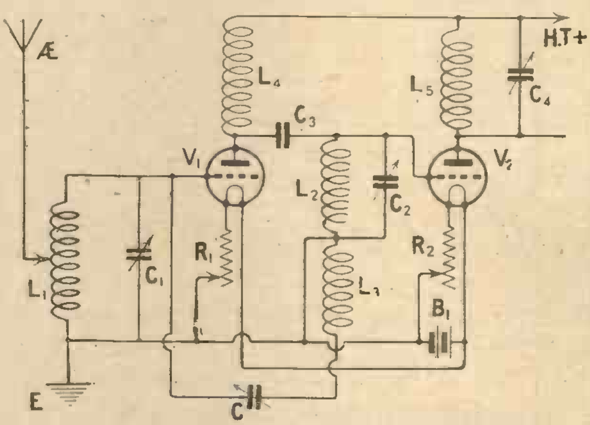

Fig. 7.—An efficient circuit in which H.T. supply to V₁ is obtained through the radio choke L4.

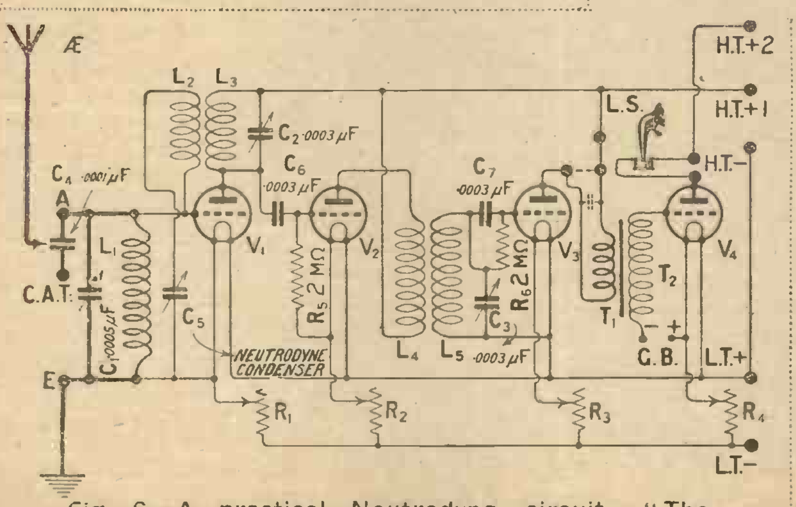

Fig. 6.—A practical Neutrodyne circuit, "The Harmony Four," described by Mr. Percy W. Harris in the September issue of this journal.

The Original Circuit

The original circuit employed by Hazeltine for his neutrodyne arrangement is shown in Fig. 3. Here a small condenser is connected between the grid of the second valve, at the point G_2, back

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to the grid of the first valve G_1. The functioning of this can readily be seen. If the voltage developed at the point A in the anode circuit of the first valve is such as to apply voltages through the capacity C_m of the first valve, across the grid and filament in such a direction as to cause oscillation, then the neutralising arrangement must be such as to apply voltages in the opposite direction.

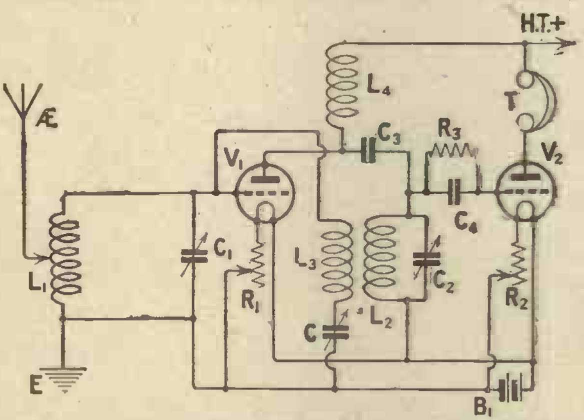


Fig. 8.—Hand-capacity effects may be obviated by placing the lower end of the condenser C at earth potential.

Now the voltage developed across the coil in the grid circuit of the second valve (which in this case is the secondary of an ordinary anode-tuned transformer), is in the opposite direction to the voltage existing in the anode circuit. Therefore at any instant the voltage existing at the point G_2 is in the opposite direction to the voltage existing at the point A. Consequently, if this voltage is allowed to produce current through the neutralising capacity C, it will produce voltages across the grid and filament of the first valve in the opposite direction to those voltages which are produced by the current flowing through the capacity of the valve itself, and thus by a suitable adjustment of the value of the condenser C, this anti-reaction can be so adjusted as to neutralise completely any tendency to oscillation, so making the amplifier absolutely stable.

Over Neutralisation

It will be obvious that, in order to accomplish this, the size of the neutrodyne condenser C must be of the same order as the anode to grid capacity of the valve. Now this capacity is very small indeed, ranging from 5 to 10 $\mu\mu$F for ordinary receiving valves, which requires rather special construction if it is to be duplicated mechanically.

However, it is not necessary to employ quite so small a capacity, as will be seen from the following considerations. The larger the condenser the more easily can the energy by-pass through it. Consequently, if the condenser is made too large, over-neutralisation will occur, and the circuit will begin to lose efficiency, and ultimately, due to certain secondary effects, it may even commence to oscillate once again, in this case on a different wavelength from that which is being received.

Neutrodyne Condensers

We can avoid over-neutralisation, however, and still use a reasonably large condenser, by reducing the size of the coil which supplies the energy in the first case, *i.e.*, L_4 in Fig. 3. With the original circuit, Hazeltine used very small condensers, made up from two lengths of wire partly covered with insulating sleeving, as shown in Fig. 4. These condensers had a capacity of the same order as that of the anode-grid capacity of the valve itself.

By taking a tapping from the secondary winding, however, the condenser C may be increased in value, and this enables us to utilise a practicable form of small condenser for neutrodyning purposes.

There are now various makes of condensers suitable for neutrodyne circuits, having a capacity of the order of 50 $\mu\mu$F.

Tuned Anode Circuits

If such a condenser were used with the circuit of Fig. 3, it would have to be connected, not to the point G_2, but to a tapping across a comparatively small portion of L_4.

It is more usual however, as will be seen, to employ a tuned anode arrangement. One of Mr. A. D. Cowper's arrangements suitable for use with a tuned anode system is indicated in Fig. 5. Here it is necessary to have a coil coupled to the tuned anode coil itself in order to produce

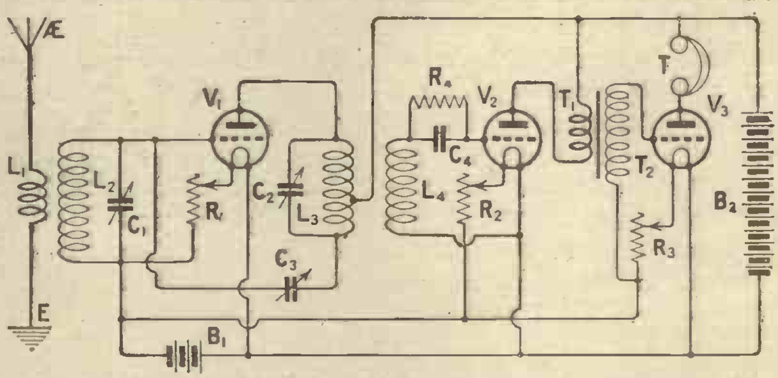


Fig. 9.—The Neutrodyne coil in this case is made part of the tuned circuit, L_3 C_2.

the voltage in the opposite direction, as has just been described.

The voltage induced into this coil is then allowed to pass current back to grid of the first valve through a neutrodyne condenser, as has just been described.

Standard neutrodyne units are made up for this type of circuit, the primary winding being tuned and inserted in the anode circuit of the valve, and the secondary winding being used as the neutrodyne winding and connected back to the grid of the valve through the neutrodyne condenser.

Operation of Circuit

After the neutrodyne condenser has been correctly inserted, the value of the capacity is then adjusted until the circuit can be brought to its most sensitive condition without causing any self-oscillation or howling.

With complete neutralisation there would be no tendency to oscillate whatever, assuming that there was no appreciable magnetic coupling between the coils in the grid and anode circuit of the same valve, but in practice the neutralising is not carried to this pitch, as a certain tendency to oscillation gives a reaction effect, which is useful.

It is found that the setting of the neutrodyne condenser remains fairly constant over a wide range of frequencies, so that the broadcast band can usually be covered with one setting.

Other Forms of Neutrodyne Circuits.

A modification of this circuit, which is employed by Mr. Percy W. Harris in the Harmony Four, which was described in last month's issue, is shown in Fig. 6. In this case the neutrodyne coil is connected to the grid of the valve and the neutrodyne condenser between the end of this coil and the negative of the filament. This, of course, enables one terminal of the neutrodyne condenser to be practically at earth potential, which gives less tendency to hand effects.

Another circuit which is a modification of the original neutrodyne, also suggested by Mr. A. D. Cowper, is shown in Fig. 7, in which the high-tension supply to the first valve is obtained through a high-frequency choke, and the high-frequency currents are by-passed through a suitable condenser on to the grid of the next valve. This is a form of circuit which is capable of giving very satisfactory results, if properly handled, and in a case like this the neutrodyning arrangement would be somewhat as indicated.

If, of course, it was desired in this case also to place one of the plates of the neutrodyne condenser at earth potential, that is to say, if any hand effects were obtained with this arrangement, the neutrodyne condenser could be inserted in the position shown in Fig. 8, which would not cause any radical alteration to the circuit itself.

A circuit which may be convenient in certain circumstances is that shown in Fig. 9. Here the neutrodyne coil is made part of the tuning circuit, the condenser C_2 being connected across the whole coil L_3.

Loud-Speaker Circuits

A stage of low-frequency amplification has been added to the circuit in Fig. 9 to enable the signal strength to be increased, to operate a small loud-speaker on near-by stations.

This circuit, however, may not prove as suitable as some of the previous ones, as there is a tendency for the adjustment of the neutralising condenser to vary the anode tune.

This defect is not present in the circuits described earlier in this article, which can be stabilised without any effect on the tuning. A good circuit for loud-speaker working is that shown in Fig. 10, in which two stages of low-frequency amplification are incorporated. This circuit would give good reception of distant stations and loud-speaker strength on a large number of closer stations.

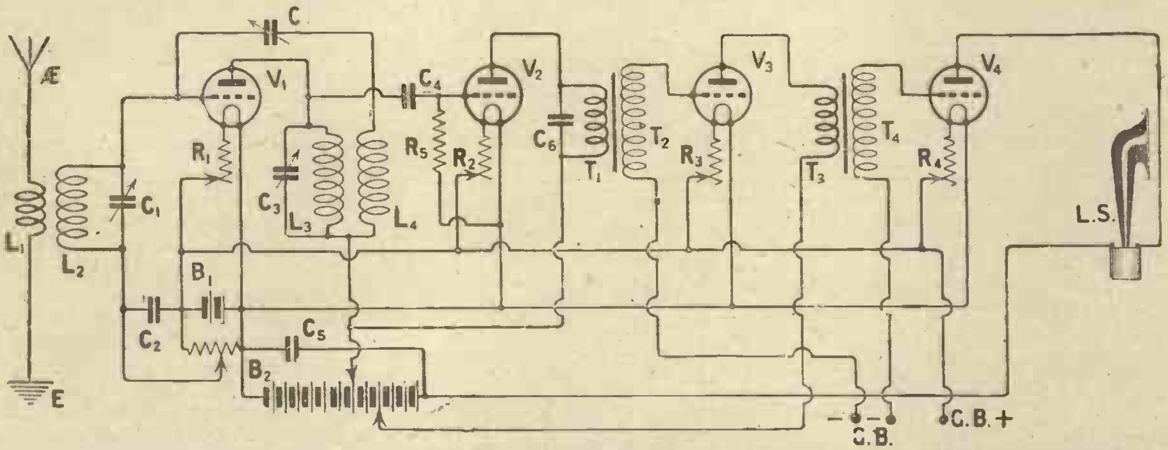
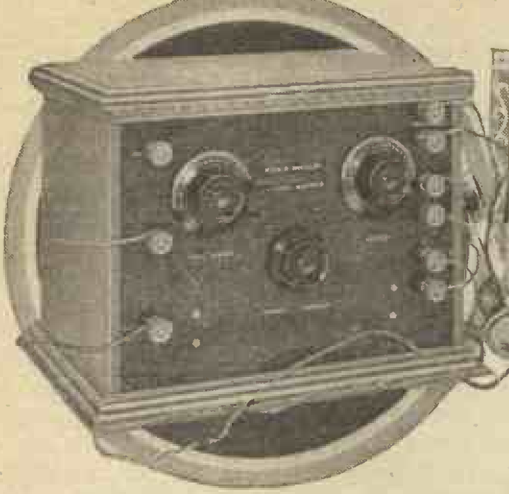


Fig. 10.—A four-valve circuit, suitable for general work. L_1 is an aperiodic coil with a small number of turns, and in conjunction with the neutrodyned portion of the circuit constitutes a very selective and stable arrangement.

Conclusions

The foregoing considerations will indicate quite clearly that there is a distinct advantage to be gained from neutralising the valve capacity. Any of the methods described may be used, although the neutrodyne itself, with the simple modifications proposed by Mr. Cowper has advantages in that various plug-in neutrodyne units may be obtained which are specially designed to work with the various types of neutrodyne condenser now on the market. Provided reasonable care is taken, the results obtained amply repay the additional trouble.



IMPROVING REACTION CONTROL
An Unusual Single Valve Arrangement

By
Stanley G. Rattee. M.I.R.E.,
Staff Editor

THE secret of long-distance reception when using a single-valve receiver largely depends upon a fine control of reaction.

Probably the most popular method by which a reaction effect is obtained in receivers of the type under consideration is that of variably coupling a coil in the plate circuit of the valve to the aerial or grid coil, and though this method has much to commend it, it has nevertheless certain disadvantages, the chief being that variation of the reaction coil coupling upsets the aerial tuning adjustments.

Reaction Control

When using a receiver of this type for long-distance reception it is often found that the required fineness of reaction coupling cannot be obtained on account of the receiver falling into oscillation before the maximum signal strength is obtained. Further, when the reaction coil is moved away to stop the receiver oscillating, it is sometimes necessary to separate the two coils by several further degrees before the non-oscillating condition is obtained.

Other Methods

Apart from the swinging coil method, there are several other ways by which a reaction effect may be obtained, chief among which is the well-known Reinartz method, where the reaction coil is immovable and adjustment given by a variable condenser.

In the receiver to be described will be found still another method by which a fine adjustment may be obtained, while the reaction setting does not affect the aerial tuning. The reaction coil is coupled to the grid coil in the usual way, but in this case the coupling is not variable, control being given by a variable condenser.

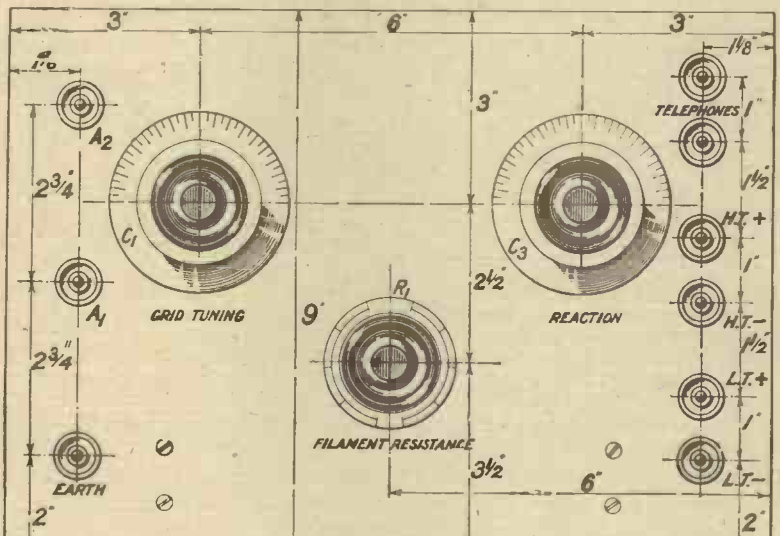


Fig. 1.—For the reception of 5XX the Aerial should be connected to A2.

The Aerial Circuit

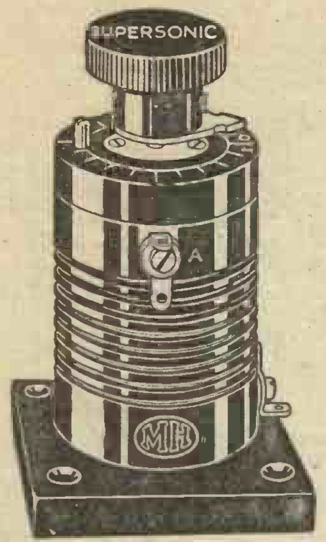
In order that long-distance stations may be received, it will be appreciated that some attention must be given to the question of selectivity, and in the present receiver auto-coupling is employed with the earth connection arranged in such a way that the aerial turns may be varied in their number. This same earth tapping also serves the purpose of allowing grid damping to be reduced, bearing in mind, however, that when reducing the grid coil turns, the aerial turns are increased in number, thus reducing selectivity. A complicated arrangement possibly, but a compromise is easily found, when the receiver becomes both highly selective and sensitive, in addition to being delightfully easy to operate.

The Circuit

In Fig. 2 is given the theoretical circuit of the receiver, and it will be seen that there are in all three coils—L_1, the grid coil, with its earth connection shown variable; L_2, the fixed reaction coil; and L_3. This last coil is a radio frequency choke, and is shunted by a variable condenser, which is used to give control of reaction; the value of this condenser is $\cdot 0003\mu F.$, and though in the present receiver this was found to be large enough, it may be experienced with some aerials that a larger value is required. In order to meet such a case, the receiver is fitted with two clips for adding a fixed condenser in parallel should occasion demand its inclusion.

5XX

Though the receiver is intended primarily for reception of the short-wave stations, the inclusion of



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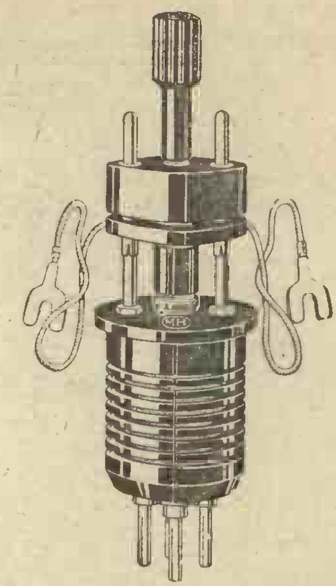

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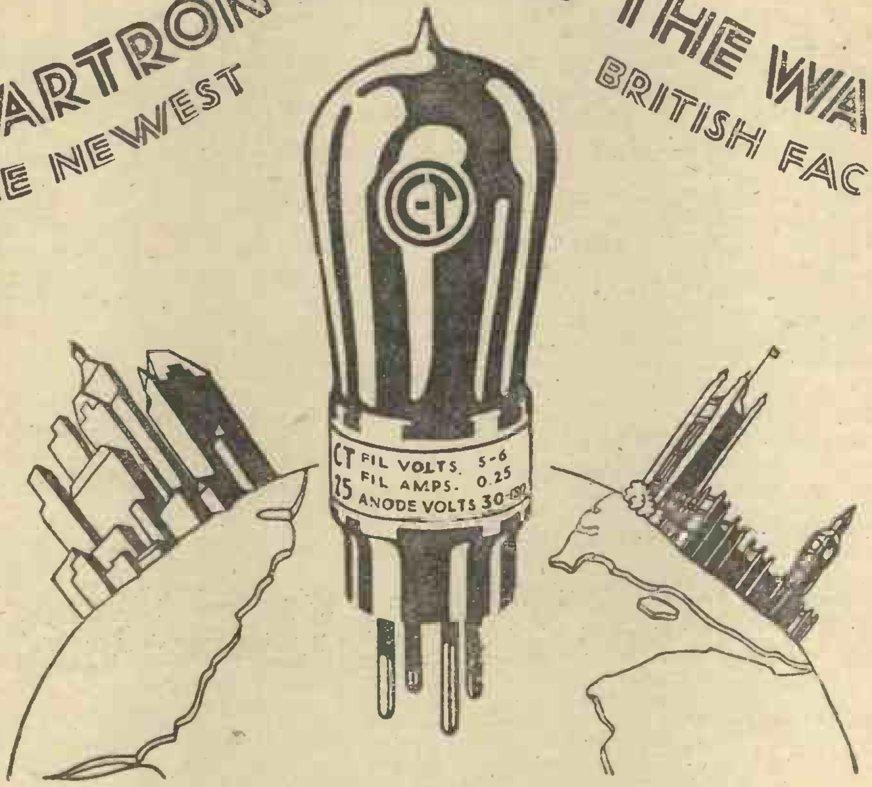

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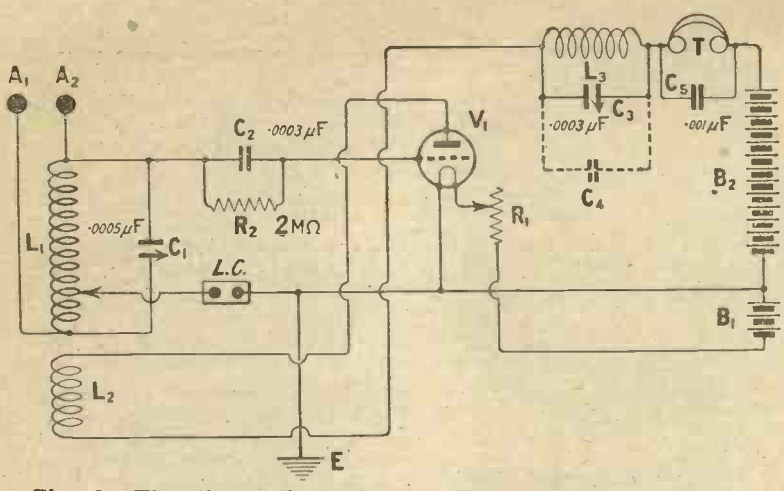


Fig. 2.—The theoretical circuit. The condenser C4 is of the clip-in type.

a loading coil socket permits the receiver to be tuned to the wavelength of 5XX; in this case, however, the aerial is connected to A_2. On account of the few reaction turns required to make the receiver oscillate upon the lower wavelengths, it is obvious that some addition must be made to make the receiver oscillate when tuned to 1,600 metres (187.4 Kc); and in order to overcome this difficulty, the coil socket which holds the choke coil is secured near to the reaction coil by one screw only, so that this coil may be coupled to the loading coil, fine control of this reaction adjustment being given by the variable condenser shunted across the choke.

Components and Materials

The coil used in this receiver is one of the special low-loss types, as may be seen from the various photographs. This type of coil is one known as the "three-step," and its origin is due to Mr. G. P. Kendall, B.Sc., who described its merits in the first issue of *Wireless*. It may be purchased ready wound from the firm supplying the former. The remainder of the components are of conventional type. As regards values, particular attention should be given to the inclusion of components having precisely the same values given in this list, otherwise considerable difficulty may be experienced in either making the receiver oscillate with easy control or else to make it oscillate over the whole range of the grid tuning condenser. It is furthermore essential that the condenser across the telephones be included.

1 "Three - Step" coil former. (Burne-Jones and Co., Ltd. This firm also supplies the coil ready wound if desired.)

½ lb. No. 22 enamelled copper wire.

1 Dual rheostat, (L. McMichael, Ltd.)

1 Clip-in condenser of .0003 μF. capacity, with stand. (L. McMichael, Ltd.)

1 Grid-leak and clips of 2 megohms, with stand. (L. McMichael, Ltd.)

1 Clip-in condenser .0002 μF., with stand. (L. McMichael, Ltd.)

2 Low-loss variable condensers, one of .0005 μF., and the other of .0003 μF. (Jackson Bros.)

9 Brass terminals. (Those illustrated are the P.O. type, obtainable from Radio Instruments, Ltd.)

2 Coil sockets for baseboard mounting. (Burne-Jones and Co., Ltd.)

1 Short-circuiting plug. (Burne-Jones and Co., Ltd.)

1 Anti-capacity valve holder. (Peto-Scott Co., Ltd.)

1 Fixed condenser of .001 μF. (Wates Bros.)

1 Spring clip. (Burndept Wireless, Ltd.)

1 oz. No. 32 d.c.c. wire. (Scientific Appliances, Ltd.)

1 Insulating panel measuring 12 in. by 9 in. by 3/16 in. (Radion.)

1 Cabinet and baseboard. (H. Agar.)

2 Right-angle brackets for securing the panel to the baseboard.

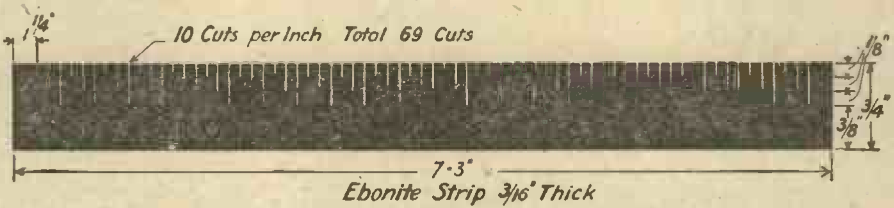
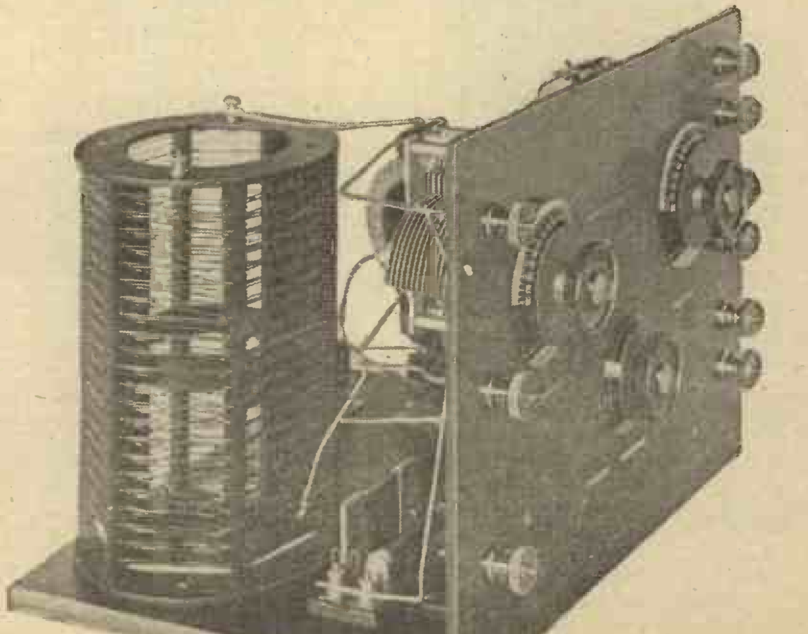


Fig. 3.—Details of the coil former strip.



The reaction coil L2 may be seen in the bottom slot of the coil former.

one set Press panel transfers.
Quantity of connecting wire.

The Coil

As stated previously, this is wound upon a "three-step" former, which will be found to allow of 69 turns being wound from start to finish. In the present receiver the last turn is removed from the former altogether, the 68th turn being secured by threading the No. 22 enamelled wire through a hole provided in the former. The vacant slot is used for winding the reaction coil, the turns of which are close wound in the same slot, there being nine complete turns of No. 32 d.c.c. wire. The actual number of turns wound for this reaction coil should preferably be found by experiment, and though in most cases nine will be found sufficient, there may be other cases where the receiver will not oscillate at the lower end of the grid condenser scale, indicating that there are too few turns.

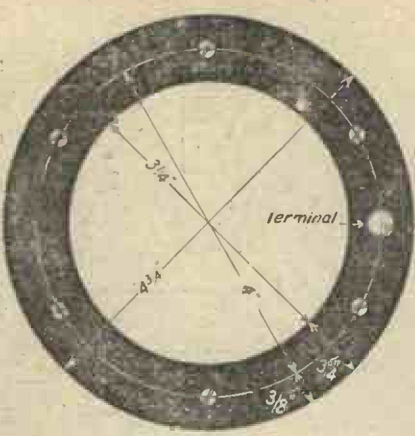
The Reaction Turns

When building the receiver it would be best to wind, say, a dozen turns for the reaction coil, when one turn at a time may be removed during the period of tuning the receiver in actual operation. This removing of turns does not in any way necessitate dismantling the coil or receiver, as they are easily removed by merely unsecuring the last turn and unwinding as required.

Construction

The winding of the coil, should it not be procured already wound, is perfectly straightforward, in that the No. 22 enamelled wire is first secured in one of the holes provided in the rings of the former and then one complete turn is wound in the first slots; the wire is then crossed over to the next slot, when the operation is repeated, the wire in this case being crossed over to the third slot. When this third turn is wound the wire is crossed over to the fourth row of slots, which will be of the same level as those of the first turn; the fifth turn will be of the same level as the second turn, while the sixth turn will be the same as the third, and so on. When sixty-eight complete turns have been wound the wire should be secured through one of the holes provided in the ring at the opposite end to that where the coil winding was commenced.

We now have one row of slots perfectly free, and into these are wound the reaction coil turns, using No. 32 d.c.c. wire; the number of turns, as previously advised, being determined by actual experiment. The beginning of this winding is secured by twisting the wire round the actual ebonite base where the first turn is to start, whilst the end of the coil is preferably not secured at all until the correct number of turns is found; the wire being of such a small gauge is soft enough to stay in position without unravelling. When the number of turns is decided upon, the end of the coil may be secured through one of the holes in the ring nearest to it.



Ebonite Disc 1/8" Thick

Fig. 4.—The dimensions of the end discs of the coil former.

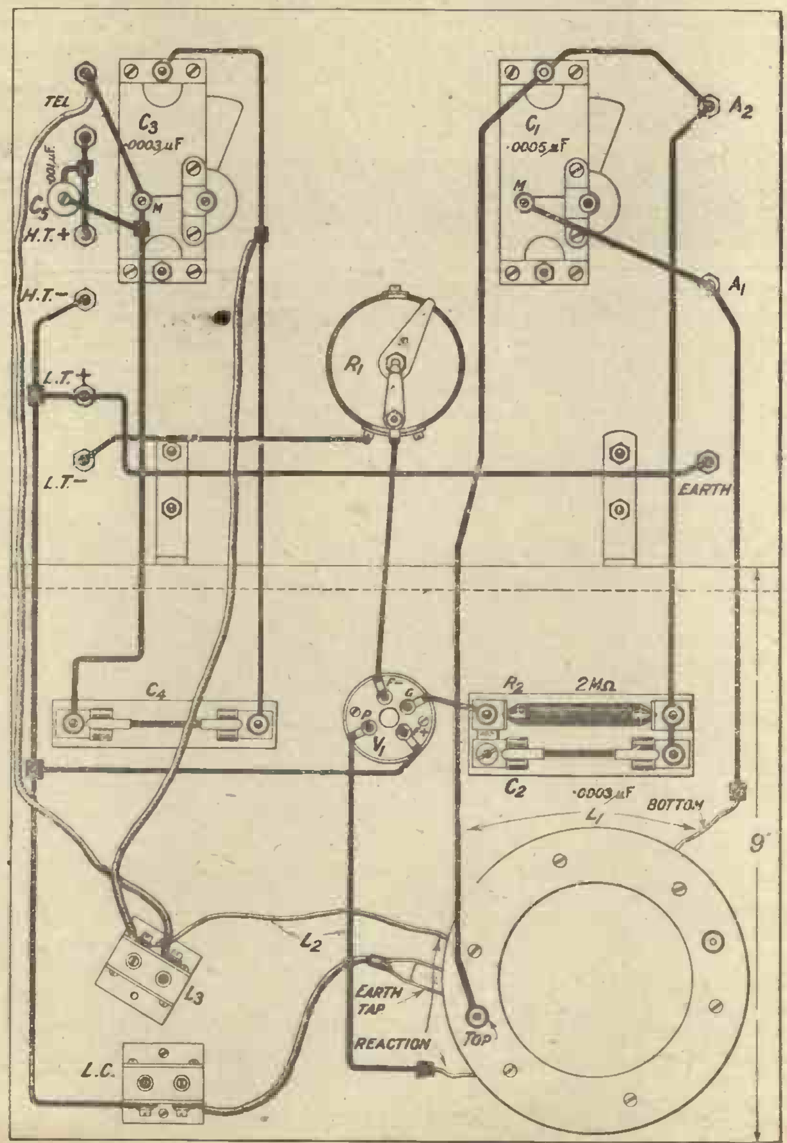


Fig. 5.—The condenser C4 may not be necessary. In any case its value should be determined by experiment.

Connecting Up

The panel, after being drilled in accordance with the instructions given in Fig. 1, should be secured to the baseboard by means of the two right-angle brackets, whereupon the components and terminals may be mounted in their respective positions, care being taken to give sufficient

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P.V. 8 D.E. ..	**22/6**	3
A.R. (L.F. or H.F.)	**8/–**	4
R.	**8/–**	.4
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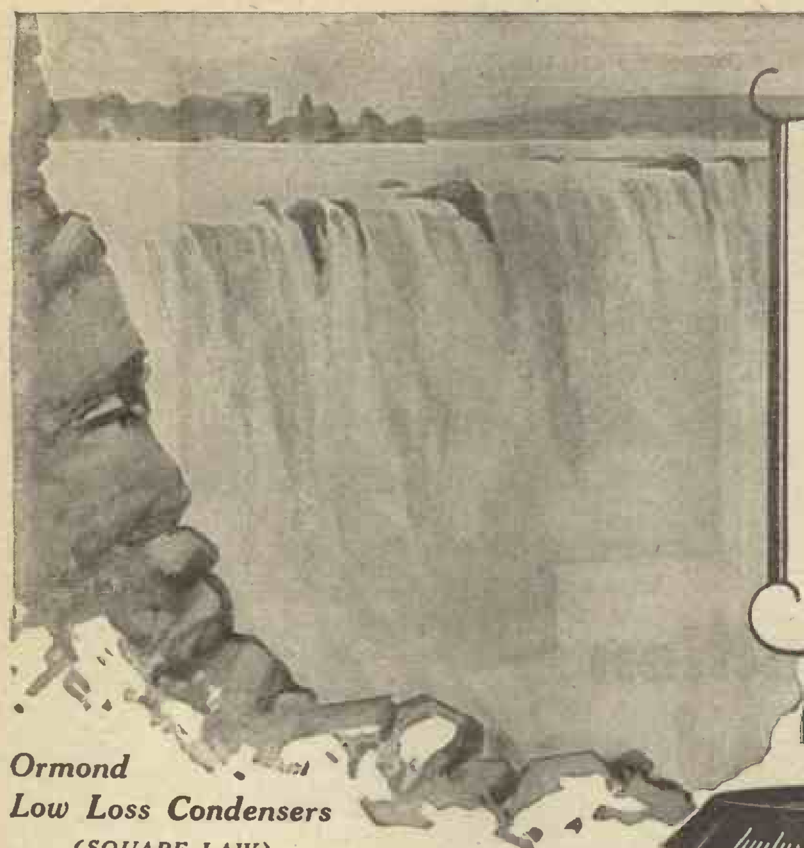

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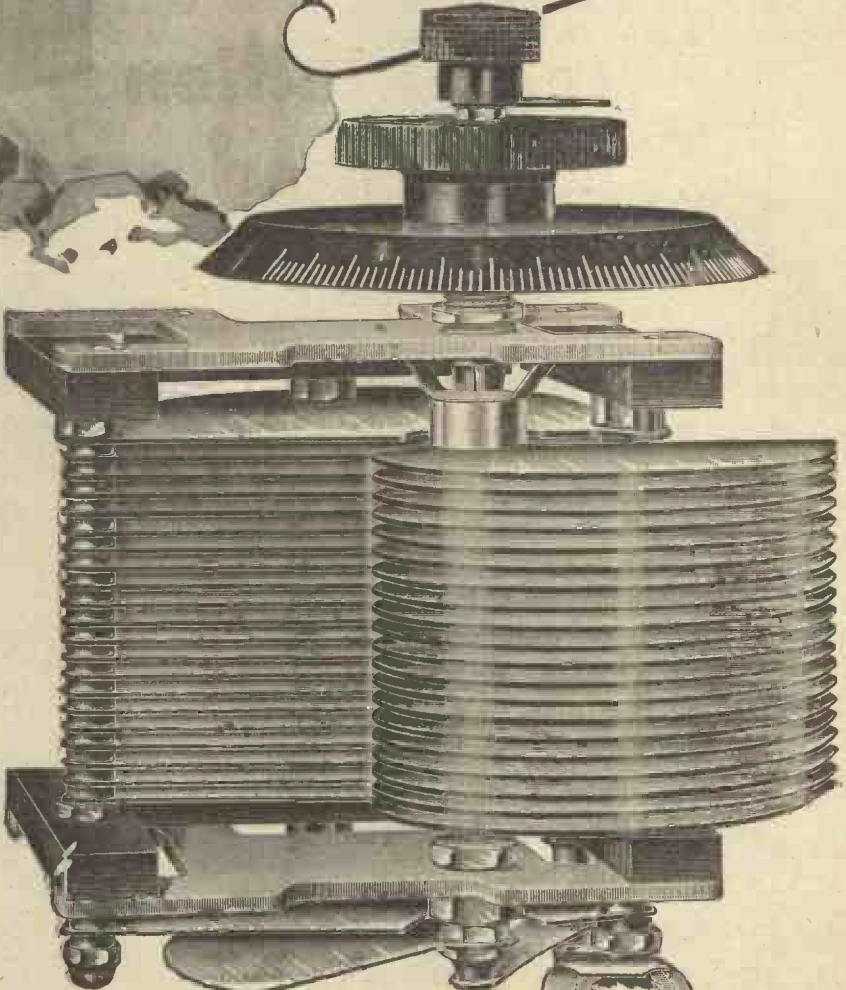

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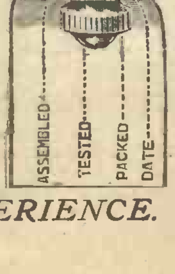

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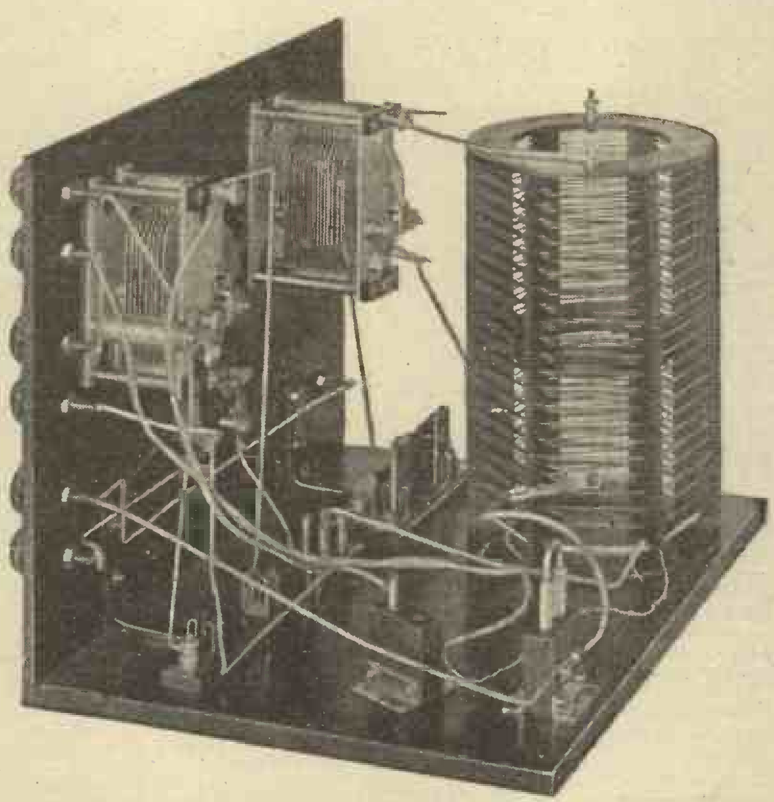
clearance between the valve and the moving vanes of the reaction condenser. The positions of the choke and loading coil sockets should also be determined upon with care.

When mounting the coil, that end which supports the reaction coil should be mounted on the baseboard, and that section of grid coil turns which is nearest the loading coil socket should be rubbed with fine emery or sand paper in order to remove the enamel, thus enabling the connecting clip to make proper contact with whichever turn is being used.

Testing the Receiver

When the wiring is completed, the receiver should be tested for oscillation before the actual reception tests are attempted. The batteries, aerial and earth and telephones, should be connected to their respective terminals, and a suitable valve inserted in the valve socket. The aerial connection should be first made at A_1, and the shorting plug inserted in the loading coil socket; a No. 250 coil or larger should be inserted in the choke coil socket, and the Burndept connecting clip attached to, say, the twelfth turn from the bottom of the coil. At this stage adjust the H.T. voltage to about 45 volts. Set the grid condenser at its 180° setting, with the reaction condenser adjusted to its zero reading. Light the valve to its normal degree of brilliance and turn the reaction condenser slowly towards its higher reading; if it is found that the receiver does not oscillate until, say, the 160° reading is reached, move the connecting clip *up* one or two turns, when the receiver will be found to oscillate more freely. If, however, it is found that the receiver will not oscillate at all, either by adjusting the connecting clip at various turns or by increasing the value of the reaction condenser by means of adding a fixed condenser in parallel, then the connections to the reaction coil should be reversed. If it is still found that the set will not oscillate, then the reaction turns should be increased in number, though if the former instruction indicating that twelve turns be wound to start with this difficulty will not arise. The position of the connecting clip will vary with different aerials, but as an indication of its approximate position the best results are obtained on my own aerial when it is connected to a turn about the fifteenth from the bottom; the actual turn number not being critical, though the smaller the figure the better for reasons of selectivity.



The choke coil socket L3 is secured to the baseboard by means of one screw only.

Absence of Control

The next problem which may face the constructor is that the receiver will not stop oscillating, which fact indicates (1) that the reaction coil is too large, and turns should be pulled off one at a time, tests being made each time until the correct control is given; and (2) if the fixed condenser is in parallel with the variable, it should be removed. The test should be carried out over the whole range of the grid tuning condenser with the connecting clip well down towards the bottom of the coil.

The reaction condenser should give a smooth and easy control of oscillation without "floppiness"; it will be found preferable to adjust the reaction turns so that the receiver will oscillate over the whole range without the ability to "howl"; the ideal being when the set will just oscillate over the whole range. A big reaction coil will mar to a great extent the smooth control which the reaction condenser will normally allow.

Valves

The receiver under description has been tried with both bright and dull emitter general purpose valves, and also with special valves, such as the B.4, D.E.4, D.E.5B., and has given equally good results with these types. Though with some valves the receiver is found to oscillate more freely than with others, there is nevertheless a good smooth control of reaction in all cases.

Testing for 5XX

When the tests upon the shorter wavelengths have proved satisfactory, the aerial connection should be changed to A_2, the shorting plug substituted for a No. 150 coil, and if the choke coil was formerly a large one, this should be changed to one of the order of a No. 100. The connecting clip should be connected to the last turn. The No. 100 coil should be set at right-angles to the loading coil (No. 150) and tuning made upon the grid tuning condenser with the reaction condenser set at, say, 90°. Increasing the reading of the reaction condenser and varying the angle between the choke and loading coils will now give a sufficient amount of reaction, control being obtained by varying the reading of the reaction condenser.

Operating the Receiver

Tuning is obtained by means of the grid tuning condenser.

(*Continued on page 67.*)

The "Three-Valve Dual" and A.B.C. Wave Trap.

SIR,—After two unbroken years of experimenting with MODERN WIRELESS circuits, I have discovered a solution to my ever-present problem of local interference such as I had not hoped for.

In the early days when the "Three-Valve Dual" (described by Mr. John Scott-Taggart in the April, 1924, issue of MODERN WIRELESS) first fascinated me, I failed to make it a success, due entirely to over-confidence, but my "Simplified Three-Valve Dual" (designed by Mr. John Scott-Taggart and described in the March, 1925, issue of MODERN WIRELESS) to-day is the result of returning to the old love after careful and logical progress with such circuits as the All-Concert and Transatlantic Three, from the encouraging results of which I have learnt so much.

Great Volume from London

For the last two months my "Three-Valve Dual" has been giving phenomenal signals on London. But distant reception seemed choked, and I frankly confess that I was on the point of thinking that I had got the best obtainable, and that the hobby of wireless was resolving itself into a losing fight against the increasing power of the local broadcast stations. It is because I think many other amateurs must have the same desperate feelings at times, and struggle with wild oscillation to fight their way outside the barrier of the local station, that I give you the following experience which occurred in the short space of ten minutes last Sunday evening.

A Transformation

Sceptically I had purchased the No. 6 Radio Press Envelope, by Mr. G. P. Kendall, on how to make the A.B.C. Wave Trap. At 9 p.m. last Sunday evening with the Type A Trap in circuit I switched on my "Three-Valve Dual" and the R.A.F. Band at 2LO roared at me loud enough to blow the ear caps off my head phones. I turned the trap condenser 15 degrees and London grew suddenly faint, at 17 degrees London vanished. At this point I hardly dared to touch the condensers on the receiver, but I did so with momentary expectations of hearing London rattling my ear drums. A 10 degrees movement and a woman's voice came through. One fractional adjustment, and I brought my switch from telephones to loud-speaker almost frantically. The room was full of sweet and mellow music, with a woman's voice clear and strong. I had got Hamburg with a vengeance, and 2LO to all intents and purposes had vanished. Then over to Birmingham, then to Paris, then to Newcastle, and I just trembled to think of this sudden and unexpected climax to my two years' struggle against London. Here was the R.A.F. Band in London raging away inside my Wave Trap, and the rest of the world at my bidding.

Only a Poor Aerial

Let me say that my aerial is not a happy one. Some 60 ft. long, 25 ft. high, trees on two sides, and walls all round is the best I can manage. My earth is the 7-lb. biscuit tin recommended by Mr. Harris, buried about 2 ft. down. The A.B.C. Wave Trap, however, seems to give the receiver astonishingly increased life. It is true that if I deliberately heterodyne London's wavelength I break the spell of the wave trap, but then this is totally unnecessary, and 5 degrees on either side of 2LO stations come in clearly on my Amplion, with London absolutely out.

No Loss of Signal Strength

The suggestion that loss of signal strength is sustained by the use of this device is not borne out by the results which I have secured on a hot thundery night in August, and if my "Three-Valve Dual" and Wave Trap combination has given me such remarkable freedom from local interference, I for one can very warmly recommend your other readers to experiment along the same lines. — Yours faithfully,

H. F. TREVILLION.

Streatham, S.W. 16.

Improving Reaction Control

By STANLEY G. RATTEE, M.I.R.E.

(Continued from Page 65.)

Reaction is obtained with the reaction condenser, and the connecting clip is changed from one turn to another until the maximum signal strength and desired degree of selectivity is obtained. It must be remembered, however, that any alteration in the position of this clip necessitates resetting both the variable condensers. Probably the best station upon which to practise for the first time is the nearest, and those readers who live fairly near to a main broadcasting station, say, within 50 miles, will be able to pick up this station by first setting the reaction condenser to its zero reading and then slowly turning the grid tuning condenser until the station is heard and tuned to its maximum strength. The reaction condenser may now be revolved very slowly until a reading is reached at which the receiver bursts into oscillation. At this point the dial should be turned quickly two or three degrees towards the zero reading or just until the set stops oscillating, and slight adjustment made upon the aerial tuning condenser. This operation should be tried with the connecting clip in various positions for the best signal strength and highest degree of selectivity, but when this is found, then the clip may be left alone.

Reaction Adjustment

The only adjustment which calls for careful handling is the reaction setting, and with most valves it will be found that the receiver will pass into oscillation with a faint click, assuming that the H.T. is 45 volts as previously indicated. This click is undesirable, and it should now be the ambition of the constructor to remove it by carefully adjusting the filament current and reducing the H.T. voltage until the set almost passes into oscillation without his being aware of the fact. As soon as these adjustments have been made, then the more distant stations may be looked for, with the set adjusted so that it is just on the verge of oscillation.

Stations Received

Using this receiver in S.E. London (in the lee of the Crystal Palace), upon a poor outdoor aerial, London is received at too great a strength for telephone use, though a few degrees on either side of this adjustment upon the grid tuning condenser eliminates the signals completely. In the reception of the more distant stations, signals are relatively as good, the reaction control being delightfully smooth, while the selectivity possible is equally attractive.

Using a D.E.4 valve with 40 volts on the plate, the loudest stations appear to be Birmingham, Newcastle, Radio-Toulouse, and Radio Belge, whilst other stations come in at good strength though not quite so loud; a number of these appear to be too modest to announce their identity, their nationality, however, would appear to be German.

Among the identified stations are Oslo, Hamburg, Frankfurt and Ecole Supérieure.

The receiver is both selective and easy to operate, the control of reaction being delightfully smooth.

A Sharp-Tuning Crystal Set

by E. J. Marriott.

(Continued from Page 46.)

Test Report

The receiver was tested on a moderate aerial about 6 miles west of 2LO. That station was received at excellent strength, and it was found that best all-round results, considering signal strength together with selectivity, were obtained with the aerial coil in nearly the maximum coupling position, and the crystal tapped across only 52 turns of the secondary coil.

It was noticed that the smaller the number of turns across which the crystal was connected, the greater was the selectivity obtained. Quite good signals were also received with the crystal across only 12 turns.

Daventry

With regard to 5XX, this station was heard at satisfactory strength, the aerial now being joined to A1 with a 150-turn coil plugged in the loading socket and the crystal connected across both the low-loss and the loading coil. Signals could also be heard with crystal tapped across only 30 turns of the low-loss coil, but in this position they were decidedly weak.

A TWO-VALVE HARTLEY-REINARTZ RECEIVER

By

John W. Barber

THE attention of serious experimenters has for some time been concentrated upon very short waves, ranging downwards from 100 metres (2998 Kc.), until at present waves of 20 metres (14991 Kc.) are in constant use, and this fact has necessitated the design of special transmitting and receiving circuits, or rather the modification of ordinary well-known circuits to suit the new conditions, and many interesting developments have been brought forward from time to time.

A Modification

The particular modification of the Hartley transmitting circuit which is in general use upon short waves, in which the main inductance is split into two portions, these latter being joined up through a variable condenser, provides much scope for experiment when the coils are increased in size so as to cover the broadcast band, and many interesting hours have been spent in getting the assembly to function satisfactorily on the broadcast waveband.

The circuit, which is shown in the diagram, and which was described by Mr. A. D. Cowper, M.Sc., in the August, 1925, issue of this journal, will be seen to consist of two valves, a detector followed by one stage of note magnification.

The aerial is joined through a twenty-turn coil, to earth, the coil being wound upon the same former as the anode and grid coils, the latter being of the same size and spaced equally on each side of the aerial coil. The inner ends of the anode and grid coils are connected together through the condenser C_1, which serves to give a very smooth reaction control. In the original circuit which Mr. Cowper described, a variable condenser of ·001 μF capacity was used, in order to obtain the best reaction control, but as I did not find anything larger than ·0005 μF necessary in my experiments, I have used a condenser of the latter size for the purpose. Should the circuit be uncontrollable in any particular circumstances a larger condenser may be substituted, or alternatively a fixed condenser of suitable size may be joined up in parallel with the existing reaction condenser. The tuning condenser is connected across grid and plate, across the outer ends of the split Hartley inductance, the usual grid condenser and leak being provided next to the grid as shown, the leak being taken to positive L.T.

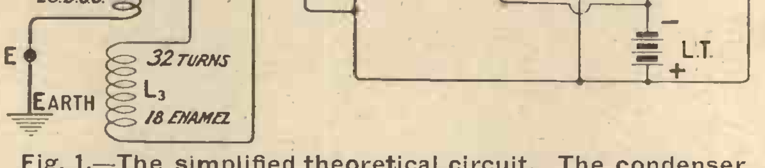


Fig. 1.—The simplified theoretical circuit. The condenser C_1 in the middle of the Hartley inductance controls the reaction effect.

A Selective Circuit

The result is a very selective circuit, which is capable of entirely eliminating strong local transmissions, thus enabling broadcasting to be received with minimum interference from undesired sources, such as ships at close quarters, as well as providing a means whereby weaker signals may be searched for without the annoying background from the local station persisting.

The secondary inductance consists of 64 turns in two portions of 32 turns each, wound in low-loss fashion upon a threaded squirrel-cage type of former, the threads being cut sixteen to the inch. Five threads are left on each side of the aerial coil, which is wound in the middle of the former, the outer positions being occupied by the two halves of the main inductance. No. 20 d.c.c. wire is used for the aerial coil, twenty turns being wound on, and a

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GOSWELL (QUALITY RADIO).—Coils, mounted 25, 1/6; 35, 1/9; 50, 2/-; 75, 2/3; 100, 2/9; 150, 3/-; 175, 3/6; 200, 3/9; 250, 5/3; 300, 6/-. Valve Holders, Legless, 1/3. Sub-Panel, 1/3. 4-Valve Sockets, 1/-. Coil Stands Panel—2-way, 3/-; 3-way, 5/-. Cam operated—2-way, 9/-; 3-way, 12/6. Low Loss Coil Former, 3/9.

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"KAY RAY" DETECTORS.—Enclosed nickel fittings, trigger movement, 2/6; Permanent, 2/-. Do., one-hole fixing, 2/6.

LOUD-SPEAKERS (Various).—Sterling "Baby," 50/-, 55/-; Dinkie, 30/-; Primax, 155/-; Amplions Dragon Fly, 25/-; Junior 27/6; A.R. 111, 50/-; A.R. 114, 65/-; A.R. 19. 105/-. Browns, all models, Ultra, 27/6; C.A.V., 27/6, 30/-. And all new models makers' prices.

LISSEN PARTS.—Anode or Variable Grid Leak, 2/6 ea.; L.F. or H.F. Choke, 10/-. Switches, D.P.D.T., 5 point Reversing, 4/- each. 2-way series Par., 2/9 each. Minor, 3/6; Major, 7/6. Universal, 10/6. Potentiometer or Wire Rheostat, 4/- each. Neutrodyne Condenser, 4/6. Coils 25, 35, 4/10 each; 50, 5/-; 60, 75, 5/4 each; 100; 6/9; 150, 7/-; 200, 8/5; Lissen X 50, 6/-; 60, 6/4; 75, 6/5; 250, 9/9. Tuner. 22/6. Mark III. Var., 17/6

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MAGNUM (BURNE JONES).—H.F. Transformers, 7/- each. Coil Holders, 2-way, 9/6; 3-way, 12/6. Valve Holders, 2/6. Vibro, 5/-. T.A.T. Tapp. Coil, 8/6. Neut. Cond., 4/6. All parts stocked.

POLAR (RADIO COMM. CO.)—R.C.R. Unit, 15/-. Condensers, Micro, 5/6; Neut., 5/6. Variable, .001, .0005, .0003, 10/6 each. Coil Stands, Cam. V., 2-way, 6/-; 3-way, 9/6. Polar Sets stocked.

LOTUS (GEARED)—2-way, 7/-; 3-way, 10/6.

R. I. (RADIO INSTRUMENTS).—L.F. in sealed box, 25/-. Anode Choke, 10/-. Permanent Detectors, 6/-, 7/6. New Var. Air Condensers and V. .0003, 22/6; .0005, 24/-.

REFLEX RADIO COILS (Made under Burndept License).—35, 8d.; 50, 9d.; 75, 1/-; 100, 1/2; 150, 1/8; 200, 2/9; 250, 3/3. Post 2d. each. Mounts, 1/- each extra.

STERLING PARTS.—.00025 Square Law and V., 23/6; .0005, 25/6. Non Pong Valve Holder, 4/3.

L.C.O. (MANSBRIDGE).—2 Mfd., 4/8; 1 Mfd., 3/10; .25, 3/-.

SUCCESS (BEARD & FITCH).—L.F., all black Super, 21/-. Choke, 10/6 Var Condensers, No Loss, List Prices.

SHIPTON.—Rheostats, 7, 30, 60 ohms, 3/- each. Potentiometer, 600 ohms, 4/6.

TRANSFORMERS (L. F.)—Ferranti, 17/6; Pye, 22/6; Silvertown, 21/-; Ormond 14/-; Royal, 20/-; Lissen T1, 30/-; T.2, 25/-; T.3, 16/6. Powquip. 14/6; Formo Shrouded, 10/6; Ormond Lates Shrouded Model, 18/6; Croix, 9/6; Wates Supra, 12/6. Brunet Shrouded 5-1 or 3-1 13/6 each.

UTILITY (WILKINS & WRIGHT).—Coil Changing Unit, 7/6. Variable Condensers, .0003, 8/9; .0005, 10/6 (Vernier 2/6 extra). Switches, Knob, 2-way 4/-; 4-way, 6/-; 6-way, 8/-. Lever, 5/- 7/6, 10/-. Nickel, 6d. extra.

UNIDYNE (THORPE K. 4).—Bower Electric Genuine only Thorpe K.4 5-Pin Valve, 14/-. 5-Pin Holders, 1/3. Sets of parts, one Valve, 46/6; two Valve. 66/6 (excluding box and panel, but including valves) List sent post free.

WATMEL. — Variable Grid Leak, 2/6. Anode, 3/6. Green Knob, 3/6. Fixed Condensers, 2/6, 3/6 (all sizes).

WOODHALL PARTS.—L.F. Transformer, 23/6. Vernier Rheostat 7 ohms, 2/6; 30, 3/6; 2-way, 10/6.

"WONDER" AERIAL.—Multi 49 Strand, Phosphor Bronze, Indoor, Outdoor, Frame Aerial, 100 feet, 3/3.

SUNDRIES.—COIL STANDS.—2-way Standard, 2/9. Cam. V., 4/6; Geared, 5/6, 6/-. 3-way Standard, 5/-; Cam, 6/6; Geared, 7/11.

COIL PLUGS (Ebonite).—Fitted Fibre, 1/6 pair. Shaped, Brass sides, 1/8 pair. Standard, 1/- pair. Panel Mtg., 1/6 pair.

IMPOSSIBLE to advertise all lines here. Send name and address (postcard, please) for illustrated folder.

ACCUMULATORS.—2 v. 40 amps., 9/6, 10/6; 4 v. 40 amps., 15/11, 17/6; 4 v. 60 amps., 22/6, 23/11; 4 v. 80 amps., 25/-, 26/-; 6 v. 60 amps., 30/-, 33/-; 6 v. 80 amps., 37/6, 38/6; 6 v. 100 amps., 45/-. Radiocell, Rotax, etc., etc.

ATHOL VALVE HOLDERS. 1/3; Aermonic, 1/6. A.B.C. Wavetrap former, 3/6.

TERMINALS. Complete, per doz.—Ormond, W.O. and Pillar, generous size, 2/-; standard do., 1/3. Nickel, 6d. doz. extra. Phone, 1/1. Screw Pins or Spades, 1/-. Do., Red or Black, 1/6. Nickelled Tags, 6d. Brass Tags (3 doz.), 6d. Flush Panel Sockets, 1/- doz.

RHEOSTATS. — Raymond, 1/6. Extra quality with Dial, 2/6. Peerless, 6 or 30 ohms, 2/6 each. 6 or 30 ohms wound on china former, 2/- each. Ormond, 2/- Ormond New Model, 2/6

AERIAL WIRE (100 feet).—Heavy, 7/22, 2/6. Ribbon (Tape), 2/9.

FLEX (Twin), etc. (any length cut).—Red and Black, 12 yds, 1/6. Miniature Silk, 12 yds., 1/6. Rubber Lead in 10 yds., 1/8. Extra heavy, 4/- doz, Insulating Hooks, 1/8 doz. Empire Tape, ½", 12 yds. 1/-.

TOOLS.—Soldering Irons, 1/-. Set of high-class drills, 1/6. 4 Taps, 0, 2, 4, 6, BA, 2/6. set. Cutting Pliers, 1/8.

PHONE CORDS, etc.—6 ft. Rubber Insulated, 1/11; 7 feet do, 2/6. Loud Speaker, do., 12 ft., 2/6; 20 ft., 3/6. Beautifully made and finished.

COIL WINDERS (Honeycomb).—Westminster, 4/- "Kay Ray," well made, 46 spokes, handle, cannot be equalled, 2/-.

EBONITE (fine quality)—Cut to size, ½d. per square inch, 3/16, ¾d. for ¼". Post extra.

VARIOMETERS. —Standard 2/11. Ebonite Former Ball Rotor, 4/6. Inside wound (Similar to Edison Bell, etc.), 6/11. Complete with Knob and Dial.

PANEL SWITCHES, Nickel SPDT, 1/-, DPDT, 1/3.

VALVES.—Bright, 8/- each: Mullard Ora, Red or Green Ring. Marconi, R4, R5. B.T.H. "R," Ediswan AR. Cossor P1., P2. 14/- each: Mullard D3, Cossor W1., W2, Ediswan ARDE, B.T.H. B3, Marconi DER. 16/6 each: Mullard .06, DE3, Cossor WR1, WR2, Ediswan .06, B.T.H. B5, Marconi DE3. 18/6 each: Cossor W 3., Marconi DE6. 22/6: Mullard DF, "AO," "A1" Ediswan PV 1, 2,5, 8, B.T.H. B4, B6, Marconi DE4, 5, 5B, etc.

RAYMOND
Variable Condensers
SQUARE LAW LOW LOSS.

One hole fixing. Ebonite Ends.

With Vernier		Without Vernier	
.001	8/6	.001	7/6
.0005	7/6	.0005	5/9
.0003	7/-	.0003	5/3

Including Knob and dial. Post 3d.

ORMOND "LOW LOSS" (AMERICAN TYPE).

Skeleton Ends, Knob and Dial.

.001	9/-	.0005	8/-
.0003	7/6	.00025	6/6

(With Vernier, 1/6 each extra)

J. B. (JACKSON BROS.)—Square Law.—.001, 9/6; .0005, 8/-; .0003, 6/9; .0002, 6/6. Standard.—.001, 8/6; .0005, 7/-; .0003, 5/9; .0002, 5/-. Square Law, with Vernier.—.001, 13/6; .0005, 12/6; .0003, 11/6. New models shortly.

WEST-END LEADING STOCKIST FOR Edison Bell, Jackson's (J.B.), Polar, Igranic, Peerless, Eureka, Magnum, Burndept, Lotus, Dubilier, Marconi, Dorwood, Sterling, Success, B.T.H., McMichael, Lissen, Woodhall, Utility, R.I., Bowyer-Lowe, Amplion, Formos, Brunet, Ormond, parts, etc.

SECOND-HAND GOODS.

PATRONISE THE LIVE FIRM! I will accept in part payment for new goods (or purchase if so desired) any articles you have no use for.
This is a stunning offer, so don't forget to take advantage of it.
Make out your list of what you have to sell, and I will offer you best prices. This applies to post or callers. Bring your goods.

VALVES. To encourage you to use accepted for delays British Valves I am willing to purchase one burnt-out valve for each valve you purchase. Prices given range from 1/3 to 4/- according to valve you buy.

No responsibility caused by manufacturers' non-delivery.

ALL ORDERS SENT IN STRICT ROTATION, accepted on those conditions.

Customers purchasing £5 worth of our OWN goods at full prices presented with a first class pair of HEADPHONES, 4,000 ohms.
Or, alternatively, if you buy 25/- worth of our OWN goods you can purchase a good pair of PHONES for 4/- extra.
Or have your PANEL DRILLED FREE.
This offer is limited to one offer per order.
Prices and offer subject to being cancelled without notice.

Bretwood Grid-leak and Condenser, 50,000 to 15 megohms., guaranteed. Price 4/6

CALLERS (NETT PRICES) COLUMN

ALL POST ORDERS FROM OTHER 5 COLUMNS.

VARI - CONDENSERS — Square Law or standard. Special Offer, .0005, with Knob, 3/11; .0003, ditto, 3/6, aluminium ends. Daventry 5XX coils, 1/-, 1/3, 1/6. Crystal Sets, 7/6 8/11. New Brownie, 10/6. **BUS BAR,** per 12 ft., 1/16th sq., 6d.; 18 sq., 5d.; 18 round, 3d. Shaw's Genuined Sealed Hertzite 8d. Neutron, Listron Uralium, Kathavox, etc.

H. T. BATTERIES.— 60 volt "Crown," 6/11; Long Life, 60 v., B.B.C., 8/11; 36 v., 5/6; 9 v. (grid bias), 2/-, 1/10, 1/-. Eveready H.T., Stocked, 1.5 dry cells, 1/8, 1/10, 2/-, 2/3.

ACCUMULATORS.— 2 v. 40 amps., 8/6, 9/6; 4 v. 40 amps., 13/11, 15/11; 4 v. 60 amps., 17/11, 18/6; 4 v. 80 amps., 23/6, 25/-; 6 v. 60 amps., 26/11, 27/6; 6 v. 80 amps., 33/-, 35/6; 6 v. 100 amps., 39/6. Best Flash Batteries, 4d. and 4½d. each. Brass Terminals, complete Pillar. 'Phone, W.O., 1d., 1½d. each. Nickel, 2d. each, 1/8 dozen. Valve or Stop-Pins and Nuts, 2 a 1d. Spade or Pin Screws, 2 for 1½d. Tags, 6 a 1d. Nickelled 4d. dozen. Flush Panel Sockets, 1d., 10d. dozen. Switch Arm, lacquered, 1 inch radius, 10 studs, 2 stops 1/4 the lot. Aerial Egg insulators 2 for 1½d. Copper Foil, 3d. foot. Shorting Plug and Socket, 4d. Valve Holders, 9½d., 10d., 1/-, 1/3. All makes stocked. Ins. Hooks, 2 for 1½d. Staples, 6 a 1d. 'Phone Cords, 6 feet, 1/3, 1/6. Loud Speaker Cords, 1/11, 2/9. Twin Flex, red and black, 12 yards, 1/6. Min. Twin Silk, 6 yards, 6d. **SPECIAL.**—Wonder Aerial, 100 feet, 1/8, also first quality, 3/- Battery Clips, 5 for 2d. Coil Former, wood handle, 1/6. Sets of Drills, 1/-, 1/2. Cutting Pliers, 1/-. Panel Switch, DPDT, 1/-; SPDT, 10½d. Lead-in Tubes, 8d., 9d., 10d., good quality. Simplex ditto, 1/3. Special Copper Earth Tubes, 4/3 Climax, 5/-. Red or Black Spades, 1½d. each. Nickel, 2d. Strawboard Variometer and Knob, 1/6. Ebonite Ball Rotor, with Knob, 3/11. "Baby" Coil Stands Standard, 2w, 1/11; 3w, 4/6. Cam Vernier, 2w, 3/3, 4/6, 4/11; 3w, 5/-, 5/6, 6/-, 6/11, all good value for money. Rheostats, 1/3, 1/6, 1/9, with dial, 1/11. Special 30 ohm, 1/3. Wates Microstats, 2/9. Dr. Nesper Loud Speaker, 14/6. "Excallite" (about size of Dinkie, handsome appearance), 21/-. L.F. Transformers, 7/6 up. Enclosed Detectors, 8½d., 1/-, 1/3, 1/6. Micrometer, 1/9. Dials, 8d., 1/-. Knobs, 2d. and 3d. Voltmeters, 4/11. **EBONITE.**—Stock sizes, 3/16th. 6×6—7×5, each, 1/2. 8×6—9×6, each 1/10. 10×8—12×6, 8/. 12×12, 5/6. 14×10, 5/6. ¼-in. also stocked. DCC Wire ½lb. Reels, 20g 9d., 22g 10d., 24g 11d., 26g 1s., 28g 1/1, 16g 1/2, half-pound. H.F. Transformers, B.B.C. 2/11, 5XX 3/6. Fibre Strip 36×1 2½d. Celluloid 3d. piece. Empire Tape, 6d. doz. yards, Ad. Tape, 3d., 5d., Nuts, 6 a 1d. Telefunken adjustable Phones, 14/11. Fine value in phones, 8/11. Genuine N and K 12/11. Ericsson (EV) continental, 11/6 pair.

CALLERS. We stock everything you require.

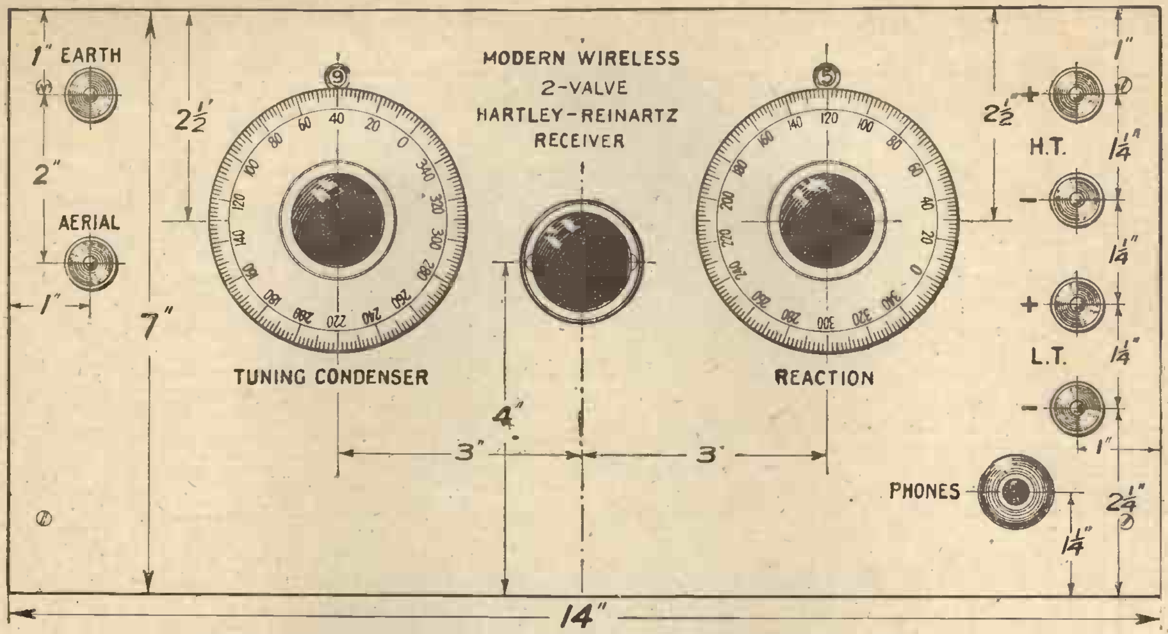


Fig. 2.—The simplicity of the panel layout is evident. Full-size Blue Print No. 132a may be obtained, price 1s. 6d., post free.

tapping made at the fifteenth turn for an optional aerial tap, which is necessary in order that the aerial may be kept out of tune with the secondary circuit. The outer coils are wound with No. 18 or 20 enamelled wire, there being 32 turns in each.

Experience Necessary

At the outset it must be emphasised that the circuit is decidedly of the "stunt" variety, and is therefore not to be recommended to the novice, only those with a thorough knowledge of ordinary reaction receivers being advised to tackle the present instrument. As previously stated, the circuit is one which, with suitable coils, is in common use upon short waves for transmitting purposes, and therefore is capable of causing considerable interference if incautiously or inconsiderately handled.

Components

The more experienced experimenter may wish to make up a set along the lines of the present instrument, and for this reason I am giving a list of the components actually used in my receiver in order that the experimenter may be able, should he desire, to make an exact copy of the original.

One insulating panel, 14 in. by 7 in. by 3/16ths or ¼ in. I have used Radion Mahoganite, but any good brand of ebonite will do.

Suitable cabinet (Camco).

Two variable condensers, square-law type, with a geared motion, either in the dial or on the condenser itself. I have used Colvern Selectors, by Collinson Precision Screw Co., Ltd.

One low-loss skeleton coil former 8 in. long by 4 in. diam. (Collinson Precision Screw Co., Ltd.)

The external appearance of the receiver is very handsome. Note that the top left-hand terminal goes to earth.

Two low-capacity valve sockets ("Antipong" Bowyer-Lowe Co.).

One filament resistance, dual type (Burndept Wireless, Ltd.).

One low-frequency transformer (Royal—R. A. Rothermel, Ltd.).

One single filament jack, and plug (Burne-Jones & Co.).

Six large terminals.

One ·0003 μF fixed condenser and 2 megohm grid leak, together with attachment for securing leak to condenser, or an extra grid leak clip (Dubilier Condenser Co., Ltd.).

Quantity of No. 18 or 20 enamelled wire, and a smaller quantity of No. 20 d.c.c. wire.

Square wire for connections.

One pair of angle brackets (Magnum).

Radio Press Panel Transfers.

General Considerations

From the design point of view, it was decided to adopt the ever-increasingly popular "American" type of layout, in which the panel, upon which the controls only are mounted, is disposed vertically with respect to a base-board, upon which the valves and other components are situated. This type of design, when housed in a cabinet the lid of which is made to lift up, is very handy, as all parts are easily accessible without disturbing battery and other leads, while at the same time the valves are well protected from damage. Again, in such designs as the present, in which coils of the "low-loss" variety are used, it is almost essential to secure the coil to a baseboard as in the present set, in order that alterations may, if necessary, be easily carried out. The type of coil former employed is supplied with angle clips for mounting purposes, and in this case the coil is easily removed by loosening two screws and lifting it off the supports.

Valve-Holders

In view of the fact that dull emitter valves will in all probability be used by any who make this set, and certainly in my own case, I have incorporated anti-capacity anti-microphonic holders, in order to reduce undesired noises as well as to reduce stray capacity effects.

A jack of the single filament type has been used, so that it is not possible to leave the valves burning when the telephones have been disconnected.

Panel Drilling

As will be seen from the drawing, Fig. 2, there are very few holes to be drilled in the panel, so that no difficulty is to be anticipated in this respect. Care should be taken when drilling the holes for the brackets by means of which the panel is secured to the baseboard, in order that the two may fit together and into the cabinet perfectly. It is as well if this

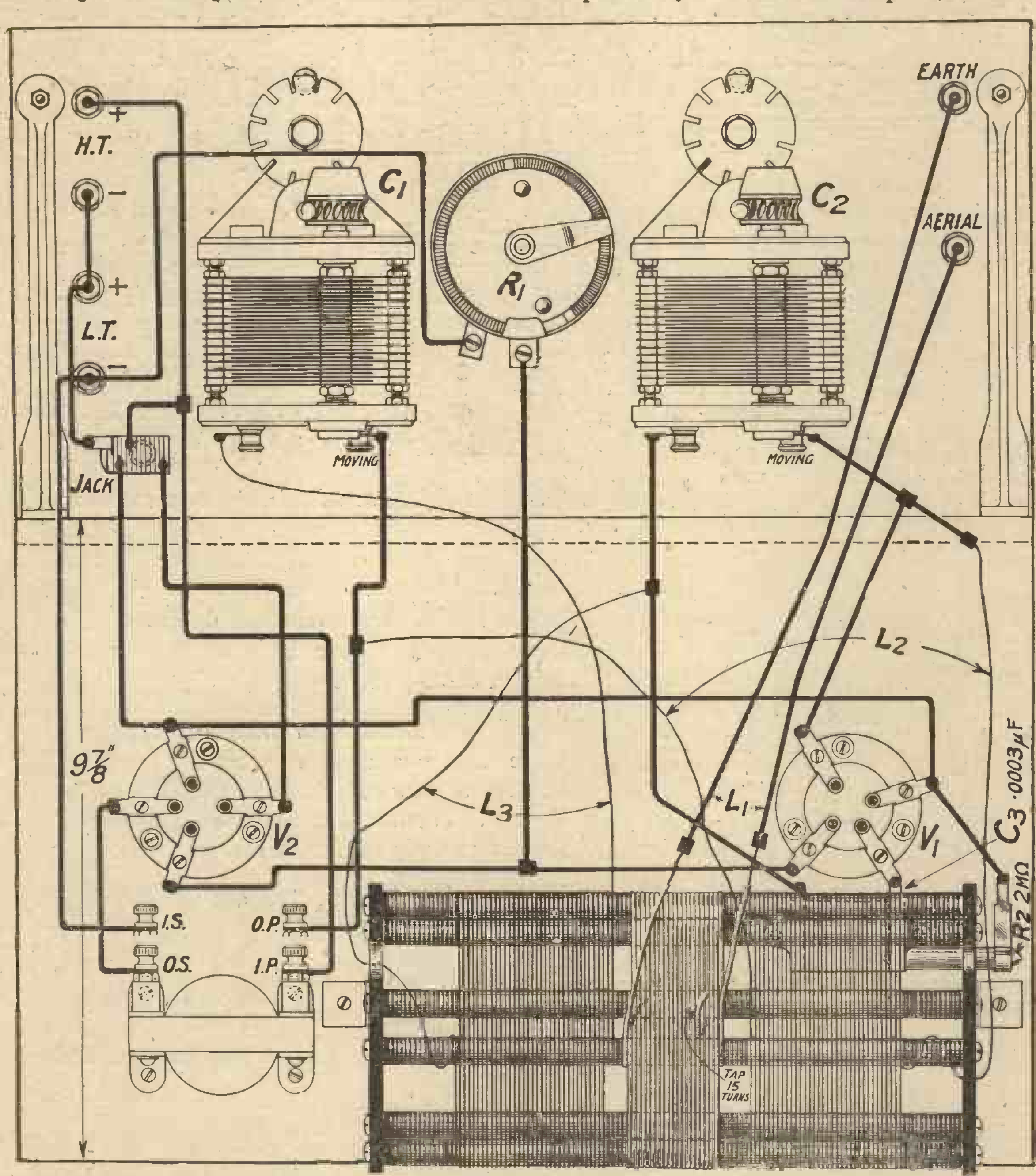


Fig. 3.—Showing how the set is wired up. The thin wires are ends of the coils taken to the correct points. Blue Print No. 132b, price 1s. 6d., post free.

The First-Fruits of Gigantic Research Collaboration-

THE combined forces of the Philips and Mullard Technical Research Organisations have achieved the first of many wonderful developments in the perfection of radio valves.

The first objective of this gigantic research collaboration was to produce a master loud-speaker valve with vastly increased life and reduced current consumption. The P.M.4 Valve is the result of their labours. No finer valve has ever been offered to the British radio public.

The Laboratories from which this master valve has emanated employ the services of over a hundred skilled technical radio experts. From end to end the P.M.4 Valve will be entirely of British manufacture.

For complete information ask your dealer for Leaflet V.R. 28.

Mullard

THE MASTER VALVE

Advt.—The Mullard Wireless Service Co., Ltd. (M.W.), Nightingale Lane, Balham, London, S.W.12.

The Finest Loudspeaker Valve ever produced

THE P.M.4 Master Loudspeaker Valve stands triumphantly alone above the accepted standard in valves for loudspeaker reception.

It is the NEW "N" FILAMENT VALVE!

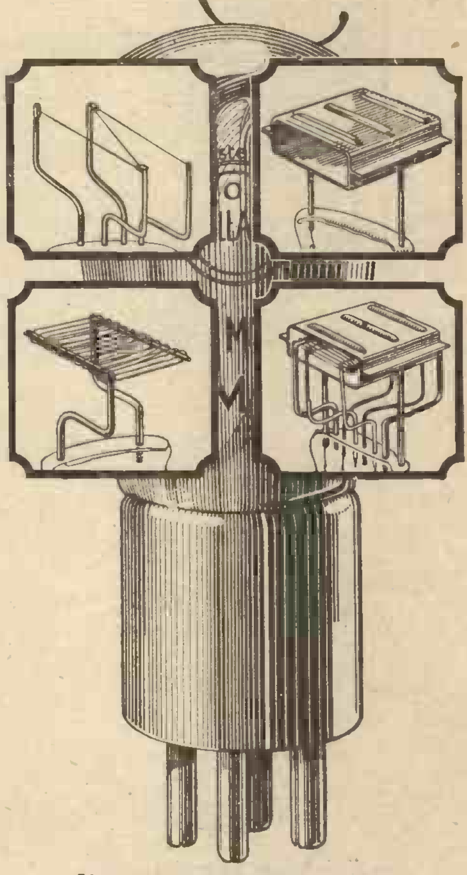
Behind its design and performance lies the most advanced knowledge in Europe.

The most striking departure in the production of the P.M.4 is the filament. This filament is prepared by an entirely new process, whereby the special coating is obtained in an extremely adherent condition, making it capable of giving considerable electron emission at very low temperatures.

There are *four* supports to this unique "N" filament. It is absolutely non-microphonic. The low current consumption of only 100 milli-amperes means vastly increased valve life and longer battery service without re-charging.

The whole construction is one of extreme rigidity and power, there being eight electrode supports. Only a 4-volt accumulator or three dry cells are required for the P.M.4 Master Valve.

Try one in your set to-night and note the wonderful purity of tone and volume you will obtain from your loudspeaker. PRICE 22/6 each

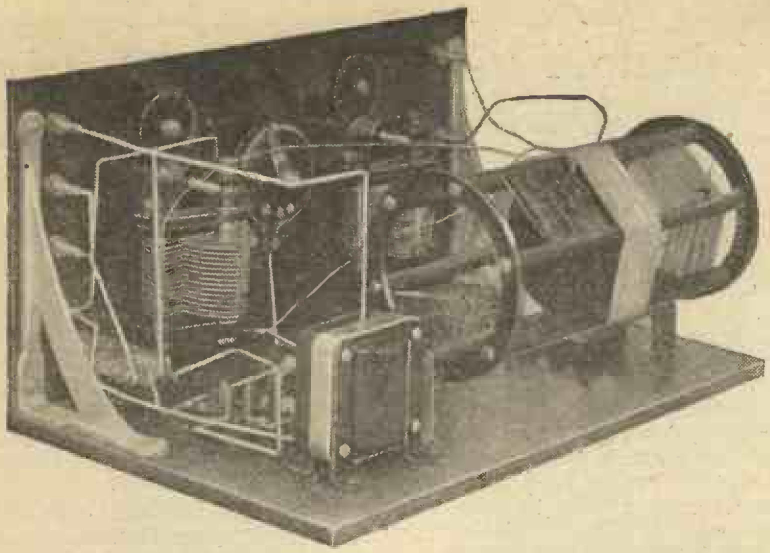


Note the wonderful construction of the P.M.4 Master Valve.

Mullard

THE MASTER VALVE

Advt.—The Mullard Wireless Service Co. Ltd., (M.W.), Nightingale Lane, Balham, London, S.W.12.



The valves are switched off upon removal of the telephone plug from the jack.

operation is carried out before any components are mounted, in order that the panel may be more easily handled.

The disposition of the parts on the baseboard has been carefully worked out, to provide good spacing of essential wires, together with ability to insert large valves into the sockets. If any departure from the design is effected, care must be taken to see that the valves will not be fouled by the moving vanes of the variable condensers. As designed, it is possible to use a D.E.5B valve in the detector socket, and a similar large valve in the note magnifying position without any trouble.

Good Spacing Essential

It is advisable to wire up the low tension side first, in order that the grid and plate leads may receive the fullest consideration. The connections to the coil and condensers should be spaced as well as possible. The remainder of the wiring is quite straightforward, and will be easily effected.

Valves to Use

The panel transfers may next be affixed, and in this connection it may be pointed out that the title of the receiver, as seen in the photograph of the front of the set, is made up from the transfers, the word "Hartley" being built up of single letters. This will be found easy to accomplish if a pencil line is lightly drawn along the position of the letters, and each letter in turn is then fixed in place, sufficient time being allowed between the fixing of each letter for the previous one to dry off.

With regard to valves, it is necessary that two valves of the same class should be used in this receiver, owing to the fact that only one resistance is provided.

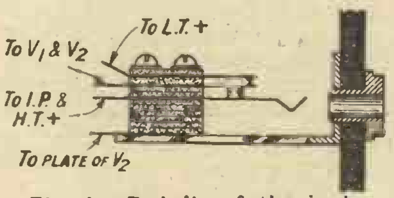


Fig. 4.—Details of the jack.

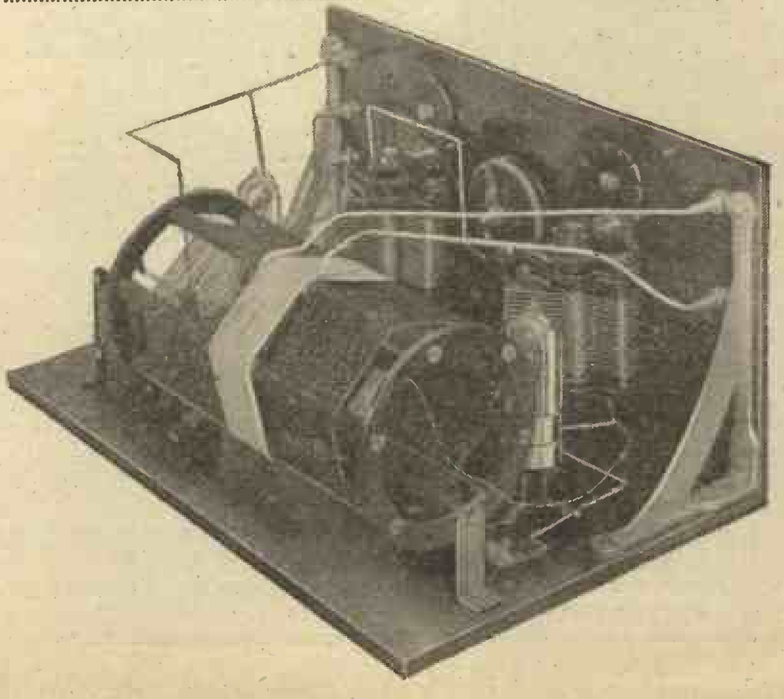
Testing

The set is now complete, and ready for an initial test of the wiring. Join up the accumulator and insert the valves. Plug in the telephone plug and turn the rheostat towards the "on" position. If each valve lights correctly, turn the resistance off and move the L.T. leads to the H.T. terminals. Turn the resistance on and note that neither valve lights up. If this is so, return the L.T. leads to the correct terminals, join up the H.T. battery, aerial, and earth. Plug in a value of high-tension voltage to suit the particular valves you use, and be sure not to run the filaments of your valves too bright.

Operating the Set

The operation of the receiver is fairly simple after a little practice has been obtained, but some difficulty may be experienced at first. Tuning is so sharp that it is quite possible to revolve the dials and hear nothing, in which case it is not safe to assume that the wiring is incorrect. The reaction condenser should be kept at a setting which is just below the point at which the set commences to oscillate, and the tuning condenser is then rotated as slowly as possible, the reaction condenser being readjusted meanwhile. Tuning is a matter for two hands, and considerable practice will be necessary before the best results are obtained.

(*Continued on page* 94.)



The ends of the centre coil are joined to aerial and earth.

Radio Press News

THE science of radio communication has developed so rapidly of recent years that the information on this branch of engineering is in a particularly scattered state.

Although many radio engineers and amateurs have a very good idea of the trend of development in the art of radio, quantitative information, such as actual figures and data, are available only through the publications of the various learned societies, or through the medium of expensive textbooks.

Moreover, it is often found that a textbook which contains information on one point will not give the particular details required on some other point. To remedy this defect, Messrs. Radio Press, Ltd., have published a complete handbook on wireless entitled *Radio Engineering*.

A Unique Collection of Data

This work, which has been compiled by Mr. J. H. Reyner, B.Sc. (Hons.), A.C.G.I., D.I.C., of the Radio Press research staff, is a unique collection of data on almost every phase of radio science.

The work is in three sections. The first section deals with wireless data pure and simple; the second section is a brief review of the systems of telegraphy and telephony in use in this country; while the third section is a collection of general physical and electrical data.

Circuit Design

Chapter I. contains information on the calculation of inductance, capacity, resistance, etc., and the measurement of these quantities at high frequencies.

The next chapter deals with the properties of oscillating circuits, and shows various methods whereby the tuning properties of any given circuit may readily be obtained. This section will prove extremely valuable in the design of wave traps, rejectors, etc.,

Valves

The next chapter is concerned with valves, giving details of their design and construction. An important feature is that tabular details and representative characteristics are given for over 60 of the principal valves in use at the present day.

Radio Transmission and Reception

The next chapter deals with radio transmitters, and much useful information is given on the subject of the design of spark and C.W. transmitters. In particular, information is given on the methods of obtaining high efficiency in valve transmitters which should prove useful to the amateur. A very complete review of the modern methods of radio reception follows, and practical data are given on many points of circuit and amplifier design.

Two more chapters follow, dealing with the design of masts and aerials, and with miscellaneous points such as high-speed working, atmospherics, screening, etc.

A Book which Every Experimenter Should Have

In the other two sections, as has been stated, there are data on the principal telegraphic and telephonic systems in use in this country, and 196 pages of mathematical and physical tables.

The whole book, which comprises 484 pages, with 314 illustrations, and 111 tables, is a new departure in wireless literature, and the volume is, unquestionably, one which should be in the home of every serious experimenter as well as the practising radio engineer. The price is 15s., or 15s. 9d. post free.

Reception Conditions in Derbyshire

An interesting letter giving details of some results obtained with the All-in Portable Receiver, described by Mr. A. S. Clark in the June issue of "Modern Wireless."

Working the set in the open air.

DEAR SIR,—I recently had an opportunity of spending a short holiday in Derbyshire, and as this seemed an excellent opportunity to study reception conditions in a country district well removed from all the main B.B.C. stations, it was decided to make use of the two-valve portable receiver, described by Mr. A. S. Clark in MODERN WIRELESS, Vol. 4, No. 5. It will be remembered that this set employs a straightforward detector and low-frequency amplifier circuit, with transformer coupling and reaction on to the aerial coil. The usual series condenser is used for C.A.T., and a loading coil for the high-power station is incorporated.

At Spinkhill

The reception to be described was carried out at Spinkhill, a delightful little village situated on the top of a hill, about eight miles south of Sheffield, and surrounded on every side by open country.

The first step was to arrange a suitable aerial and earth connection. The aerial, thanks to a convenient tree, was not difficult, and consisted of 50 feet of rubber-covered flex. One end was attached to an insulator fastened on the tree at a height of about 20 feet, the other end passing through an open window, across a room, and straight on to the set, this end being but 7 ft. from the ground. The earth presented more difficulties than the aerial, because no water main was laid on to the house and it was impossible, for several reasons, to erect a counterpoise under the aerial. Some preliminary experiments were made with a few yards of flex laid across the floor of the room. This sufficed to bring in the Sheffield relay station at good 'phone strength, but other stations were weak and the set was inclined to be unstable. This short counterpoise was therefore replaced by about 20 ft. of 26 gauge d.c.c. wire, which wandered across the room and out of the door, where it was securely fastened to a garden fork, the latter then being thrust into stony ground.

Screening Effect by Hills

Both the Sheffield and Leeds-Bradford stations now came in at tremendous strength on the 'phones, and subsequent test with a borrowed loud-speaker (a Junior model) showed that fair loud-speaker reception was possible, even during the afternoon, from 2LS at 35 miles. On a slightly higher wavelength was Nottingham. This relay station was 30 miles away, and although incapable of operating the loud-speaker, really good 'phone strength was obtained. At approximately the same strength was Manchester on 378 metres (793·2 Kc.). One might have expected really powerful signals from this station, since it was less than 40 miles distant, but a glance at the map will show that the famous Derbyshire Peak lies exactly between the two places, and this undoubtedly accounts for the loss of signal strength. Clear reception was possible at all times from Birmingham (65 miles), Newcastle (115 miles), and 2LO (140 miles), and their strength improved somewhat after sunset. The Bournemouth station (185 miles) was heard on several occasions, but only by careful adjustment of reaction. Stoke-on-Trent is only 8 metres above Sheffield in wavelength, and consequently could only be heard when the latter was not working; even then reception was rather difficult, due most probably to the intervening hills.

Reception of Daventry

The only other British stations heard were Aberdeen, Glasgow and Hull, and these were very weak indeed. Petit Parisien came in on one occasion at about the same strength as 2LO, but this reception was after sunset. The high-power station at Daventry was received at about the same strength as it is heard in London with the same receiver.

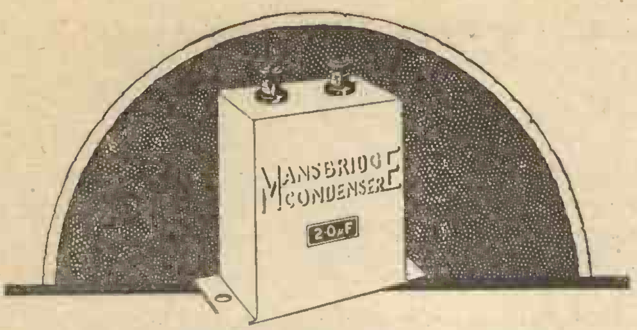
Freedom from Interference

Whilst giving all due credit to the receiver, which invariably seems to give good results, the ease with which a number of distant stations could be tuned in at any time of the day shows how fortunate are those amateurs who are in a position to set up their aerials in the open country far removed from the screening effects of surrounding buildings and the howls of "local oscillators." To one living less than 10 miles from 2LO and on the west side of London, the most noticeable features were the freedom from interference with all the stations received, and particularly the absence of mush from powerful arc stations. On one or two occasions very slight interference was experienced from ship stations, but this seldom lasted long.

On Another Aerial

It may be of interest to record that the "portable" was also tested on the aerial of a friend living barely a hundred yards away. To our great surprise Sheffield was not nearly so loud, but 2ZY was practically at loud-speaker strength.

The valves used in the set were two D.E.3's, operated from a 4½-volt dry battery tapped at 3 volts. Best results were obtained with 13·5 volts H.T. on the detector and 72 on the amplifier.—Yours faithfully, K. T. ARTER.



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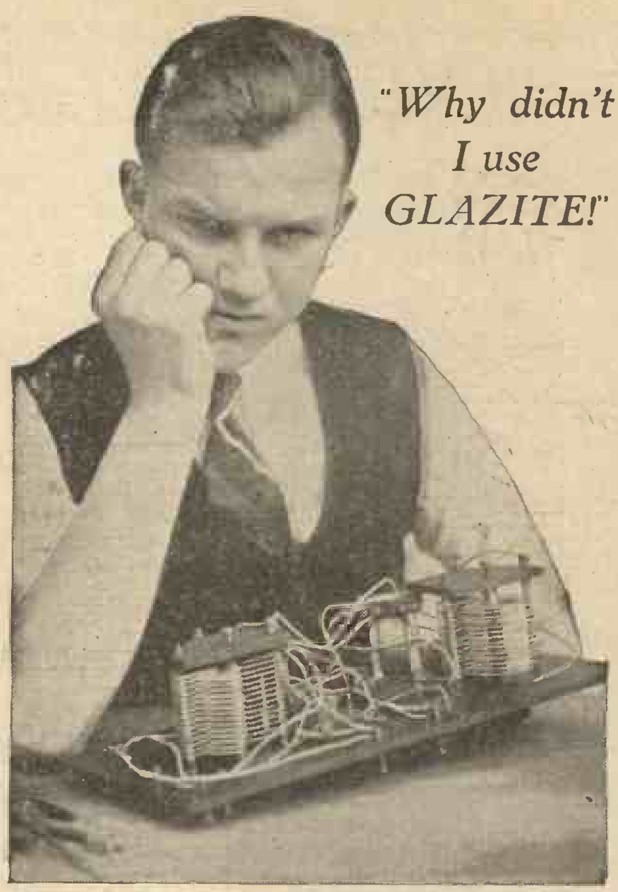

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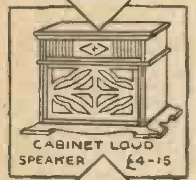

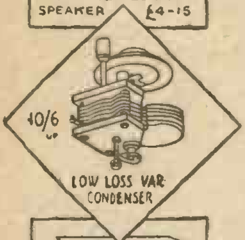

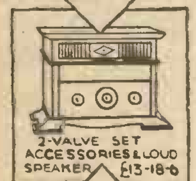

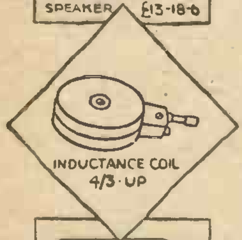

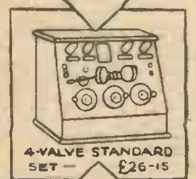

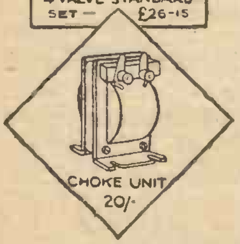

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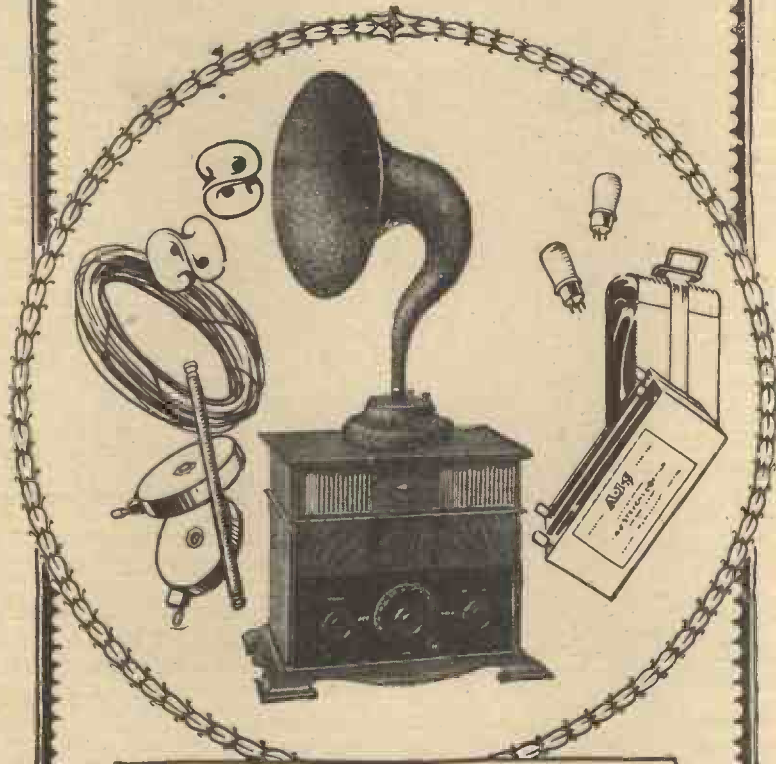

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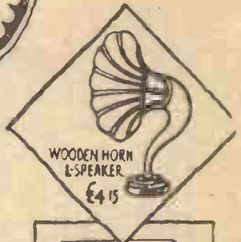

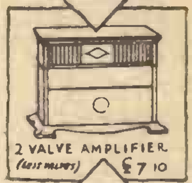

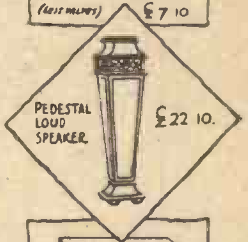

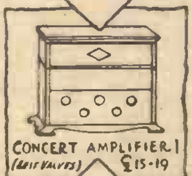

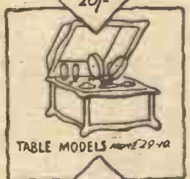

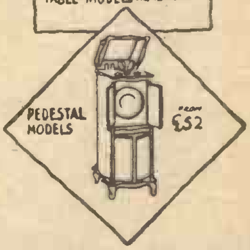

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The Life of a Valve

By Capt. H. L. CROWTHER, M.Sc.

An interesting description by our Deputy Director of Research of some of the chief factors which govern this important subject.

THE life of the thermionic valve is of extreme importance to everyone interested in wireless transmission or reception. The chief factors on which the life of a valve depend are not generally realised, and it is therefore proposed to outline briefly the essential points to keep in mind, so that one is able to obtain the longest possible life for any given valve.

In considering the question of life, valves should be divided into at least two definite classes, namely, ordinary bright emitters, and dull emitters, since in each of these cases the life is dependent on essentially different properties of the filament. The dull emitter that will be considered is the type with the highly thoriated filament. The coated filament dull emitter, and the low vacuum or soft valve will not be dealt with at present, as these are not in such general use.

Life of Bright Emitter Valves

By bright emitter valve is meant one which has an ordinary tungsten filament, which is normally run at a temperature of from about 2,000°K to 2,700°K. The life of the bright emitter essentially depends on the life of the tungsten filament. It is generally assumed that the condition in which the valve is used does not influence its life. That is, the life of the valve is approximately the same whether it is used in a transmitter or a receiver, or whether it is simply run as a lamp, without high tension on the anode. This of course would not hold good in the case of valves with faulty vacuums, since under these conditions the application of H.T. to the anode causes abnormal disintegration of the filament.

Evaporation of the Tungsten Filament

Whilst the valve is in use the tungsten filament slowly evaporates and in consequence gets gradually thinner. For a time this process is probably more or less uniform over the entire length of the filament. The filament then becomes slightly thinner at one spot, possibly owing to a slight flaw in the filament. This spot becomes hotter than the remainder of the filament. In consequence the evaporation at this particular point becomes more and more rapid, with the result that the filament ultimately fuses or burns out. The time required for a ten per cent. reduction in the diameter of the filament due to evaporation is generally considered the maximum figure that can be allowed for the life of the filament.

Effect on Life of Increase of Filament Current

Since the evaporation of a tungsten filament increases very rapidly as the temperature is raised it is very important that the filament current should not be more than is necessary to give the electron emission required.

Experiments have shown that the life of a tungsten filament is inversely proportional to at least the 15th power of the filament current. That is, a ten per cent. increase in the filament current above normal reduces the life of the filament to less than one-quarter of its original value. Thus if a 0.5 amp. filament valve gave a normal life of 400 hours, it would only last for 100 hours with a filament current of 0.55 amps.

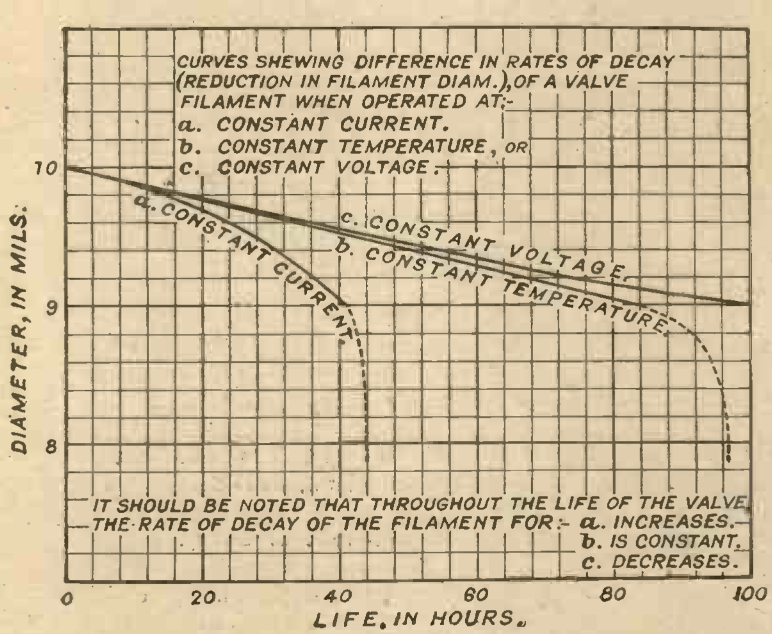

Fig. 1.—Curves showing how the rate of decay of the filament varies throughout the life of a valve.

The Longest Possible Life under Working Conditions

For a valve to function properly, a certain minimum electron emission is required. The emission from an ordinary tungsten filament is directly proportional to its area and to its temperature. Owing to evaporation, the resistance of the filament gradually increases throughout its life. It is thus impossible to keep both filament current and voltage constant. If the current is to be kept constant then the voltage will have to be gradually raised. In this condition, the temperature and also the emission gradually increase. Thus after a short time the valve is being run at a temperature considerably higher than is necessary to give the required emission. The life of the valve under these conditions is thus much shorter than it need be in order to give a

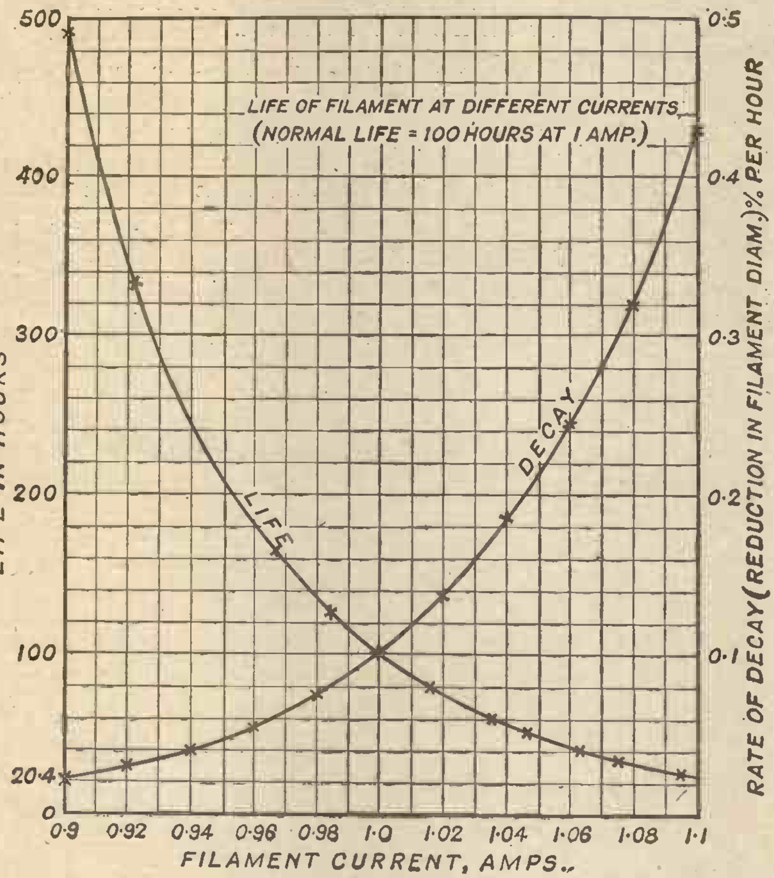

Fig. 2.—The effect of different values of filament current upon the life and rate of decay.

definite fixed value of anode current or emission. Therefore a valve operated at a constant current is used inefficiently as far as life is concerned.

Constant Filament Voltage Preferable

It is therefore much preferable to run a valve with a constant voltage across its filament, although in this case the emission gradually falls owing to the filament slowly becoming thinner. This, however, is not serious and seldom affects the operation of the valve.

A valve gives the longest possible life when operated at a constant filament voltage. This voltage, of course, should not be more than is necessary to give the necessary emission.

Life of Dull Emitter Valves

The dull emitter valve, as is generally known, contains a filament which consists of a mixture of tungsten and thorium. Although thorium is usually contained in the ordinary bright emitter filament, it is only in comparatively small quantities compared with the percentage of thorium in the dull emitter filament.

The highly thoriated filament is capable of giving a high emission at a very low temperature, and one at which the emission from an ordinary filament would be negligible. Such a filament can be used at a temperature of the order of 1,300° *K.*

Emission may Decrease

The life of a valve as a dull emitter is not necessarily the life of the filament itself. In the case of the bright emitter valve the emission is maintained until the filament actually burns out. In the case of the dull emitter, however, the emission may fall off, either temporarily or permanently, long before the filament actually fails.

In this type of valve the emission at the working temperature depends almost entirely on the presence of thorium on the surface of the filament. Temporary loss of emission may occur through the evaporation of most of the surface thorium. By suitable treatment the surface of the filament can be reconditioned and the valve is then as good as before.

If, however, the distillation of the thorium from the filament has been more or less complete, then the valve is useless as a dull emitter. This loss of thorium may take place before the filament has completed 75 per cent. of its actual life. This failure in emission before the filament actually burns out is not serious, as the life of the filament at the working temperature of the dull emitter is extremely long. When the valve fails as a dull emitter it can still complete its life as a bright emitter valve.

A Noteworthy Point

Temporary loss of emission may be caused by either running the filament at a temperature higher than that normally used or else using too much high tension. For example, if a valve which normally operates at 3 volts is run at, say, 4 volts for a few minutes, it may lose a large percentage of its emission and be quite useless when again run at its normal three volts. Similarly, if the anode voltage is raised much above its normal value the emission may be reduced to a fraction of its original value.

For dull emitter valves, therefore, it is very important not to exceed the values of filament voltage and high-tension as recommended by the manufacturers for the particular type of valve in use.

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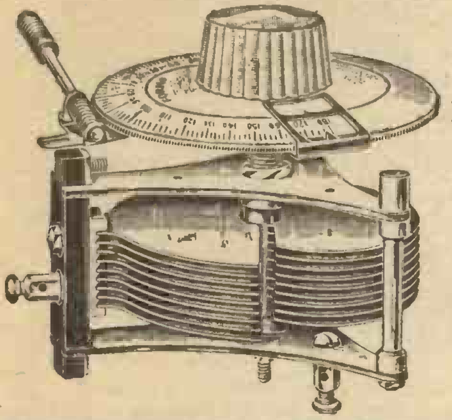

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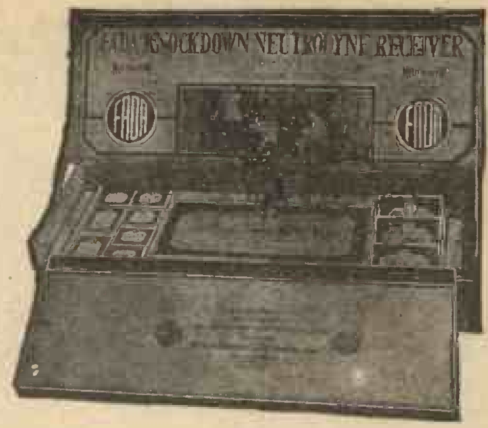

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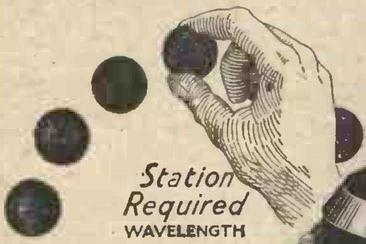

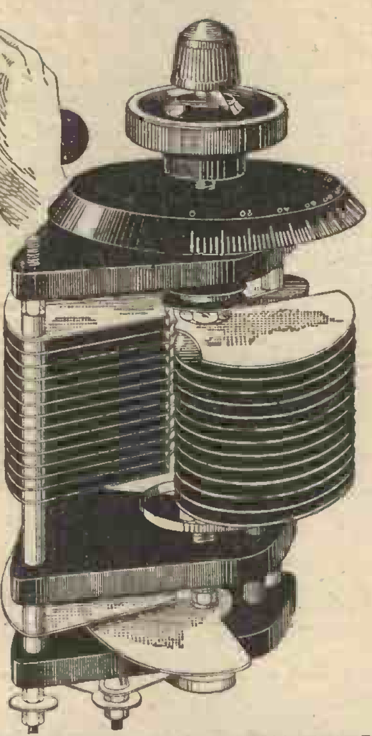

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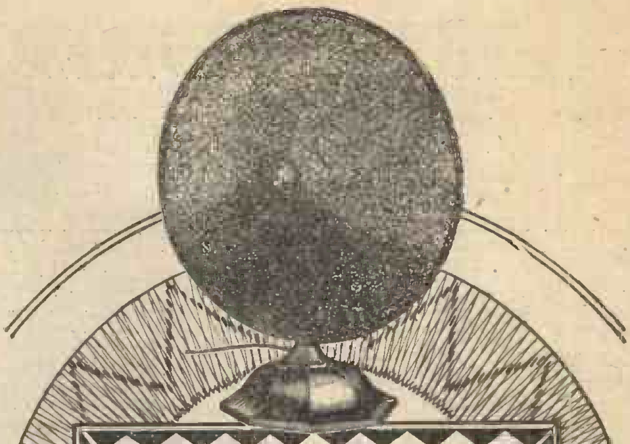

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A Low-Loss Loud-Speaker Reflex Circuit

By A. D. COWPER, M.Sc., Staff Editor.

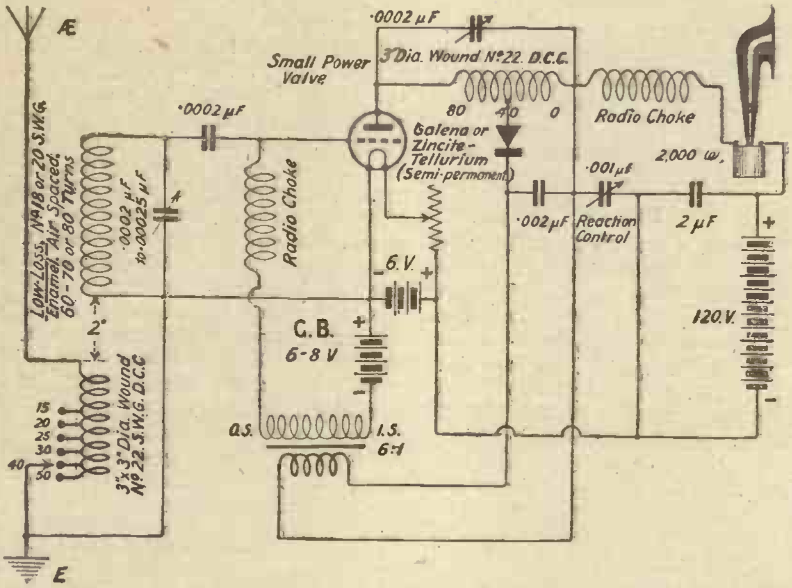


Fig. 1.—The L.F. transformer should be of good quality and preferably of the high-ratio type.

The author of this article claims that although this circuit is not to be recommended for long-distance work, quite the loudest signals he has ever heard when using a single valve, were received from 2LO at a distance of twelve miles.

THE very loudest signals ever heard by the writer on a single valve were obtained with the low-loss crystal-valve dual amplification circuit shown here, in which a number of separate factors that make for high efficiency in reception have been incorporated in the one circuit, and where, by making use of crystal rectification, combined with a heavily negatively biased valve of the small-power type, the heavy damping influence of a rectifying valve is to a large extent eliminated.

Low-Loss

The writer has had occasion recently to call attention to the surprising magnitude of this damping effect, which appears to baffle most of our efforts to attain a really "low-loss" circuit; but the effect of negative grid-bias in diminishing this damping of the valve is quite remarkable, when measured directly in the manner suggested by him in *Wireless Weekly*, July 29 issue. By using a crystal for rectification in a lightly-coupled tuned-anode circuit it is possible to operate with a negative grid; and by utilising one of the modern small power or L.S. valves with ample H.T. it is practicable to obtain a full degree of L.F. amplification in the same valve, without experiencing the distortion due to overloading the valve.

Coils

Full use can then be made of really low-loss tuning arrangements; the aerial has the semi-aperiodic, extremely loose coupling which the writer has shown by actual measurement to be most favourable for signal strength, with a secondary inductance of the low-loss type made up with spaced windings of a generous gauge on a skeleton former, and tuned by a parallel tuning condenser of low maximum capacity. The inevitable damping effect of the crystal detector across the tuned anode is diminished by placing it across only one-half of the inductance (as in the manner suggested for obtaining the maximum signal strength in plain crystal reception, where a low-resistance aerial and earth connection are available). Both signal strength and selectivity are favourably affected by this device. The low-frequency reflex feed is by the "parallel" method favoured by the writer, *via* a radio choke connected behind a small grid-condenser; this eliminates casual H.F. feed-back *via* the distributed capacities in the L.F. transformer, etc. An ample H.F. by-pass condenser is also inserted across the primary of this transformer.

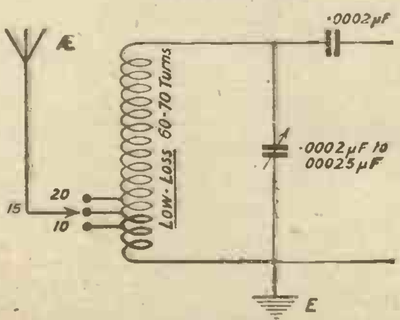


Fig. 2.—An alternative method of aerial coupling employing a simple tapped coil.

Buzzing

A common fault of dual amplification circuits is that of buzzing or whistling, particularly when the crystal detector is disturbed. One reason for this is that the heavy damping of the crystal is necessarily relied upon largely to restrain the valve from oscillating, and in many dual circuits there is no fine control available to regulate the degree of this damping.

In a powerful, but admittedly tricky, neutrodyned dual circuit the writer described in *Modern Wireless*, Vol. 2, No. 7, which apparently aroused considerable interest at the time both here and in the States, the fine control necessary for obtaining the last ounce of signal strength was obtained as suggested by the title, by a small neutrodyne condenser operating in the manner now familiar in the neutrodyned-tuned-anode H.F. coupling. Here the control is effected by the expedient described by the writer in *Wireless Weekly*, Vol. 4, No. 10, and subsequently utilised a good deal as a method of measuring H.F. resistances. The tuned-anode is isolated "up in the air" by a good radio-choke, which latter is bridged by a "reaction-control" condenser, which gives the needed fine control over the degree of inherent capacitative feed-back, and, therefore, enables the circuit to be adjusted nicely for the degree of damping offered at the moment by the crystal; or can even control self-oscillation when the crystal is put out of action. The result is that buzzing and whistling are unknown, with any reasonably intelligent operation of the circuit; and, at the same time, the ultimate degree of power is obtained from the crystal-rectifying device for whatever setting has been obtained.

An Important Point

An obvious disadvantage of this method is that the tuning of the anode circuit varies appreciably with alteration of the reaction-control condenser; if for no other reason, the circuit should not be brought forward for *distant* reception (inevitably involving searching). It is almost invariably found that the margin between quiet oscillation and howling is small in a dual circuit, so that such circuits are not, in general, recommended for critical work. The writer cannot too strongly emphasise that this particular dual circuit is *not* recommended for real long-distance work; but solely for loud-speaker reception of the *local* station, in which service he has found it to give more volume, and better reproduction, than any in his experience. Then the triple tuning-control (two of these controls are fairly flat) is not prohibitively difficult.

Details

The maximum effects will not be obtained unless each single one of the details implying efficiency be attended to; the valve *must* be of the small-power type, such as the D.E.5, or P.V.5D.E., to mention only two of the several types now available; at least 100 volts of H.T. should be employed, more if possible, and really ample negative grid-bias must be used. The plate current is fairly heavy in operation (some 5 or 6 milliamperes in normal operation with proper grid-bias), so that a large type of H.T. battery—or better still, an H.T. accumulator battery—should be used, with the usual 2 μF blocking condenser across it. A modern large L.F. transformer of high ratio (6:1 or even higher) should be used for the reflexing; too large a grid-condenser should be avoided, as the effect of this is to lower the tone or "pitch" of the reproduction considerably.

Construction of Inductances

The *primary* coil is a 50-turn tapped solenoid of No. 22 d.c.c. wound on a 3 in. diameter plain dry cardboard former. The aerial is permanently connected to the upper end; the earth connection is made to a tapping point at No. 15, 20, 25, 30, 40, or 50 turns, as practical trial shows to be best, and according to aerial dimensions and wavelength. This will cover efficiently the ordinary B.B.C. short-wave range, with aerials varying from a short single wire to a large triple arrangement. A very small indoor aerial might possibly require a larger number of primary turns, which is readily adjusted. A simple alternative device is that of the auto-transformer semi-aperiodic coupling which the writer has advocated frequently; here alternative tappings should be tried at, *e.g.*, No. 10, 15, 20, or even higher for a small indoor aerial on the secondary low-loss inductance. There appears to be no advantage in a low-loss primary.

The Grid Coil

The secondary must be of the low-loss design, of stout-gauged air-spaced wire on a skeleton former; the latter to avoid possible subsequent evil effects of moisture if, *e.g.*, dry cardboard were adopted here, rather than to give any measurable improvement in immediate efficiency. The writer actually used a standard Collinson Precision Screw Co.'s low-loss former, 3½ in. diameter and 6 in. long, wound with about 65 turns of No. 20 enamel-insulated wire, with about the usual spacing of 16 to the inch. The primary is mounted fully 2 in. below the commencement of the secondary winding, and at the "earth" end of the latter. There is no advantage at all in putting it closer, provided that it is roughly tuned by the tappings so that the natural frequency of the aerial, etc., is just *above* that of reception.

The tuned-anode inductance is wound in a fairly low-loss manner (for we have the crystal-damping here, so that the ultra-low-loss is irrelevant) with 80 turns of No. 22 d.c.c. on a 3 in. former, 4½ in. long, of dry cardboard with a centre-tap for the crystal connection. This must have a minimum of direct magnetic coupling with the other inductances, so should be placed well away from the low-loss secondary, and so as to form the crossing of a T when the former represents the vertical stroke, *i.e.*, exactly at right angles and symmetrically placed. Wiring should be kept as short as possible and well isolated for the same reason. The circuit would be uncontrollable if much direct magnetic back-coupling were permitted.

Radio Chokes

The radio chokes can be of the commercial type, or simply narrow

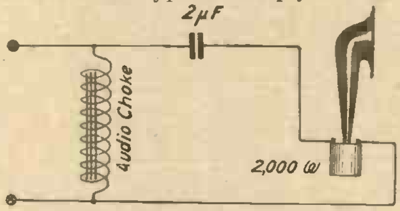


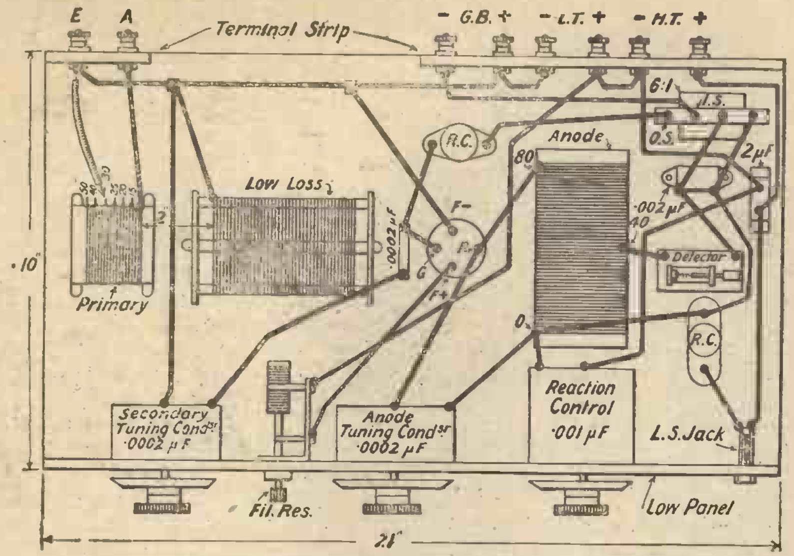
Fig. 3.—A simple filter circuit. The addition of a clip-in type fixed condenser across the loud-speaker is useful for tone control.

slab-coils of some 300-400 turns of thin wire (No. 32-36) wound between insulating cheeks, and 1/16 in. wide, with 1 in. internal and 3 in. external diameter. Plug-in coils are unnecessarily cumbersome for this service; resistance is immaterial here. The reaction-effect will be hard to control if much casual capacity is present between the anode and crystal circuit wiring and "earth" (*i.e.*, short-circuiting the ·001 μF control condenser). An extremely desirable addition, when using power amplification, as here, is a choke-capacity coupling to protect the windings of the loud-speaker; there are several suitable L.F. chokes available for this purpose on the market.

The type of crystal detector is actually not a critical matter at all. The writer recommends the use of one of the very stable and reliable combinations, recently revived for use in semi-permanent types of detectors.

Operation and Results

The setting of the two condensers will correspond roughly (and can, of course, be made to correspond still more closely by adjusting turns). Except when very close in, not much will be heard until the anode circuit is at least in rough tune with the grid circuit; this is shown by powerful self-oscillation when the crystal is disconnected. Corresponding settings can thus be noted. The ·001 μF condenser is then used to control the H.F. feed-back to a point well short of self-oscillation, whilst search is made simultaneously on grid and anode



The general lay-out used by the author in his experiments. Note the method of arranging the tuning coils.

condensers. There should be no difficulty in picking up the local station on the 'phones ; it is quite futile to attempt to tune in distant stations at first. As stated explicitly, this is not a long-distance receiver, and the control has not the fine simplicity of a straight reaction circuit.

After finding the station, the optimum tapping of the semi-aperiodic primary is quickly found ; then the secondary is tuned critically. Finally, that anode tuning which appears to show the most powerful reaction effect is sought, *i.e.*, the setting in connection with which the ·001 μF control condenser has to be set to the lowest reading to avoid self-oscillation. The crystal is then set to give optimum signals, and the reaction control is adjusted so as to bring to bear all the power the crystal will stand without distortion appearing. Any large adjustment of the reaction control must be accompanied by a corresponding *small* adjustment of the anode tuning.

Results

When adjusted thus, real " loud-speaking " was readily attained, at about 12 miles from the local station and on a good aerial, at a strength comparable with a cabinet gramophone and readily relayed over the land-line telephone. With the window partly open on the first-floor, the Savoy band was readily audible in the street, the large loud-speaker used being pointed away from the window.

Similar results were obtained with a small single-wire aerial as well. On " capacity aerial " alone, that is, without either proper aerial or earth connection, but merely casual pick-up on wires, etc., the band was audible along a passage and in another room in a quiet house at night, using the single valve. With the good aerial Bournemouth was tuned in directly on the loud-speaker some feet away, after other stations had finished, and one o the Paris stations was excellent o the head-phones; but as emphasised, such work is not the proper sphere for this type of loud-speaking dual circuit.

In the immediate neighbourhood of the local station, the smallest indoor aerial should suffice for good loud-speaking; for remoter suburbs evidently a good attic aerial and low resistance earth connection are all that will be needed. No A.C. hum was noticed at all, although close to the 50-cycle A.C. lighting mains.

Components

Components actually used in the experimental receiver were: Collinson Precision Low-loss Former; J.B. standard pattern tuning condensers; Lissen radio chokes; Grafton Electric 6:1 L.F. transformer, fixed condensers, and 120 volt accumulator H.T. battery; "Maxtone" Auto detector; Ediswan Dulcivox loud-speaker base; Scientific Supply Stores' large fibre loudspeaker horn, H.T. and filament resistance; Ediswan P.V.5D.E. valve; Ever-Ready grid-bias battery. Primary and anode formers were the ordinary 3 in. cardboard tube, carefully dried.

A. D. C.

The "Tri-Cell" Receiver

SIR,—As Mr. Percy W. Harris desired reports on his "Tri-Cell" as described so lucidly in the September, 1924, issue of MODERN WIRELESS, I am sending you the following results.

I originally assembled my set from a circuit described by the Editor in his article, "Dual Amplification Circuits I can Recommend," in the March, 1924, issue of MODERN WIRELESS. From this I get most excellent results. Being out to get the utmost from a single valve receiver, the "Tri-Cell" in the September issue appealed to me, so I introduced the third coil, but as aerial tuning was good on the original set, I decided not to alter same.

Using a Wecovalve, a 50 Igranic coil in the aerial circuit, 100 coil in the plate and a 50 in the detector circuit, I get selective tuning. Bournemouth comes in at good loud-speaker strength, remaining B.B.C. main stations and so far Stoke, Liverpool and Plymouth at very good 'phone strength (4 pairs). 5XX comes in practically at 6BM strength. The Paris stations, Madrid, Copenhagen, Munster and a host of other Continental stations which I have not yet identified come through well.

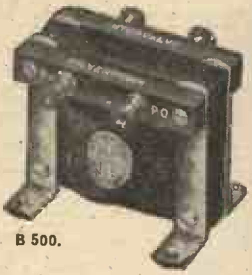
Having introduced a D.P.D.T. switch I can easily compare results with the original circuit, and now I feel I must congratulate you and Mr. Harris on giving the readers of MODERN WIRELESS such a magnificent one-valve circuit which is so easily and so economically constructed from the details and which I, as a most satisfied user, can thoroughly recommend.

Wishing your most excellent publications the success they so well deserve.—Yours truly,

H. H. MATTICK.

Fordingbridge, Hants.

Silvertown Wireless Accessories



B 500.

B 558.

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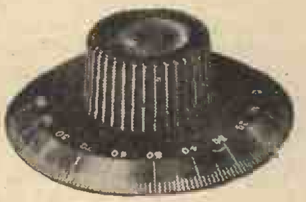

B.500. **INTERVALVE TRANSFORMER.** Guaranteed for 12 months. Price **21/-** each. This Transformer has been adopted by leading manufacturers of Wireless Receiving Sets and discriminating amateurs in all parts of the world. **Excellent results have been obtained on tests carried out by the National Physical Laboratory. Copy of the curve can be had on application.**

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EBONITE CONDENSER DIALS AND KNOBS. In one piece, graduated in white, 0-180°, highly finished, complete with fixing screw, dial approximately 3 in. diameter. Complete, **1/3** each. Dials only, **10d.** each.

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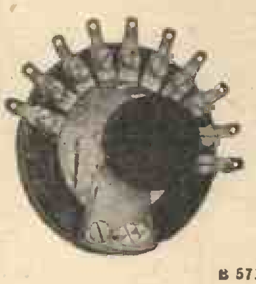
B.599. **SILVERTOWN - FILAMENT RHEOSTAT. ONE HOLE FIXING.** Circular pattern, on ebonite former, complete with knob, pointer, black celluloid scale engraved in white and two terminals for connections. The resistance wire is wound on an insulating rod, thereby giving a perfectly smooth adjustment. B.599—Wound to approximately 5 ohms resistance. B.600—Wound to approximately 30 ohms resistance.

B 505.

B.505. **TESTING BUZZERS. Complete with Switch.** Mounted on ebonite base with terminals and shunt, or mounted with terminals, shunt and switch. **7/-** and **8/-** each. Supplied unmounted, **3/6** each.



B 570.

B.570. **10-WAY INDUCTANCE OR CAPACITY SWITCH.** (Patent 226245.) This switch is of the under panel mounting type, and is fitted to the panel by means of the two countersunk head screws supplied. It enables the experimenter to build up large capacities, and is an invaluable addition to any set. Price **5/6** each.

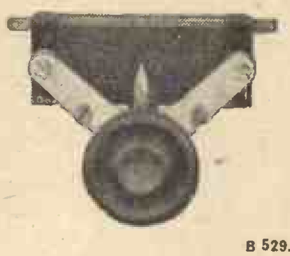
B.513. **TELEPHONE HEADPIECES.** The "Stalloy" diaphragms are matched so as to secure a balance of tone and quality. Resistance from 120 to 12,000 ohms. Price (4,000 ohms.), **20/-** each.

B.529. **POTENTIOMETERS.** (For panel mounting.) On rectangular ebonite former, complete with knob and pointer. Former mounted on cast brass frame. Resistance approximately 400 ohms. **7/6** each.

B 513.

AN AID TO ENTHUSIASTS.

We have prepared a logging chart for recording wave-lengths, condenser settings, etc., of those stations which require careful calibration to tune in. A copy of this chart, printed on stiff card, with hanger, can be obtained free of charge at any of our Branches or from any high-class dealer.



B 529.

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NEWCASTLE-ON-TYNE: 59, Westgate Road.
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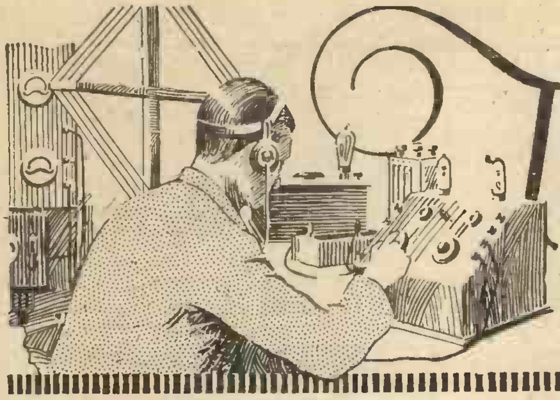


Tested by Ourselves

"Ariane" Portable Aerial

A SAMPLE of the "Ariane" portable aerial has been submitted by Messrs. B.E.N. Patents. This consists of a strip of enamelled wire-gauze about $\frac{7}{8}$ in. wide and some 11 yards long, wound on a reel, with swivel, and with insulator and connecting terminal at the outer end. It is suggested that this can be suspended in any convenient position indoors, and does not require supplementary insulators. Tested practically, firstly as a short indoor aerial in conjunction with a sensitive single-valve reaction receiver, and in the same room, satisfactory reception resulted on the local station, and the valve oscillated with ease.

A Second Test

In a second test, under favourable conditions, using the whole length along a first-floor corridor and as lead-in down the staircase as well, in direct comparison with a similarly-erected aerial of standard 7/22's stranded copper wire of like dimensions, at a dozen miles from the local short-wave station the Ariane aerial gave 2·5 micro-amperes rectified current with a good galena crystal used in a low-loss, "proportional-crystal-tap" crystal-receiver of the most favourable design; as compared with precisely the same figure for the stranded wire. The capacity of the Ariane strip was slightly greater, the optimum crystal-tap point being sensibly the same for both aerials. The signals were clearly readable with this strength. At shorter distances undoubtedly good reception is possible with this small aerial.

A Special Twist Drill for One-Hole-Fixing Devices

THE modern one-hole-fixing component necessitates a larger hole in the panel than the usual small hand-drill can accommodate in its small chuck. Messrs. Clifton and Co., Ltd. have accordingly brought out a useful special size of twist-drill which will make a $\frac{3}{8}$-in. diameter hole in the ebonite panel, but which at the same time has a shank reduced to $\frac{1}{4}$-in. diameter, and hence small enough to hold in the chuck of an ordinary geared hand-drill or breast-drill. This drill, a sample of which has reached us and has received practical test, is 5 in. long and has a parallel $\frac{1}{4}$-in. diameter shank $1\frac{1}{4}$ in. long. On trial it proved to be fast-cutting and keen; and eminently suited for this special service.

The B.T.H. L.F. Transformer.

B.T.H. L.F. Transformers

INTERVALVE low-frequency transformers of 4:1 and 2:1 ratio have been submitted by Messrs. The British Thomson-Houston Co., Ltd. These are of medium size, standing about 3 in. high by 2 in. square. Both are enclosed in an insulating case of the familiar B.T.H. chocolate-brown colour, and have an unusually generous iron core of thin laminations. The four terminals are arranged conveniently on the sides of the case, and are plainly marked. The case also provides holding-down lugs. As might be expected in a product of a firm of Messrs. B.T.H.'s reputation, insulation-resistance, workmanship and finish were beyond reproach.

On practical test against standard large types, under the most favourable conditions as to grid-bias and plate-potential and controlling a small power-valve, in telephony reception the 4:1 ratio instrument gave excellent results, both as to the degree of amplification and freedom from distortion. After a low-impedance detector-valve the results were almost comparable with the standard, if a little "low-pitched"; after a high-impedance "R" detector-valve the performance fell off a little. But for a medium-sized instrument, the result was really good; the instrument can accordingly be recommended for the first or second stage.

The 2:1 Ratio Type

The 2:1 instrument showed a disappointing performance in the matter of degree of amplification, whether in a first stage or in a second or third stage of transformer-coupled L.F. amplification, using the proper equipment of power-valves and stabilising devices, and in comparison with the 4:1 and 6:1 ratio instruments which both modern practice and theoretical considerations as to matching valve and transformer primary impedances dictate. The tone was good, and, of course, stability may be obtained a little more easily in a third stage transformer-coupled L.F. valve if a low-ratio instrument be used (as in current American practice), and amplification thereby sacrificed; but it is not easy to see the point of a 2:1 ratio instrument in ordinary practice.

"National Super-Crystal Detector"

A WELL-THOUGHT-OUT crystal detector of the horizontal glass-enclosed type for the galena cat-whisker combination has been submitted for our criticism by Messrs. National Wireless and Electric Co., under the name of the "National Super." Whilst of the ordinary pattern of horizontal detector, in this instrument special trouble has been taken to give a real micrometer fine-adjustment to the catwhisker holder, by means of a sliding telescopic plunger device controlled by a fine-thread screw and by a small fluted ebonite handle. A screw chuck is provided for holding the fine, springy whisker.

Rapid Dismounting

Another thoughtful point is the provision for rapid dismounting and change or adjustment of crystal by means of a cap held in place by a small knurled-head screw with a lock-nut; on withdrawing this a short distance the end-cap and glass barrel can be swung aside and removed. Care must be taken not to tighten this locking-screw too far, since either the brass brackets or the panel must give in such a case. The crystal is held in position by a knurled ring provided with three fingers; it can be removed in a few seconds when needed. The whole instrument is mounted on an insulating base measuring 4 in. by 1½ in., for mounting on baseboard or panel-top by two screws. Finish and workmanship appear excellent, and on practical trial the instrument operated excellently and gave fine adjustment for the whisker. It can well be recommended.

"Lanite" Crystals

We have received from Messrs. Lanite Laboratories samples of their "Lanite" crystal and special catwhisker, termed "Lanidium." The first appeared to be an ordinary type of finely-granular and brightly-crystalline galena, and showed the usual properties of this substance. The quantitative rectifying efficiency in a good setting of the usual catwhisker was on a par with standard galenas, though it was noticed that a fair proportion of haphazard settings were not of this order. The special whisker enclosed in the box with the crystal showed the same behaviour, quantitatively, in conjunction with another galena crystal as a standard type. The combination of whisker and crystal was satisfactory when used in the accepted manner, *i.e.*, with light, sensitive contact.

"Full-o-Point" Crystal

We have received samples of the "Full-o-Point" crystal from Messrs. Wineberg and Co. These are a galena of coarse grain and irregular structure, showing a number of large facets very bright in appearance. On test, whilst one reading was obtained, in the rectification of the local station's wave, equal to that given by a standard type of hand-set galena rectifier, and two other readings approaching this standard, the majority of chance settings showed a decided drop in the micro-ammeter reading, and a number of inactive spots were noticed above the general average of galenas marketed for use in crystal receivers. We do not feel, accordingly, that we can recommend this crystal until greater uniformity of rectifying qualities has been attained by the makers.

"Atlas" Low-Loss Variable Condenser

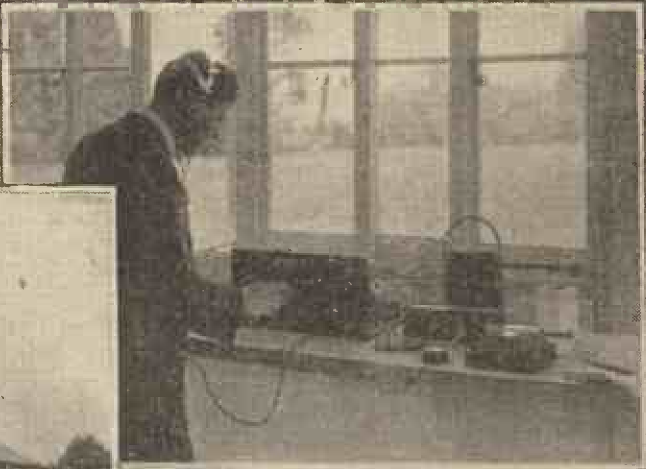
From Messrs. H. Clarke and Co. (Manchester), Ltd., comes a sample of their "Atlas" square-law variable condenser, of

The "Atlas" Low-Loss Variable Condenser.

what is described as a "low-loss" type, and of nominal ·0005 μF capacity. This instrument has skeleton metal end-plates with rotor supported in substantial bearings mounted on these end-plates so that the whole can be connected to earth; the usual cam-shaped plates are used. The insulation resistance, when dry, was adequate. Tested in critical oscillating valve circuits at ordinary frequencies, the condenser showed an absence of any sensible high-frequency losses, being on a par with ordinary types with ebonite end-plates when in a normal dry condition. The maximum capacity was ·00054 μF, and minimum just under $9 \mu\mu F$. The usual type of single-hole-fixing is provided. Good terminals are fitted, but no means of fixing securely the knob and scale. The workmanship and finish appeared satisfactory.

PROGRESS AT OUR ELSTREE LABORATORIES

The first two huts at Elstree are now completed. This photograph shows the site itself with the research hut in the foreground. Note the entire absence of trees, wires, iron pipes, etc., which could cause trouble with short-wave experiments.



Work has already commenced in the test hut, which is shown in the left-hand photograph, while the view above depicts the ideal conditions under which testing and research will be carried out.

From our Readers.

Appreciation of "Modern Wireless" Sets

SIR,—A further note of appreciation on the sets described in MODERN WIRELESS. I must have constructed at least a dozen of these, from "S.T. 100" onwards. My latest are Mr. Cowper's "Simple Selective Set" (MODERN WIRELESS for April, 1925), and the Simplified Three-Valve Dual (MODERN WIRELESS March, 1925, by John Scott-Taggart). To the former I added one stage of power amplification, and the results were extraordinary, and the set being constructed in the American style it made a most useful portable instrument. I wrote to Mr. Cowper thanking him, and he took a very kind interest in some further modifications for the reception of short waves, which I have carried out with much success.

The "Three-Valve Dual" was completed recently and was really originally the W1 3-valve receiver, which had been superseded by the Cowper set for loud-speaker work 17 miles from 5SC. So having a spare panel and handsome cabinet doing nothing, I converted the W.1 to the Three-Valve Dual, taking great care in spacing wires. I expected little, but received much; and at the moment Gleneagles' band is full loud-speaker strength on a short indoor aerial. I have logged Belfast, Dundee, Edinburgh, Bournemouth, Manchester and several Continental stations on the loud-speaker up to date. I consider this is excellent for summer conditions. The receiver is really delightfully easy to handle, and I am looking forward to the winter months and to enjoying many pleasant hours with the "Simplified Three-Valve Dual."—Yours truly,

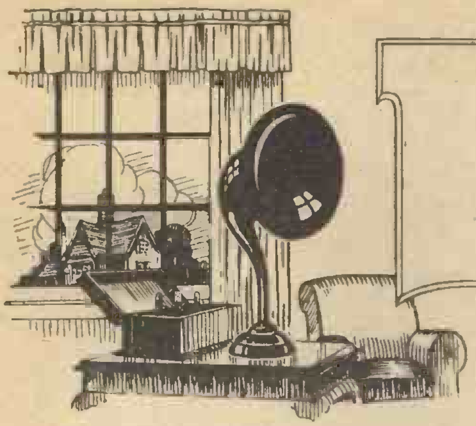
WILLIAM SCOTT, M.B., Ch.B.
Alexandria,
Dumbartonshire.

The General Purpose Three

SIR,—I think it may interest you to know the results I have obtained from my "General Purpose" three-valve receiver, described by Mr. Johnson-Randall in MODERN WIRELESS, April, 1925. I am able to receive all B.B.C. stations except Edinburgh and Plymouth at good 'phone strength, and several of the nearer ones on loud-speaker. Birmingham, 35 miles, being too loud for comfort. This set seems to have an appetite for Continental stations, some of my best being Petit Parisian, Radio-Toulouse, Hamburg, Frankfurt, Rome, and a Dutch on about 360 metres.

Some evenings Toulouse comes in at quite good loud-speaker strength. One evening last week I heard an American station, WGY, at about 12.35 a.m., but atmospherics were so bad that at times nothing was distinguishable. Considering that I have been at wireless for just under a year, and that I am only just 16, I do not think results at all bad. If you can make any use of this letter I shall be very pleased indeed. Meanwhile I remain a faithful reader of your excellent papers.—Yours truly,

S. E. KENWORTHY.
Priors Lee, Salop.



Readers' Experiences

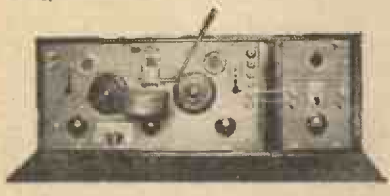
Envelope No. 4

SIR,—I enclose photograph of the "All-Concert de Luxe" receiver which I have constructed from instructions given in Envelope No. 4 by Percy W. Harris. I have incorporated a switch to cut out the third valve.

Have also built, as you will see by the photograph, an extra L.F. unit from instructions given in "Twelve Tested Wireless Sets," also by Mr. Harris, but made to match the design of the set.

The results I have obtained with this set are really marvellous; my aerial is 30 ft. high, total length 65 ft. about, and with coils 35, 75, and 75, I tuned in one evening twenty-seven stations in under fifteen minutes.

I get most of the British main stations on the loud-speaker with three valves, Glasgow, one of the most distant, coming in quite well.



Mr. Wall's "All Concert de Luxe" Receiver, with Note Magnifier added.

With the four valves the loud-speaker brings in several Continental stations, also Edinburgh relay station and KDKA.

I have made my own coils for KDKA (one of which is seen in the receiver as photographed).—Yours truly,

Felixstowe. S. D. WALL.

"Full Volume from Three Valves"

SIR,—With reference to the article "Full volume from Three Valves," by Mr. A. Johnson-Randall, in the July issue of *Modern Wireless*, I should like to state that it fully justifies the author's remarks as to tone and volume, and it is well worth the time taken in constructing it.

On plugging in all three valves the Junior Amplion Loud-speaker has all its work cut out to carry the volume, and taking into consideration the above remarks the tone obtained is exceptionally pure.

I have a single aerial 25 ft. high each end, and the valves are Ediswan A.R.D.E. for the 1st and 2nd stages and a Cossor W.3 for the last stage.

The above remarks, I think, show that I for one am fully satisfied with the working of the set, and can only thank you for the opportunity of constructing same.—Yours truly,

R. C. SHARWOOD.

Catford, S.E.

A Simple Selective Set

SIR,—May I heartily endorse the tribute paid to Mr. A. D. Cowper, M.Sc., on page 926 of the last number of MODERN WIRELESS. There is no Radio Press writer who gives me greater interest.

I have made up several circuits of his, including "A Simple Selective Set," given in the MODERN WIRELESS some months ago (April, 1925). This I consider to be the ideal one-valve design for reception of short-wave broadcasting.

Finally, I hope to see more of Mr. Cowper's articles on the lines of "Low Resistance Frame Aerials and Distant Reception" in the March issue of MODERN WIRELESS.—Yours truly,

Glasgow. THOMAS SCOTT.

A Two-Valve Hartley-Reinartz Receiver

By JOHN W. BARBER. *(Continued from Page 75.)*

The setting of the reaction condenser will be found to affect that of the tuning condenser, in a similar manner to that in which an ordinary reaction coil affects the tuning of a simple reaction receiver, hence it will be necessary to follow up adjustments of the tuning condenser with adjustments of the reaction condenser, in order to find the best setting for a particular station. The local station can be tuned out with remarkable ease, and it has been possible to receive Bournemouth, at five miles from London, with no interference from the local station, while during an initial test on a bench hook-up it was necessary to join up a crystal set to find out whether 2LO was working, since that station was not discovered in two or three rotations of the tuning dials! When the operation of the circuit was understood more clearly, it was possible to receive several distant stations in a few minutes using the detector valve only, but as the reception was only in the nature of a preliminary test to find out the best number of turns in the coils, the call signs of the various stations were not waited for, but music was clear and distinct in all cases.

Results

After building the receiver up into its present form, the first station to be received was Radio-Toulouse on 275 metres (1090 Kc.), which came in at characteristically good strength. London is, of course, too loud at five miles for comfortable telephone reception, although it is hardly loud enough to operate a loud-speaker at sufficient volume for a medium-sized room.

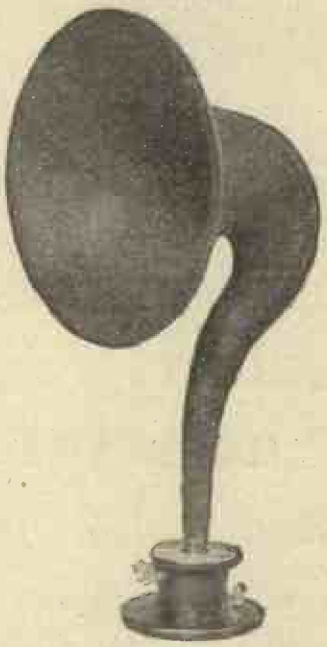
Other stations received include 5IT, 5SC, Hamburg, Brussels, several British relay stations, Petit Parisien, and L'Ecole Supérieure. In view of its selectivity, this set will provide the means whereby many distant stations may be heard without local interference.

Serenada Loud Speakers

The Perfect Reproducers.

The real joy of Radio Entertainment comes with the possession of a reliable LOUD SPEAKER and the SERENADA is the instrument which attains this ideal. The SERENADA LOUD SPEAKER is the latest advancement in Reproducers. Its symmetrical lines are so designed to give maximum volume with PERFECT CLARITY AND MELLOWNESS OF TONE. For Quality and Price it has no equal. EVERY INSTRUMENT GUARANTEED FOR TWELVE MONTHS.

MODEL 50.



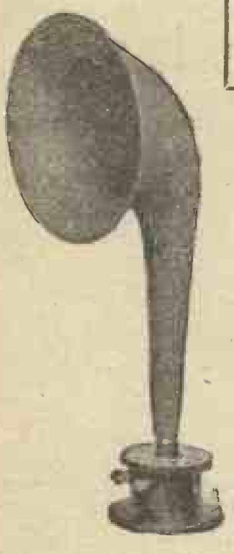
Height 27 inches. Flare 14 inches.
Price £4 4 0.

THE SERENADA LOUD SPEAKER IS A THOROUGHLY BRITISH PRODUCT.
It makes a very definite advance on all types of Speakers. Its pleasing design and finish make it an ornament in every home, whilst a special device eliminates all extraneous noise and, in conjunction with the non-metallic horn and super vernier adjustment, assures perfect satisfaction in every respect.
THE SERENADA SPEAKS FOR ITSELF.

Send for attractive Booklet B/20 giving full particulars of the Serenada Loud Speakers.

Ask for a demonstration from your local dealer. He will be pleased to give it.

MODEL 25a.



Height .. 22 inches.
Flare .. 10 inches.
Price .. £2 10 0

MODEL 30.

Height .. 23 inches.
Flare .. 12 inches.
Price .. £3 3 0

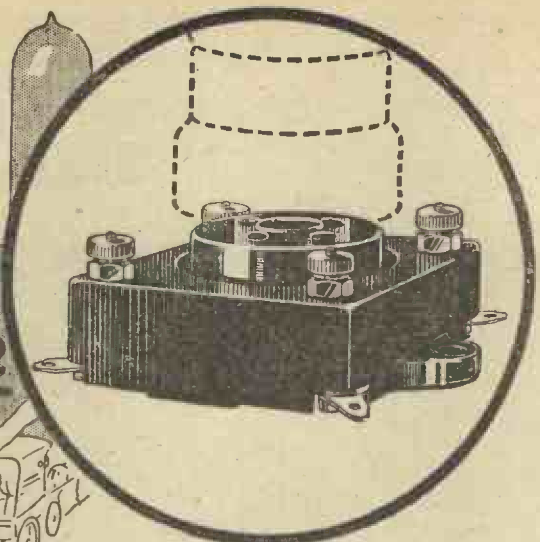
SPECIAL FEATURES OF THE SERENADA.

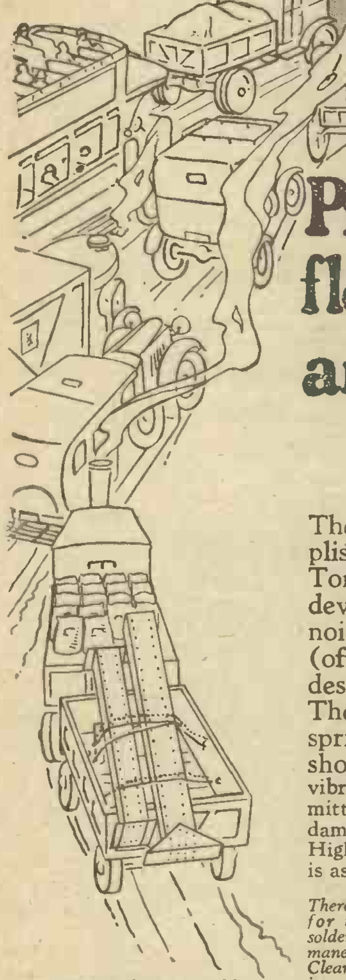
1. Maximum efficiency with either weak or strong signals.
2. A specially constructed device, which ensures absolutely VIBRATIONLESS REPRODUCTION.
3. A specially designed COBALT STEEL MAGNET which works in conjuction with balanced windings on laminated cores of soft iron, giving the correct flux.
4. STALLOY RUST-PROOF DIAPHRAGMS.
5. The base is of a NON-MAGNETIC MATERIAL, artistic in design, and finished in a pleasing shade of black.
6. The adjustment is by a lever, which gives ease of control without the use of GEAR WHEELS OR GADGETS.
7. A NON-METALLIC HORN, fitted to the base by a screw-necked ferrule, thus making a perfect and positive connection, and preventing any loss in volume of sound.
8. This Horn, specially constructed with ideal acoustic properties, gives a round and natural tone, FREE FROM METALLIC NOISES INHERENT IN METAL HORNS, and amplifies song, speech and instrumental music without adding to or subtracting from the original rendition.

Visit our STAND at the RADIO EXHIBITION, Royal Horticultural Hall, Westminster, S.W.1, Oct. 10 to 16.

THE SERENADA MANUFACTURING Co. Ltd.
22, PAPER STREET, LONDON, E.C.1. *Telephone:* CLERKENWELL 7830.

Vibration-distant shocks - they are always here





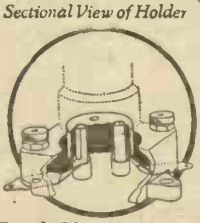
Protect your valves - float them on springs and kill noise in the filament!

The simplest, most efficient method of accomplishing this is to use a Benjamin Clearer Tone Valve Holder. This new shock-absorbing device prevents the transmission of outside noises to the filament. Outside vibrations (often inaudible to the ear, yet invariably destroying pure tone) are completely dissipated. The secret lies in the four delicately adjusted springs, cushioning the valve against all external shocks. Though responding to the slightest vibration these springs are immeasurably strong, permitting the tightest valve to be inserted without fear of damage. EACH SPRING HAS ONE TURN ONLY. High insulation, low capacity and great mechanical strength is assured by using Bakelite for the body of the holder.

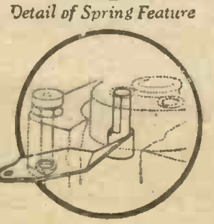
There are terminal connections for the experimenter and soldering tags for the permanent set. The Benjamin Clearer Tone Valve Holder is easily cleaned—little or no dust can collect in the sockets. The springs themselves, as shown in the lower of the two diagrams, form the valve pin sockets. No soldered joints — all one solid metal piece from tag to valve leg. No flexible wire connections. The spring supports are not affected by stiff bus bar wiring. For Good Reception with Dull Emitter Valves Benjamin Clearer Tone Anti-Microphonic Valve Holders are absolutely essential.

2/9 *Each.*

Sectional View of Holder



Detail of Spring Feature



BRITISH **BENJAMIN** *MADE*

CLEARER TONE VALVE HOLDER

Patents **(ANTI-MICROPHONIC)** *Pending*

From your Dealer or direct from:

THE BENJAMIN ELECTRIC LIMITED
Brantwood Works, Tariff Road, Tottenham, N.17.

The Benjamin Battery Switch gives perfect current control, 2/- each.

Advertising

—in the Radio Market

JUST how effective your advertising is in the radio market depends primarily upon the mediums you use—and in this market the mediums that claim your first attention are the Radio Press publications, MODERN WIRELESS, THE WIRELESS CONSTRUCTOR, WIRELESS WEEKLY, and WIRELESS.

With their circulation of 850,000 they carry sales messages to radio enthusiasts all over the country and abroad, all of whom are keenly interested in the announcements of anything that will improve the efficiency of their apparatus or add to the enjoyment of their hobby.

By such a contact with the radio public, the Radio Press publications offer advertisers a service which ensures their advertising reaching every section of the wireless public, thereby securing the best results possible.

Ring CITY: 9911 (6 lines), or write for particulars and rates to the Advertisement Manager:—

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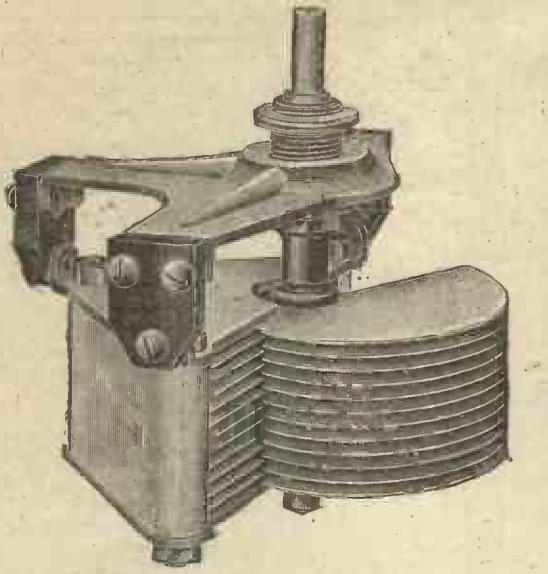
Bush House, Strand, London, W.C.2



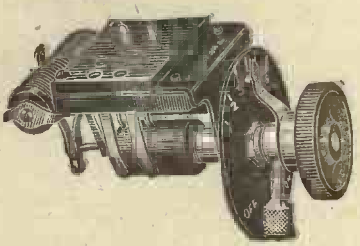
"UTILITY" LOW LOSS CONDENSERS

are essentially low loss due to unique design. One end plate only is used, thus reducing end plate losses by half. All solid dielectric is external and shielded from the electrostatic field. The spindle bearing is of generous length, automatically takes up wear, and end play and end thrust are entirely eliminated. These condensers are immediately convertible to Vernier type, by fitting the "Utility" Vernier dial.

All condensers have the usual "Utility" one hole fixing.

PRICES :

Ref. No.	Max. Cap.	Low Loss Type.	Vernier Low Loss Type.
W.M. 159 ...	.001 mfd.	14/9	19/9
W.M. 160 ...	.0005 ,,	12/6	17/6
W.M. 161 ...	.0003 ,,	10/-	15/-
W.M. 162 ...	.00025 ,,	9/6	14/6
W.M. 163 ...	.0002 ,,	9/-	14/-

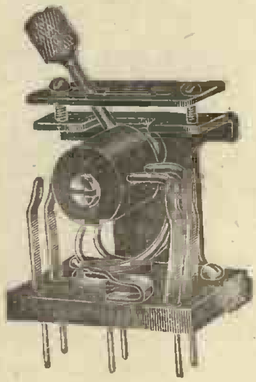


"UTILITY" VALVE SWITCH UNIT

embodies in one unit our well-known "Utility" switch, a valve holder and rheostat. It is for use in multi-valve sets, to control a valve, to switch it in and out whilst still preserving the continuity of the circuit.

It has many advantages over separate components, such as lower self capacity, less wiring, one hole fixing and lower cost.

PRICE (complete with wiring diagrams), 8/6 each.



"UTILITY" NO CAPACITY CHANGE OVER SWITCHES.

Made to change over any number of contacts. The design ensures that self capacity is negligible and contacts are rubbing and therefore self cleaning. Made in 2 styles —Knob and Lever Patterns.

PRICES (Each) :

	Knob.		Lever.
No. W.M. 130/1* ...	3/6	No. W.M. 147/1* ...	4/6
No. W.M. 130/2 ...	4/-	No. W.M. 147/2 ...	5/-
No. W.M. 130/3 ...	5/-	No. W.M. 147/3 ...	6/-
No. W.M. 130/4 ...	6/-	No. W.M. 147/4 ...	7/6
No. W.M. 130/5 ...	7/-	No. W.M. 147/5 ...	10/-
No. W.M. 130/6 ...	8/-	No. W.M. 147/6 ...	10/-

* This figure shows the number of poles changed over, e.g., W.M. 130/4 indicates Knob type 4 pole change over.

Nickel plate finish—Knob type, 3d.; Lever 6d. each extra.

Utility
GUARANTEED
COMPONENTS

Satisfaction is guaranteed, because if you have any cause for complaint, you have only to send it back to us and we will replace it entirely free of charge.
Every "Utility" product is unconditionally guaranteed.

WILKINS & WRIGHT, LTD., Utility Works, Kenyon Street, Birmingham.

E.P.S. 1.

Guaranteed to abolish Hand capacity effects

THE ONLY VARIABLE CONDENSER SO GUARANTEED

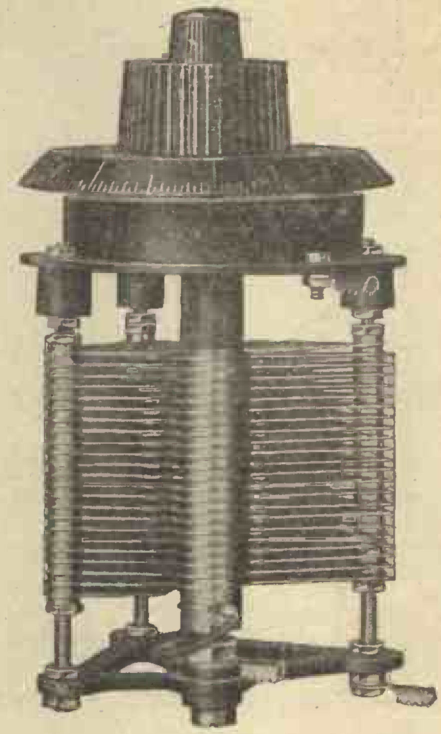
Protected throughout the World

We back our statement that " the Fulstop variable condensers abolish hand capacity effects " with an unconditional guarantee to refund the money to any purchaser who does not find it true.

No other manufacturer can give this guarantee, which accompanies every Fulstop. No other device eliminates hand capacity and it is protected throughout the world.

You can tune to a metre with the new Super Fulstop—Fulstops get more stations.

In the Super-Fulstop, tuning is effected by means of a clockwork multigear giving the use of two ratios of movement: a 2 to 1 and a 125 to 1 ratio. Both are effective on all the vanes and with actual readings on the dial. The dial gives 200 actual readings, each capable of infinite adjustment. It is a no-loss condenser, perfectly square law and has brass vanes.



PRICES.

·00025	25/6
·0005	28/6
·001	30/6

Also made in two other Models.

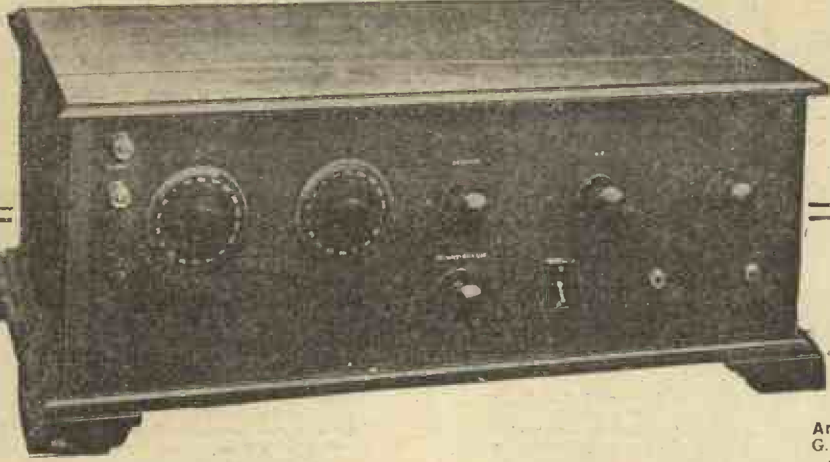
	Standard Fulstop. (Geared 2 to 1)	Plain Fulstop. (No Gears)
	Guaranteed to abolish hand capacity.	
·0002	9/6	8/3
·0003	10/3	8/9
·0005	11/3	9/6
.001	13/3	11/6

Send for full descriptive leaflet. All models are guaranteed for 12 months.

If any difficulty in obtaining, write to us and we will send direct, post free.

Fulstop VARIABLE CONDENSER

J. H. NAYLOR LTD - WIGAN



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MAGNADYNE
THE LATEST DEVELOPMENT IN BRITISH SUPER-HETS

DOES the programme of your local Broadcasting Station always suit your taste? If not the **Magnadyne** will extend your field of audition to some 30 or more British and foreign stations, enabling you to choose a programme to suit yourself.

Complete, ready Wired and Aerial Tested	**£35 0 0**
Plus Marconi and Western Electric Co. Royalties ..	**£5 10 0**

Prices, Kit of Components, £17 17 0.

The heart of a Super-Het is the Interfrequency Transformers and Oscillator Coupler, known as **Magnaformers.** Price per Outfit, including 5 Interfrequency Couplings and Interchangeable Oscillator Coupler, **£5.**

(Supplied on 7 days' approval against cash.)

Interchangeable Oscillator Couplers can be supplied at **12/6** each, or **15/-** including 6 Pin Holder.

For Super-Hets Portable Sets and all cases where Dull Emitter Valves are used, specify and use Magnum "Vibro" Valve Holders, **5/-** each.

Kendall 3 Step Former, as used in the set described by Mr. S. Rattee, and fully described in "Wireless," **10/-.**

Or ready wired, **12/6.**

Send stamp for lists dealing with Components for Radio Press Circuits, also the Magnadyne Super-Het.

THE COASTAL THREE.
Supplied ready wired and Aerial Tested, **£12 0 0.**
Plus Marconi Royalties, **£1 12 6.**

An Acceptor Wave Trap, as described in this issue by Mr. G. P. Kendall.

	£	s.	d.
1 Magnum Cabinet, as described	0	13	5
1 Ebonite Panel, 8 by 5 by ¼ drilled ..	0	4	6
1 Colvern Selector Condenser, .0005 ..	1	1	0
2 Angle Brackets (small)	0	2	0
1 Ebonite Shelf, 7 by 2 by ¼, drilled	0	1	6
4 Magnum Heavy Terminals, complete ..	0	1	8
1 Rotary Switch, with studs and stops ..	0	2	6
1 Collinson Coil Former	0	5	6
1 Clip and Flex	0	0	6
No. 20 Enamelled Copper Wire	0	1	0
2 yards No. 16 Sq. Sec. T.C. Wire	0	0	4
	£[illegible]	13	[illegible]
Complete, ready wired and tested	£3	5	0

THE COASTAL THREE.
As described in this issue by Mr. Johnson-Randall.

	£	s.	d.
1 Magnum Terminal Panel	£0	4	6
2 Igranic Variable Sq. Law Condensers, .0003	2	2	0
3 Anti-Microphonic Valve Holders	0	15	0
1 C.A.V. L.F. Transformer, 1st stage ..	1	7	6
1 McMichael Potentiometer	0	7	6
3 " Dual Rheostats	1	2	6
1 " Fixed Condenser, .0003, and Leak 2 meg.	0	4	0
1 Magnum 2 Coil Holder, type R	0	9	6
1 " Single Coil Holder	0	1	9
2 " Angle Brackets (small)	0	2	6
4 Nickelled Terminals, complete	0	0	10
1 Dorwood Precision Fixed Condenser, .001 ..	0	3	0
1 Gambrell Coil, aT	0	6	6
1 " " C	0	6	9
6 yards No. 16 Sq. Sec. T.-C. Wire	0	0	8
1 Set Radio Press Transfers	0	0	6
	£7	14	6
1 Mahogany Cabinet and Baseboard, as described	£1	7	6
1 Ebonite Panel, drilled	0	12	0

NOTE.—Where a complete set of components is purchased together, a Marconi royalty of 12s. 6d. per valve holder is payable.

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Telephone: Hop 6257. Telegrams: Burjomag, Sedist, London. Cables: Burjomag, London.
TRADE ENQUIRIES INVITED.

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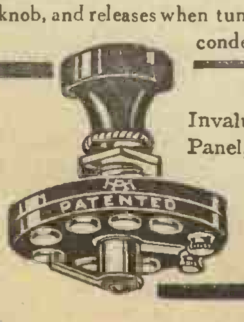
EVERY CONDENSER A VERNIER FOR 2/-

ONE Hunt "Easitune" Anti-capacity Vernier Tuning Handle (Fig. 910) will fine-tune every condenser. One touch of the spring grips surely any condenser knob, and releases when tuning is done. Perfectly insulated. Tuner's hand 5½ ins. from condenser knob. No hand-capacity. Price 2/- each. Postage 3d. extra.

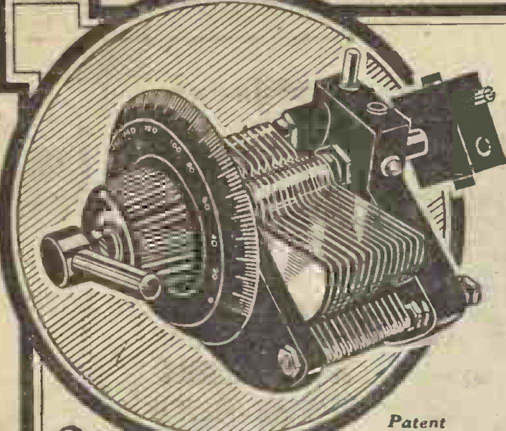


THE EXPERIMENTER'S GRID-LEAK.

Invaluable for pure reproduction and delicate long-distance tuning. Under Panel, **Single Hole** fixing model, Fig. No. 1,104, "NEWLEAK," **5/-** EACH, as illustrated. Top of panel mounting, Fig. No. 1,100, 4/6 EACH. Standard Model ½–5 megohms, other calibrations to order. Anti-capacity handle 5½ in. long, Fig. No. 1,110, **9d. each.** POSTAGE 3d. EXTRA. *Obtainable from all dealers or direct from:*

A. H. HUNT, LTD., (DEPT. 5), TUNSTALL ROAD, CROYDON.

H.P.



A new device for simplifying Radio

Patent applied for.

The **SEAMARK CONNODE** REGD

The chief difficulty in Radio is that the beginner cannot tune in successfully. Tuning is erratic on account of reaction being difficult to control. Moving a reaction coil has the effect of adding or subtracting stray capacity to or from another and adjacent coil. This means that the second coil is thrown out of tune. Hence the ever-present difficulty in tuning.

Verniers and "micro-adjustment" coil holders add further complications. They represent more knobs to turn. They mean separate and individual adjustments. When you correctly adjust one, you automatically upset the other. This increases the beginner's difficulties.

The Seamark Connode will take all standard makes of coils. It gives smooth and vernier-like control of coupling or reaction, without embodying a vernier. The adjustment is always the same for a given wavelength. It is adjusted from one point only—"one hand control."

The Seamark Connode means the multi-valve set with one dial control. Provision is made for one or three hole fixing as desired. Manipulation of the connode is simple. There is no annoying "will 'o the wisp" hand effect. The Connode can give your set increased selectivity.

The Seamark Connode is polished and high grade. It is a scientific instrument of great beauty. Square law qualities are embodied. It was conceived by a wireless engineer, designed by a mechanical engineer, and is produced under ideal conditions from first quality material. The superior advantages of this instrument are obvious to beginner and expert alike.

Price: **19/6**

Write for descriptive list.

Sole Patentees and Manufacturers: **C. E. NEEDHAM & BROTHER Ltd., 2, MILK ST., SHEFFIELD**

Long Life Batteries which Improve Reception

The new **GECOPHONE** Super-capacity High-Tension Radio Batteries have made an instantaneous appeal—Wireless users have found them to be "just the thing" they have long been wanting.

Their outstanding merits:

LONG LIFE—4 to 5 times as long as other types,
LARGE CAPACITY,
SILENCE IN USE,
MINIMUM INTERNAL RESISTANCE,

are the outcome of much research and experiment, and make for an immense improvement in reception.

These Batteries are the latest development in BRITISH Battery manufacture and will undoubtedly become the Standard H.T. Batteries for Radio use.

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HIGH-GRADE MEASURING INSTRUMENTS For All Purposes

We stock nearly 50 different types of measuring instruments totalling in all nearly 200 Calibrations, while any special reading or calibration can be supplied to exact requirements on request. Let us know what you require. We can help you!

Fig.		Each
152	Double reading voltmeter, 0-7v. 0-100v.	12/6
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151	Pocket type ampmeter, 0-2½a. 0-15a or 0-25a.	7/6
133	Pocket type volt and ampmeter Each all readings	10/6
160	Panel type voltmeter, 0-7v. 0-15v. or 0-25v.	9/-
161	Panel type ampmeter, 0-2½a, 0-15a. or 0-25a.	9/-
165	Panel type voltmeter, 3¼ in. dial, calibrated 0-15 to 0-200v. Prices from	17/6 to 30/-
166	Panel type amperemeter, 3¼ in. dial, 0-15 or 0-25 amps.	17/6
	0-35 amps.	19/-

Postage 6d. each, obtainable from all dealers, or direct from

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(Dept. 5),
TUNSTALL RD., CROYDON.

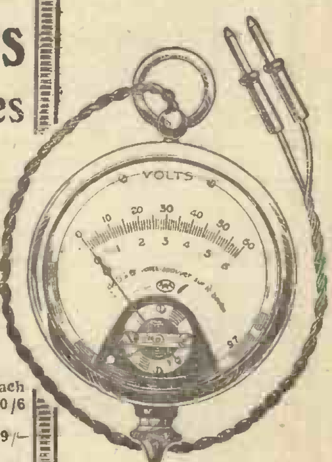

Fig. 152.
Diam. of case 2 ins.
COMBINED VOLTMETER READING 0/7 VOLTS AND 0/100 VOLTS.
Price 12/6 each.
2 Spears are provided, one for each reading.

H.P.

The truth about the Mansbridge Condenser

In view of certain misconceptions, it is well that the public should know the facts about the Mansbridge Condenser—its origin and development.

THE Mansbridge Condenser was invented in 1906. Up to this time all condensers were made by assembling alternate sheets of either mica or paper with tinfoil. This process was carried out by hand and was, therefore, relatively slow and expensive. The Mansbridge patent effected several improvements.

Firstly, it enabled the condenser unit to be assembled at a rapid rate because the dielectrics and conductors are fed in continuous strips. Secondly, by reason of the very thin layer of metal which is used in the foiled paper forming the electrode (or conductor), the condenser is not easily short-circuited. This feature forms its well-known self-sealing property.

Undoubtedly the Mansbridge Condenser was a wonderful advance—and even to-day is unexcelled where a compact condenser of large capacity is required.

As a pioneer condenser-making firm, it was only natural that these improvements should attract the attention of the Telegraph Condenser Co. Ltd., and negotiations were early concluded between this Company and the inventor for manufacturing condensers under his patents. Since then T.C.C. Mansbridge Condensers have been supplied in large quantities to the British and Colonial Post Offices, while during the War the T.C.C. supplied the Army with the majority of Condensers for field telegraphs and many other purposes. In fact, there is hardly a corner of the globe into which these familiar little green condensers have not found their way.

The Mansbridge Patent lapsed in 1919 and, provided that it possesses the requisite scientific resources, the right kind of machinery and a capable staff, any firm can now make Mansbridge Condensers.

But—and special emphasis is necessary here—experience plays a very big part in condenser making. The T.C.C. reputation has been built up over a period of 20 years. Obviously, the mere possession of a plant will no more ensure accurate Mansbridge Condensers than the purchase of a kit of tools will make a man a skilled mechanic The manufacture of Mansbridge Condensers presents its own difficulties—just as any other product. These difficulties must be faced and overcome. For many years T.C.C. experts have been co-operating in making in the T.C.C. Mansbridge a Condenser which, in all the world, is unequalled for accuracy, dependability and constancy. When you choose a T.C.C. in its familiar green metal case in any value from .004 mfds. to 2 mfds., you obtain a *genuine and fully guaranteed Mansbridge Condenser.*

T.C.C. genuine Mansbridge Condensers

¶ *Millions of these T.C.C. Mansbridge Condensers have been made.*

Backed by 20 years' Condenser Knowledge

Telegraph Condenser Co. Ltd.
West Park Works, Kew. S.W.

Gilbert Ad, 3556

The Latest

Wireless Handbook

for the

EXPERIMENTER, ENGINEER, AND RESEARCH WORKER.

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J. H. REYNER, B.Sc.(Hons.), A.C.G.I., D.I.C., Staff Editor of "Wireless Weekly," "Modern Wireless" and "The Wireless Constructor."

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Fill and post this form to-day.

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Published Price 15/-
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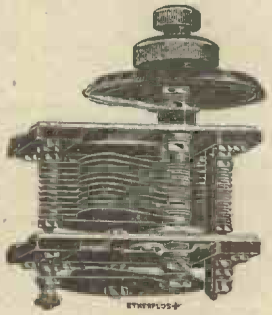
Write your name in Block Letters.

ETHERPLUS
RADIO ACCESSORIES = ENSURE {PERFECT RECEPTION

Variable Brass Vaned

Low Loss

CONDENSERS



Brass Pointer under Dial. Heavy Gauge Brass Vanes. Brass Pig-tail Spring Connection on Rotor. Latest type Friction Washer. All metal parts highly polished. Loss is practically negligible. Construction and finish of the highest grade.

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W/84	.0003	11/-	W/88V	.0003	12/6
W/85	.0005	11/-	W/89V	.0005	12/6
W/86	.001	14/-	W/90V	.001	15/6

From all dealers or post free from

M.&A.W., 9-15, Whitecross St., London, E.C.1

Full illustrated list of "Etherplus +" Components post free on application.

All the best Valve-Holder features are contained in

The new Woodhall Universal Valve-Holder, which is adaptable for use above or behind panel, or for baseboard mounting. Spiral spring suspension to sockets, perfect spring contact with valve legs, air dielectric only between valve sockets, quick-grip terminals. Plate socket coloured red. Self-adjusting to all variations in valve-leg spacing. **2/6**

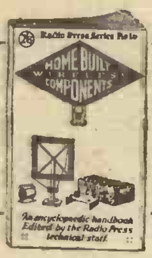
WOODHALL

Universal Valve-Holder

Anti-microphonic, anti-capacity, sure-contact.

Obtainable from all Dealers.

WOODHALL WIRELESS MANUFACTURING CO., LTD.
21, Garrick Street, W.C.2. (*One minute from Leicester Square Tube Station.*)



Make your own Components!

Wireless components are expensive, and an enthusiast can appreciably lower the cost of building a set by making his own. Such things as grid leaks, fixed and variable condensers can be easily constructed at home with the minimum of expense and trouble. Among the many books published by Radio Press, Ltd., is one called "Home-Built Wireless Components." With the aid of this useful book you will find it an easy matter to build your own components.

You require no more tools than those to be found in every wireless man's workshop. Besides, it will give you great satisfaction to be able to say that you built everything in your set except the valves.

RP
RADIO PRESS

Obtainable from all Bookstalls, Newsagents, your local Wireless dealer, or 2/8 direct from Dept. M.

RADIO PRESS, LTD.,
Bush House, Strand, W.C.2.

Home Built Wireless Components

PRICE 2/6

Barclays Ad.

What Others Think.

IT would be easy for us to write an advertisement telling you all about the sterling merits of the M.L. Transformer.

We think it is the best transformer that has ever been placed on the British market. Perhaps that is only natural since we are so interested in it. But here is what someone thinks who has no interest in the M.L. transformer, other than that of a satisfied user.

His testimonial is entirely unsolicited. Here is what he says:—

> *"As you are aware, I have tried out practically every make of L.F. Transformer available to the amateur, and, in my considered opinion your latest production is superior to anything I have previously tested."*

The 1:6 ratio is used for amplification after a crystal rectifier. The 1:4 ratio is used for single stage L-F Amplification. The 1:2-6 and 1:4 ratios are used respectively in the first and second stages of two-stage amplification.

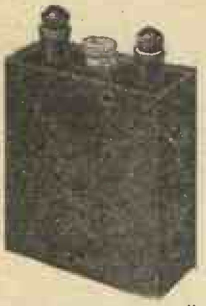
25/-

S. SMITH & SONS (M.A) LTD.
179-185 Great Portland Street, London, W.1
Telephone: Langham 2323 Telegrams: "Speedomet, Telew, London"
Also at Birmingham, Manchester, Glasgow and Belfast.

S·SMITH & SONS (M·A) LTD

E.P.S.41

PETO & RADFORD BATTERIES



This 2-volt "*Dagenite*" Cell can be supplied with side buttons and carrying strap at slight extra cost.

Wireless experts are agreed that the very best Battery on the market to-day is a Peto & Radford Battery in a "**Dagenite**" Container.

"**Dagenite**" is our own special composition which has been tested and tried for over twelve years—it is absolutely impervious to acid, it will not ror nor crack nor leak and it will not break, even when dropped.

For convenience, for economy, for efficiency and for best Radio results these "**Dagenite**" cells are unrivalled.

Ask your own dealer, or write to us for latest price lists.

PETO & RADFORD

(Proprietors: Pritchett & Gold and E.P.S. Company, Ltd.)

Head Offices and Showrooms:

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Telephone: VICTORIA 3667 (5 lines).
Telegrams: "STORAGE, SOWEST, LONDON."

AMATEUR CONSTRUCTORS

WE SUPPLY COMPLETE SETS OF COMPONENTS AND CABINETS FOR ALL CIRCUITS IN MODERN WIRELESS, WIRELESS CONSTRUCTOR, ETC.

BELOW.—A LIST OF PARTS FOR CONSTRUCTING

THE COASTAL THREE

As described by Mr. A. JOHNSON-RANDALL in this issue.

		£	s.	d.
1	Ebonite Panel, 16 in. × 8 in. × ¼		8	0
2	.0003 Sq. law condensers, Igranic	2	2	0
1	L.F. Transformer, C.A.V. 1st stage	1	7	6
3	Bowyer-Lowe valve holders, Anti-Pong		9	0
1	Single coil holder		1	6
1	Dorwood fixed condenser, .001		3	0
1	Grid leak and condenser unit, McMichael		4	0
3	Dual filament resistances „	1	2	6
1	Potentiometer „		7	6
1	2-way coil holder type R, Burne-Jones Co. ..		9	6
11	Terminals complete, nickelled		1	10
1	Ebonite strip, 7 in. × 2 in. × ¼ in.			10
2	3 in. Brackets		1	4
1	Set R.P. Transfers			6
18	Lengths No. 16 sq. sec. Tinned copper wire ..		1	3
1	Polished Mahogany Cabinet, with baseboard as described	1	8	0
		8	8	3

Send stamp for lists and let us quote you for Parts for the set you contemplate building.

Carriage and Packing Free on Orders Value £2 and over.

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'Buses Nos. 4A, 30A, 19, 19C, 43A, 144A, 144B, 143F.
Trams Pass the Door, Nos. 33, 79T, 19, 13, 39, 35.

NORMAN RADIO LTD.

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Save Money on Valves!

—GUARANTEED BRITISH MADE.

RADION G.P. A 4-volt bright valve, for general purpose use. } 7/-
RADION D.E. 06 / RADION D.E. 06 H.F. 3-volt "very dull" filament valves. } 10/6
RADION D.E. 34 / RADION D.E. 34 H.F. 2 volt D.E's. of great efficiency. } 10/6
RADION PYRAMID VALVES - 22/6

THE POWER VALVES DE LUXE. No. 1. 6 volt. No. 2. 4 volt. The most powerful on the market. We guarantee the filament.

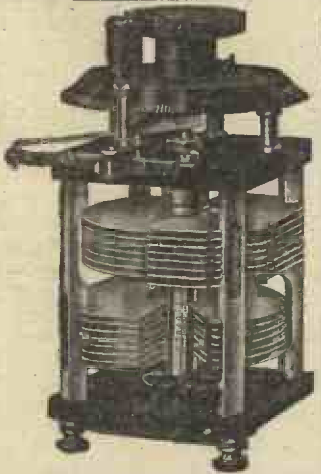
From united Dealers or direct, Post Free.

RADIONS LTD., BOLLINGTON, nr. Macclesfield, Cheshire

Interesting literature concerning Radion Valves and our unique valve repair service gladly sent free on request.

RADION Reliable Valves

Well below 20 Metres

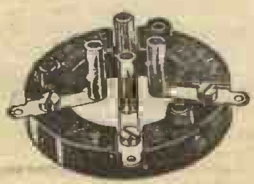


A famous Short Wave expert made a set with these condensers and found it oscillate on wave lengths well below 20 metres. With balanced vanes soldered to solid brass standards and moving plates on ball-bearings the "Four Square" Condenser is the most efficient instrument of its kind. Each one has four available capacities with the lowest losses in wireless. Write for descriptive brochure.

The Bowyer-Lowe FOUR-SQUARE CONDENSER

For Short Wave Sets use BOWYER-LOWE Low Loss Components

Valves are SAFE with "Antipong"



Safe from accidental shocks. Safe from Microphonic noises. Safe from interelectrode capacities. The result is richer, louder signals and a longer life for every valve. The Antipong Holder is mounted on a Bakelite Ring. Universal Fitting. All screws supplied.

"Antipong" Valve Holders

Obtainable from your dealer, or direct from BOWYER-LOWE CO., LTD., Letchworth. Price **3/-**

"TURRET" MASTS

COLUMBIAN TIMBER MASTS BY NAVAL EXPERTS.

27 ft. Turret Two £2 4 6 | 45 ft. Telescopic —£4 10 6
38 ft. Complete — 3 19 6 | 55 ft. „ — 6 15 6
42 ft. Telescopic — 4 4 0 | 58 ft. super — — 6 19 6
40 ft TURRET TWO — £2 18 9

SIMPSON & BLYTHE, 8-9, Sherwood St., Piccadilly, W.

Think this over carefully——

IF your progress in wireless has stopped at the building of a simple Crystal Set you are denying yourself one of the real thrills of Radio: The thrill of long-distance reception. Why not decide to build a good Valve Set now? Valves are cheap, and the upkeep costs of a really good Set are very low.

A good Valve Set built the Pilot way is wonderfully economical to make. Every Pilot Set is based on a proved Radio Press design—the Panel is drilled and engraved—the components fit snugly together—every part is supplied down to the last screw—the special diagram renders the wiring a simple operation of an hour or two. Everything, in fact, which human ingenuity can contrive to make Set-building easy has been done under the Pilot Service.

When completed, the Set is one of which you can be justly proud. In appearance it will possess all the characteristics of the professionally built Set, yet its entire cost is no more than the bare price of the components.

The following are a few of the well-known Sets available under the Pilot Service: The ST100, All Concert de Luxe, Harmony Four, Transatlantic V, Anglo-American Six, and many others of proved efficiency. Send 3d. for a copy of the Pilot Chart and see how little it costs to build a really good Set—fully guaranteed to give you excellent results and backed by our Service department.

PETO-SCOTT Co., Ltd.

Head Office & Mail Order: 77 City Rd., E.C.1

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PILOT RECEIVERS.

P.S. 3576

Hearing's Believing

The "SPARTA" is different. You notice it at first hearing. There's nothing harsh or discordant about its reproduction. Just a natural voice bringing to your home all the good things of wireless—exactly as they are performed before the microphone. For you can *control the tone*. The six stops provided in the modulator see to that. They cover the whole range of vocal and instrumental reproduction. And the result is supremely good Loud Speaker reproduction. Don't take our word for it. Ask your dealer for a demonstration—hearing *is* believing.

Type "A," 120 ohms.
Type "H.A.," 2,000 ohms.
Type "H.H.A.," 4,000 ohms.
£4 15s.
The "Little" Sparta, 55/-

Every component used in the "Sparta" is the outcome of equally careful thought—it is, in fact, the co-ordination into one instrument of all the worth-while features in Loud Speaker construction.

Type "B," 120 ohms, **£5 15s.**
Type "H.B.," 2,000 ohms, **£6.**
Type "H.H.B.," 4,000 ohms, **£6.**

All Type "B" Speakers are characterised by the patent 6 position tone selector. This consists of an ingenious arrangement of blocking condensers, which smooths away all trace of harshness, resulting in a remarkably pure distinctness of tone

SPARTA
LOUD SPEAKER

Fuller's United Electric Works, Ltd.
Woodland Works, Chadwell Heath, Essex.

MADE BY B.B.C. BRITISH BATTERY CO LTD WATFORD — **WIRELESS DRY BATTERIES** — FOR **B.B.C.** SETS

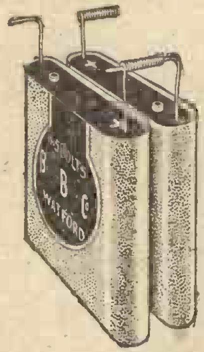
No. 1 W.

Standard Pocket Lamp Size—4½ volt *with* patent spiral wire terminals *and* plug sockets to take Wander Plugs.

Note:—1 doz. = 54 volts.

Used units replaced easily.

Connect as illustrated

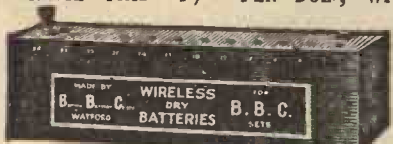


To connect in Series insert straight Terminal in Spiral of next battery. Bend spiral and thus ensure permanent electrical connection without soldering.

Guaranteed BRITISH MADE at our Watford Works.

Patent No. 202760.

PRICE CARRIAGE PAID 7/- PER DOZ., WITH PLUG



Prices include Wander Plug. Carriage paid.

		Each.
No. 2W, 16½ volts, 3 volt tappings.	Price	3/-
No. 4W, 36 " " " "	"	6/6
No. 5W, 60 " " " "	"	12/-
No. 6W, 9 volts, Grid, 1½ volts tapping	"	2/3

BRITISH BATTERY Co., Ltd.

CLARENDON ROAD, WATFORD, HERTS. (*Telephone: Watford 617.*)

Barclays 1029

"THERLA"

GUARANTEED CONDENSERS AND GRID-LEAKS.

It is a well-known fact that of all wireless apparatus the fixed condenser and gridleak show the greatest departure of actual from the nominal capacity. This is due principally to manufacturing difficulties.

THERLA FIXED CONDENSERS.

Size 250,000 ohms
500,000 "
1,000,000 "
" 1 megohms
" 2 "
" 3 "
} Price 1/9

Grid Condenser and Leak 3/-

The precise methods of manufacturing employed by The Electrical Research Laboratories, however, enable them to submit every individual Therla product for separate test at Faraday House, and every genuine Therla Condenser or Grid Leak carries the personal guarantee of these famous laboratories that it is within a guaranteed limit of accuracy plus or minus.

THERLA GRID-LEAKS.

PRICE.

.0001 to .0015 mfd. 1/3 each.
.002 mfd. to .006 mfd. 2/- each.
Grid Condenser with Clips 1/3.

Sole Distributors:

SEL-EZI WIRELESS SUPPLY CO. LTD.

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Telephone Regent 1140 — LIVERPOOL Royal 1682

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AT YOUR DEALER

6/-

WANT MORE STATIONS?

Like that elusive distant one you heard last night . . . Well, the cheapest, simplest way to get them is to replace your old dials with

PELICAN UNIVERNIER

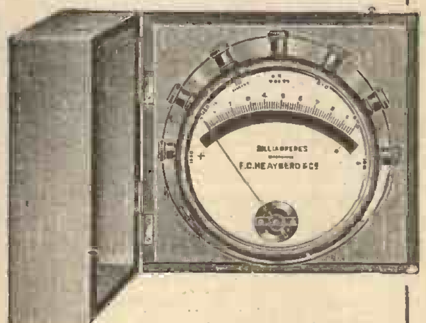
Pell, Cahill & Co., Ltd., 64 Newman Street, London, W.1

HIGH-CLASS ELECTRICAL MEASURING INSTRUMENTS

F SUPRECISION H

REGISTERED.

Radio Multi-Range Testing Sets



6 in. dial. No. 109. Ranges: .5ma, 10ma, 100ma, 1000ma, 5 volts, 100 volts. **Price £6 6s. 0d.**
4½ in. dial. No. 999. Ranges: 12ma, 6 amperes, 12 volts, 120 volts. **Price £4 4s. 0d.**
2½ in. dial. No. 103. Ranges: 3ma, 12ma, 120ma, 6 amperes, 6 volts, 120 volts. **Price £2 10s. 0d.**
2½ in. moving coil panel milliammeters. **Price £1 4s. 6d.**
Sauty capacity bridges. **Price £7 15s. 0d.**
Microammeters, 6 in. dial. Range: 0—150. **Price £5 15s. 0d.**

Full illustrated list of measuring Instruments of every description sent free on request. Orders despatched promptly to all parts of the world. Please write Dept. M.W.

F. C. HEAYBERD & CO.

(Instrument Makers),

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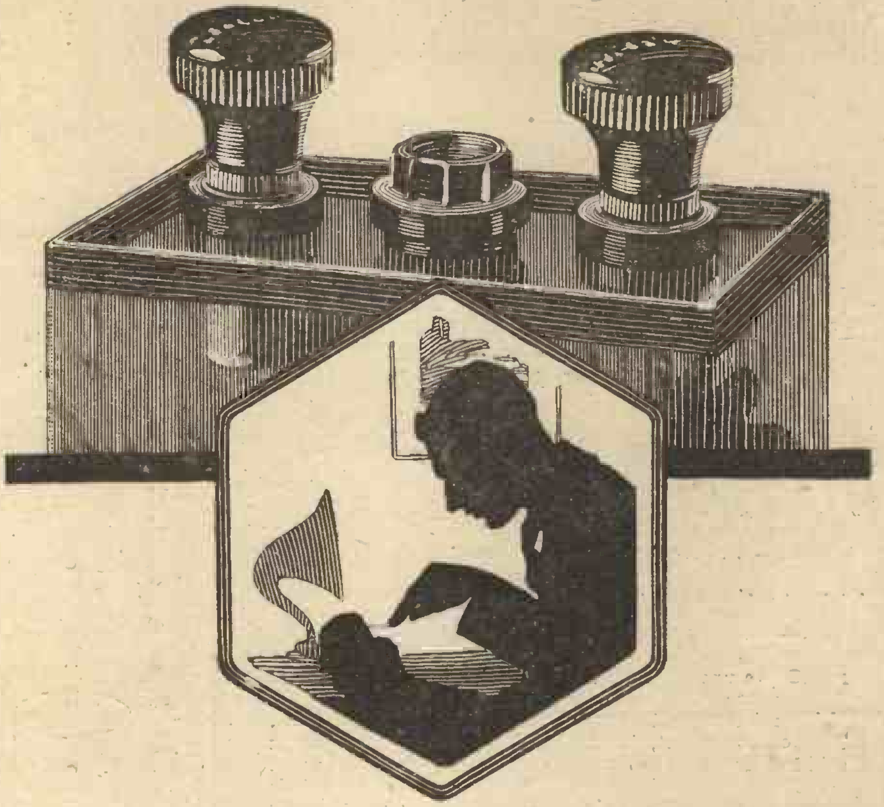
Telephone: ROYAL 4682.



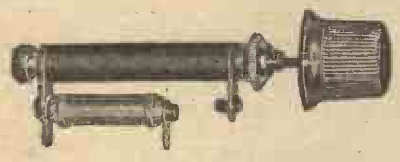
Under the Microscope

TO the unexperienced eye a variable grid leak is just that and no more. Examine one under a powerful microscope, however, and we find out vital facts. The carbon pellet, impregnated paper or pencil mark grid leak looks like so much coarse sandpaper, and when current passes a minute arcing effect is noticed. This is so small as to be invisible except under the highest magnification. But as constant dropping wears away stone, so this arcing may ultimately consume considerable portions of the leak material, rendering it inconstant in action and finally worthless. The use of such a leak produces a faint hissing noise that spoils the reception of weak signals.

By fitting a "Bretwood" variable grid leak you eliminate all such possible disadvantages. The material used is such that current flow is perfectly smooth and uninterrupted although it offers a high steady resistance.

The "Bretwood" gives accurate readings consistently from 10,000 ohms. to 100,000 ohms.

PRICE, 3/-. Postage 2d. With Condenser (as illustrated), 4/6. Postage 3d.



Other guaranteed Bretwood Specialities include :—

The "BRETWOOD" Filament Resistance. Price 5/-. Postage 3d.

The "BRETWOOD" Anti-Capacity Switch. Price 5/-. Postage 3d.

The "BRETWOOD" Anti-Capacity Valve Holder. Price 1/9. Postage 3d.

WIRELESS BRETWOOD GUARANTEED SPECIALITIES

Obtainable from all Dealers

BRETWOOD LTD.

12-18 London Mews Maple St. London W.1

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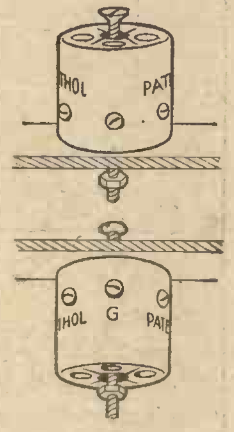
Athol
TRADE MARK

VALVE HOLDER



For—

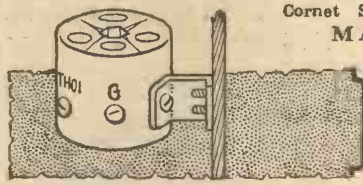
ANY CIRCUIT,
ANY SET,
ANYWHERE.

Its porcelain base gives perfect insulation. The four brass sockets fit loosely, and are almost entirely air-spaced. The connecting screws are brought out to the sides, reducing capacity effects to a minimum.

The ATHOL is truly the valve-holder for every use. It allows of one-hole fixing to base-board or above panel; can be easily mounted *below* the panel, thanks to reversible brass sockets; or behind vertical panels with the aid of special brass support.

A marvel of value at **1/3**, complete with soldering tags and fixing bolts. Brass support for vertical panels, 2d. extra.

ATHOL ENGINEERING CO.,
(Contractors to the Admiralty),
Cornet Street, Higher Broughton,
MANCHESTER.



1/3

THE "KENMAC BOOK" CRYSTAL RECEIVING SET.

(PAT. PENDING.)

THE LATEST NOVELTY IN CRYSTAL SETS.

EFFICIENT, COMPACT, GUARANTEED TO GIVE EVERY SATISFACTION. PROVISION MADE FOR 5 XX LOADING COIL.

Actual Size; 4¾" by 3½" by 1" CLOSED.

PRICES:

Leather covered (Red, Green, Blue)

£1 : 1 : 0

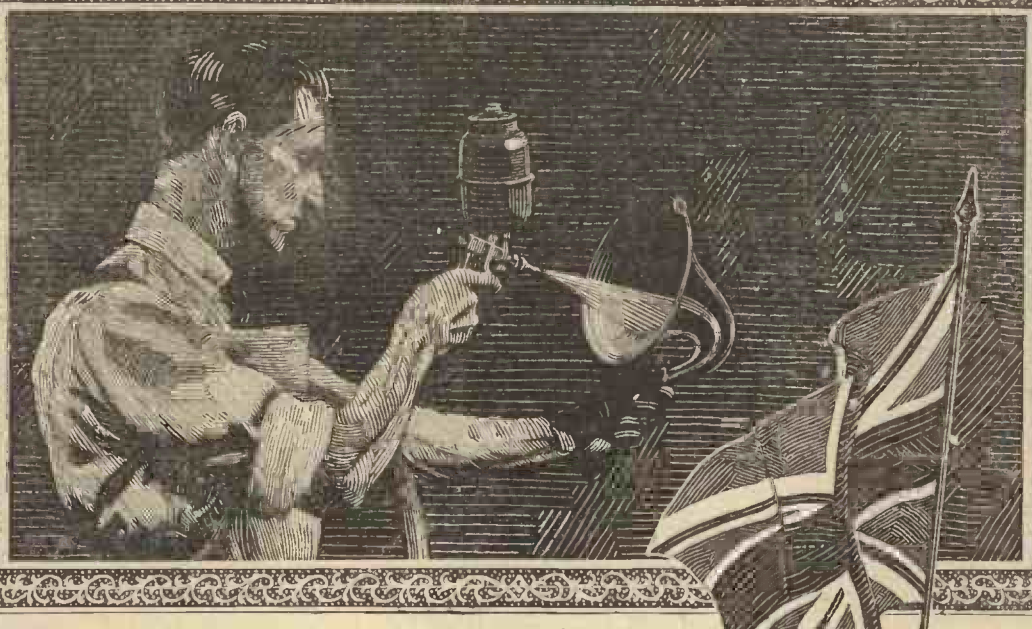
Tortoiseshell (Imt.) (Non-inflam.)

£2 : 2 : 0

(OPEN)

THE KENMAC RADIO LTD. (Dept. M), Dalling Road, Hammersmith, London, W.6.

THE FIRST WIRELESS LOUD SPEAKER WAS A Brown



Hear this new Brown
–and no other will ever satisfy your critical ear

THE four new Brown Loud Speakers—of which that illustrated on the right is one—represent a big advance in the design of these fine quality British Loud Speakers. Hitherto many wireless enthusiasts have purchased their Loud Speakers on appearance alone—only to find that a handsome and pleasing outline does not necessarily mean purity and mellowness of tone. The Brown, on the other hand, has invariably been bought *on actual performance.* It has achieved a wonderful reputation throughout the world solely for the naturalness of its reproduction.

In the Brown, external shape has always been subservient—in the interests of good music—to the actual design of the reproducer itself. But now the Brown Loud Speaker has been greatly improved in appearance and these four new models possess a dignity and beauty which place them in a class by themselves.

Ally this new beauty of outline to the wonderful sensitiveness of the Brown tuned reed movement and you possess a Loud Speaker which is a positive joy for all time.

S. G. Brown, Ltd., N. Acton, London, W.3

Retail Showrooms: 19 Mortimer Street, W.1.
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Depots (Wholesale only) · 13 Bushy Park, Bristol.
Cross House, Westgate Road, Newcastle

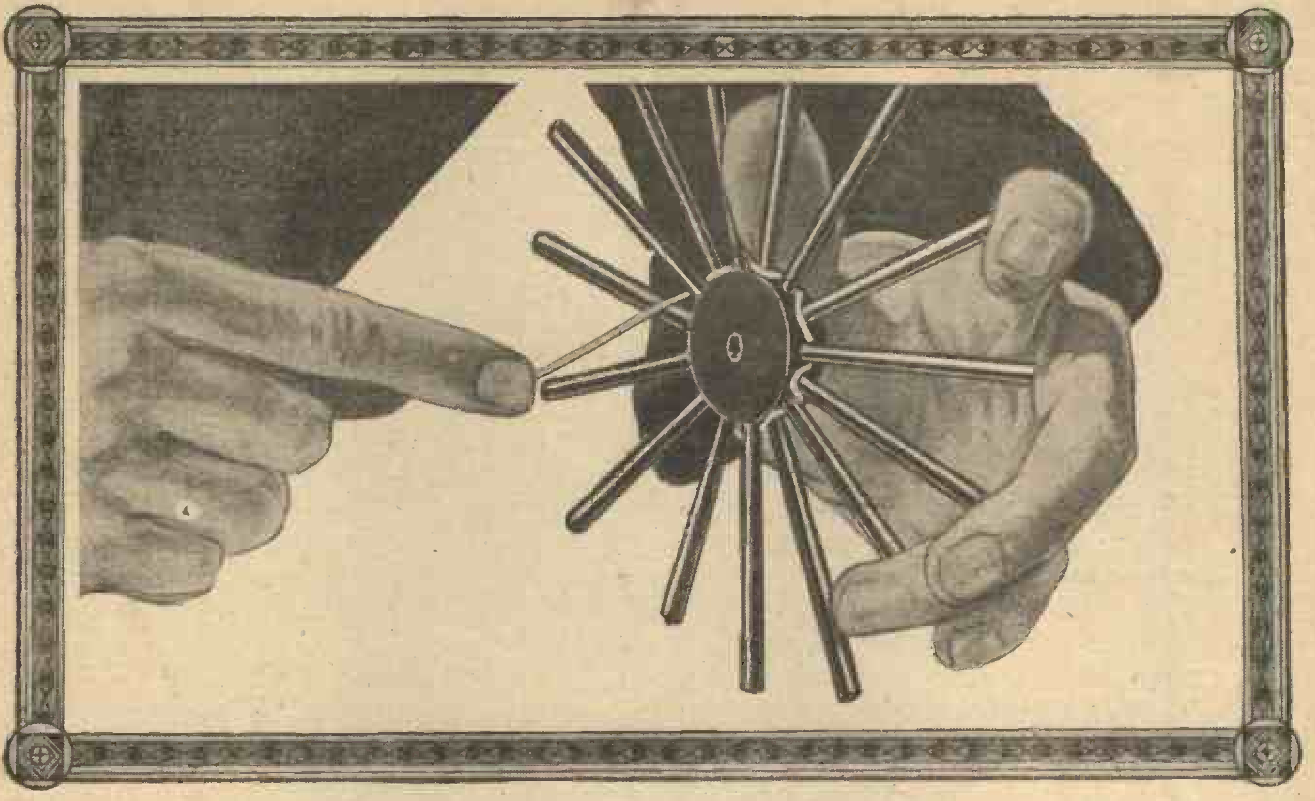
¶ To the Trade: We have instituted a special Dept. to see that your orders are filled promptly. In case of special difficulty write to us at once.

The new HQ

A handsome instrument possessing the same beauty of outline as the famous Brown Q Loud Speaker. Gives a wonderful volume of crystal clear tone. Attractively finished in rich brown colour or a velvet black with polished nickel fittings. Height 20". 4,000 ohms resistance. Also in 120 and 2000 ohms.

£6

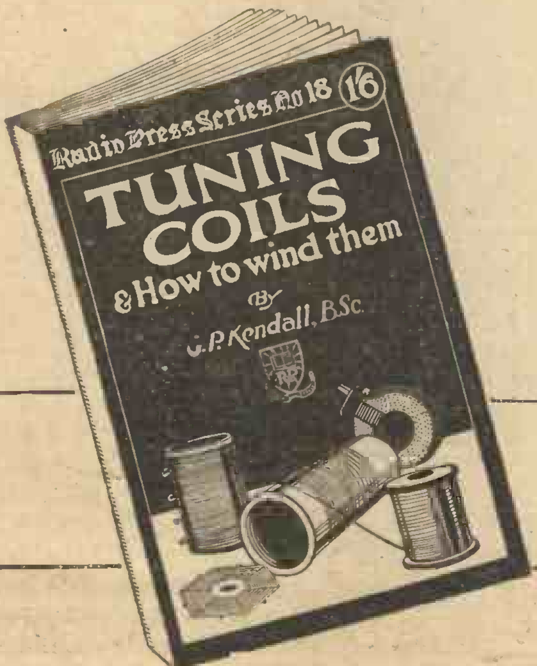
BRITISH Brown THROUGHOUT



"Tuning Coils and how to wind them"

BY G. P. KENDALL, B.Sc.

1/6 **POST FREE 1/8**



THIS useful Radio Press book provides the radio enthusiast with a wealth of information on Tuning Coil Winding.

With its assistance you will find coil winding an entrancing hobby, and a fine way of constructing really efficient coils.

The instructions given in the book are clear and lucid.

Simple Tables show how many turns of wire should be wound for all the important wavelengths, thus enabling the enthusiast to produce coils of accurate dimensions for the stations he wishes to receive, obviating waste of wire, and recourse to mathematical calculations.

Obtainable from all Newsagents, Bookstalls, your local wireless dealer, or direct from Radio Press, Ltd., Dept. M.

Radio Press, Ltd.

BUSH HOUSE, STRAND, LONDON, W.C.2.

Barclays Ad.

A good — Transformer makes all the difference

PRICE 18/6 from all dealers or direct from the manufacturers.

RESULTS PROVE THIS.

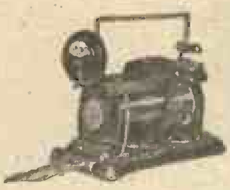
Maximum magnification without distortion is the ideal which the makers of U.S. Transformers have reached and rigidly maintained. The U.S. Super is the equal of any transformer on the market, regardless of price. The windings are on a core of the finest Stalloy iron, and the whole is a worthy product of skilled British labour and sound materials.

U.S. All British

U.S. RADIO COMPANY, Ltd. (Dept. 2)
Radio Works, Tyrwhitt Rd, Brockley, S.E.4
PHONE: Lee Green 2404.
WIRES: Supertran, Lewis, London.

THE · SUPER · TRANSFORMER

A.C. MODEL



Output 6 amps. 9 volts. Complete with Pole indicating Ammeter and all connecting leads and adapter. To standard voltages 100/110, 200/220, and frequencies, 50/60.

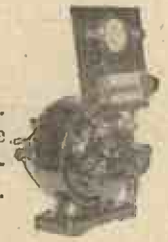
£6 : 6 : 0

Other voltages and frequencies £1 extra.

"ELLA" BATTERY CHARGERS

WORK FROM A LAMPHOLDER IN YOUR OWN HOME

DC. MODEL



Output 5 amps. 9 volts. Machine only. £5 12s 6d. With Switchboard and Pole Indicating Ammeter and Regulating Resistance as illustrated ... £6 15s. 6d.

"ELLA" Battery chargers save their cost many times over.

Write to Dept. "A" for descriptive leaflet. Trade supplied.

For further particulars write to—

LIONEL ROBINSON & CO.
3a, STAPLE INN, LONDON, W.C.1.
Telephone: Holborn 6323 (2 lines).

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after 25 years of hard work **AND SUCCESS.** Why? Because I have helped thousands of people to better their positions socially and financially. I am assisted by a large and expert staff and the advice we give is sound. If we cannot help you we will say so; if we can we will tell you how.

We have booklets setting out the possibilities in connection with each of the subjects shown in the lists; send for the one in which you are interested, or ask for **MY PRIVATE ADVICE**, which is free. You incur no obligation. **Have You ANY Ambition?**

The Bennett College specialises in all Exams. in the following subjects, and guarantees tuition **until successful.** No extra fees.

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Marine Engineering

TECHNICAL—Cont.
Mathematics
Matriculation
Metallurgy Mining
Mine Surveying
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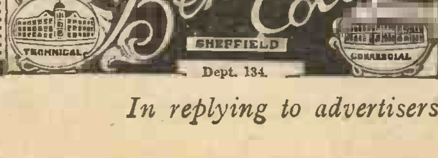

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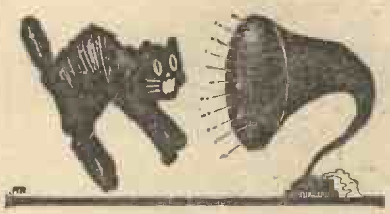
WOODS'  WOODS'

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