DON'T MISS FREE MAP WITH CALL SIGNS *NEXT WEEK*

Amateur Wireless and Electrics

Next Week

SPECIAL BROAD-CASTING NUMBER

(See page 64)

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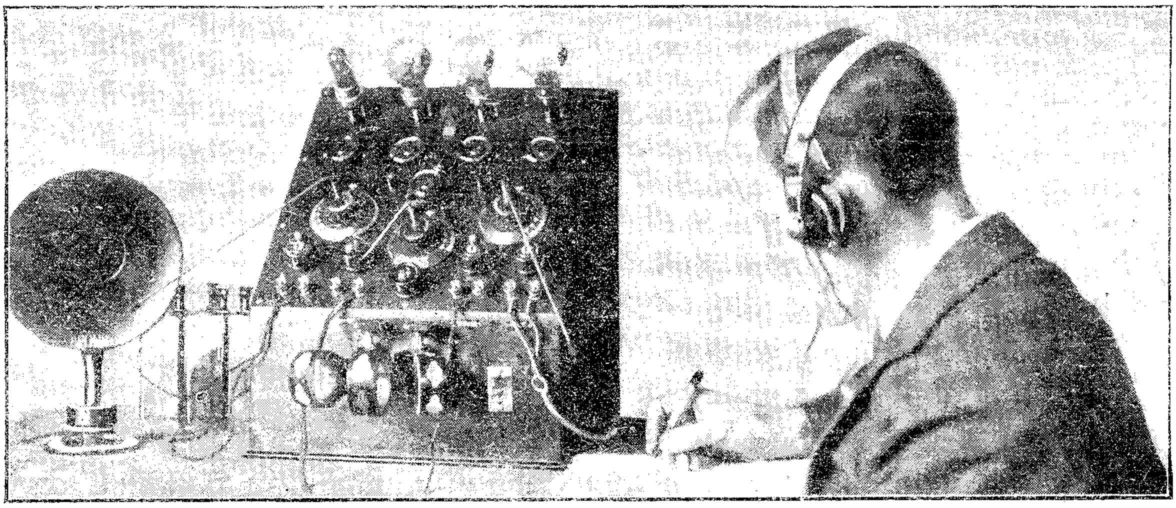


AN AMATEUR'S (Mr. W. S. HUTTON'S) FOUR-VALVE SET THAT HAS GIVEN EXCELLENT RESULTS

THIS WEEK'S FEATURES

THERE IS A SPECIAL ANNOUNCEMENT ON PAGE 64

Amateur Wireless and Electrics

Vol. II, No. 33 January 20, 1923

WHAT CAUSES FADING?

THE problem of fading is of great interest, and though no solution has as yet been arrived at, some little progress has been made by recent investigations.

Tests

Amateur tests carried out in a district some 200 miles from the nearest broadcasting station seem to make it clear that no blame for the trouble can be laid at the door of the transmitting stations, and the theories involving that link in the chain of broadcasting communication must therefore be ruled out. This leaves the two alternatives—the receiving apparatus and the medium through which the waves travel in their passage from the transmitting aerials.

The tests were made within a radius of four miles, and it was found that, while none of the experimenters reported perfect reception of the whole programme, there was no similarity in the experiences regarding fading. An item would be heard excellently at one point, and serious fading trouble would be met with at another point in respect of the same item, while a few minutes later the position would be quite reversed. On one or two occasions the fading occurred synchronously at all the stations.

Two of the stations where the tests were made were, however, only a few hundred yards from each other, yet there was a considerable difference in the reports by the operators. While apparently absolving the transmitter, the tests cannot be said to have helped much in pointing the way to a solution.

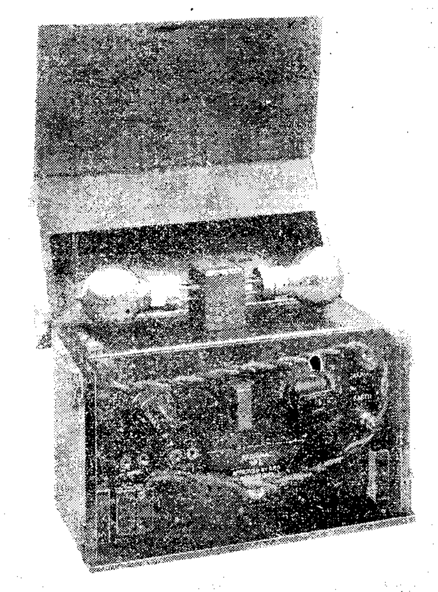
Theories

In some quarters it has been argued that the phenomena is due to the blocking of the grid condenser, caused by the use of grid leaks of insufficient value, the idea being that an overcharge, such as atmospherics, paralyses the valve for the time being, and the leak can only work away to gradually relieve it. A variable condenser and leak has been tried, also shorting of the grid condenser when fading takes place, and potentiometer control of the leak, but these expedients have not been found to improve matters.

Adherents to the belief that the atmospheric conditions are to blame are numerous, and one of the most popular suppositions is that clouds of moisture passing backwards and forwards over a district may take away part of the energy of the transmitting station. It is only right to point out, however, that in aeroplanes wireless reception from the ground has been much better when the aeroplane was above the clouds than when below them. In addition, during the amateur tests mentioned above a white mist lay on the ground at some of the receiving stations, while at the others the conditions were clear. The results did not bear out that the mist had any effect.

Are Our Neighbours to Blame?

A rather interesting speculation is that fading is due to the behaviour of near-by receiving stations—those who offend in the matter of oscillations. If such a station at a very short distance be oscillating, it is conceivable that its wave will come in practically as strong as the carrier wave of the broadcasting station. Before long a point is bound to be reached when these two waves will neutralise each other, so far as listeners-in on the particular sets which are receiving both are concerned; that neutralising would cause fading—at any rate, that is the theory. G. A. F.



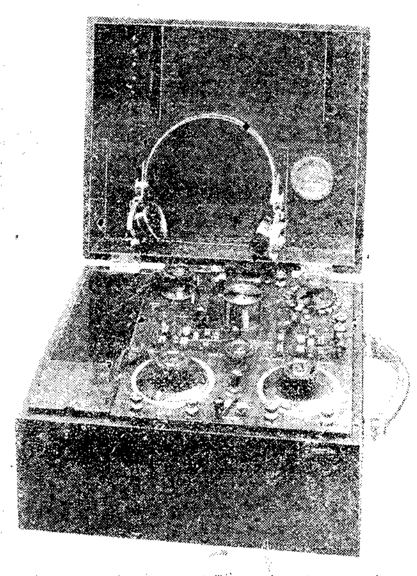
Radio Mac II Converted Set.

CONVERTED APPARATUS

THESE self-contained sets are ex-Government instruments modified so as to be suitable for broadcast reception. That on the left was originally a B Mark II detector-amplifier, but the wavelength range is now from 300 to 1,000 metres. A variable condenser is provided for fine tuning, and duolateral coils can be plugged in.

The other photograph shows what was formerly a C.W. Mark III transmitting set which is now a two-valve receiving set. The coils remain exactly as before. A variable condenser has been added, so that the range of wavelength is from 300 to 1,500 metres. A variometer is embodied to render very close tuning possible.

The instruments are retailed by Leslie MacMichael, Ltd., and were exhibited at the "Model Engineer" Exhibition.



C.W. Mark III Set after Conversion.

More About Vario-couplers

Types :: Uses :: Construction

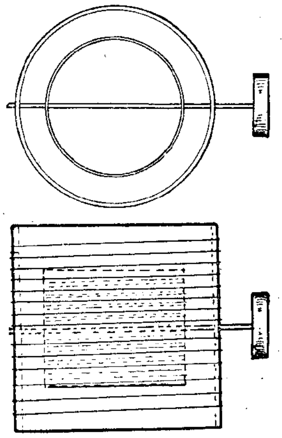


Fig. 1.—Ordinary Type of Vario-coupler.

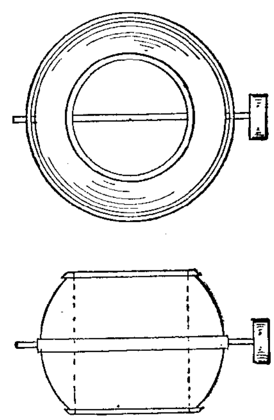


Fig. 3.—Ball-type Rotor (Constant Capacity).

IN this article it is intended to deal only with those arrangements which have a secondary or reaction coil rotating inside the primary coil.

The most usual type is where the axis on which the coil turns passes through the centre of the windings (Fig. 1). It is necessary with this arrangement to leave a space between the turns for the spindle to pass through, which means a loss of efficiency since the continuity of the coil is broken. This can be overcome by adopting the following method of pivoting the inner coil. The axis is fixed to opposite points on opposite circumferences on the smaller coil, and rotates in bearings at similar points on the larger coil. (This will be clearly understood from the illustration, Fig. 2.)

It is obvious that the continuity of the winding is unaffected since the axis does not pass through the turns on either coil. Further, the control knob has to be turned through half a revolution (180 deg.) to change the coupling from maximum to minimum—from tight to loose. This 2 to 1 ratio is especially valuable when the degree of coupling has to be very exactly defined, as is the case with the reception of telephony. Suitable sizes for the coils (for short wave work) are:

Outer or primary coil, 3½ in. outside diameter by 2½ in. long.

Inner or secondary coil, 2½ in. outside diameter by 2 in. long.

These sizes give a maximum degree of coupling which is not too tight to cause self oscillation, an important consideration where broadcast reception is concerned. The illustration, Fig. 2, shows a convenient way of mounting these coils with a switch for varying the primary inductance on top of the containing cabinet.

If the coils are to be used as an aerial tuning inductance and closed circuit inductance, the "ball" type of inner coil is more suitable for two reasons. Firstly, the degree of coupling can be made much greater than with other arrangements, a desirable feature since there are no ill effects arising from tight coupling in this case. Also the shape of the rotating part inside the A.T.I. is such that the capacity effect it has on the outer coil is constant. Hence a variation in coupling does not affect the tuning of the aerial circuit.

This type of former can be readily turned out of any hard wood and mounted on two short spindles or one continuous spindle (Fig. 3).

It is not advisable to use the spindle as the connections for the coil, for however carefully the rubbing contacts are made noises are produced on turning the control knobs.

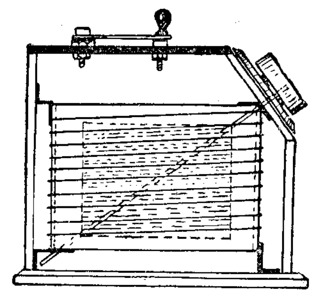


Fig. 2.—Fine-coupling Device.

Since the coil need only rotate through 90 deg., connections can be established by flexible wires (covered) soldered to the ends of the winding.

It is advisable to note that the winding must be put on in two parts and joined at the centre, as it is only possible to wind "up the hill." The winding should be started at each end and continued upwards (inwards), and the two ends then soldered together and tucked inside.

H. R.

Dielectric Constant of Mica

IN an article in the "Physical Review," J. R. Weeks, Jnr. states that for samples of mica, without visible air films, the dielectric constant ranged from 6.4 to 9.3. For sheets having air films the values were from 2.9 to 5.6. Sheets split from the sample which had given the value 2.9 were measured and the results varied from 6.6 to 8.4. Similar experiments confirm the belief that the low results are to be attributed to the presence of air. This probably explains the reason for the wide divergence between values of the dielectric constant of mica given in handbooks.

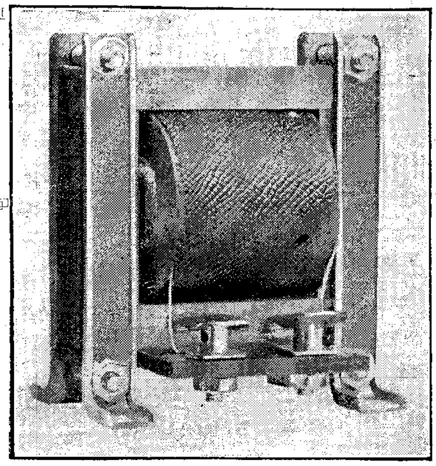
A Loud-speaker for Eight Shillings

WHY do loud-speakers cost so much? I have just constructed an instrument, for the modest sum of eight shillings, which gives results quite equal to those obtained from factory-built loud-speakers costing three or four pounds. The basis of the apparatus is an ex-army loud-speaker which was purchased from an advertiser in AMATEUR WIRELESS for the sum of seven shillings and sixpence. This is an ear-piece with extra large diaphragm, and came, I fancy, from a trench-set. It is of 200 ohms resistance. The horn, purchased at a second-hand store for threepence, is an ordinary tulip-shape aluminium horn from an old phonograph.

The fixing of the horn to the ear-piece presented some difficulties. It is essential that there should be an air-tight connection, because the action of a loud-speaker depends on setting in motion the column of air between the diaphragm and that portion of the horn where it begins to widen out. After several trials—soldering of two aluminium surfaces being thought out of the question—a piece of rubber tube of sufficient size was slipped over the end of the horn and then rubber and horn and ear-piece were tightly bound together with bare copper wire. The result is not beautiful to look at, but it answers. With three stages of note magnification Paris time signals can be heard all over the house, and London, Paris, Birmingham and Manchester broadcasting really do "flood the room with music." There is very little distortion, which is probably due to the good design of the horn. Of course there must always be some distortion in a loud-speaker, apart altogether from that due to the note-magnifiers, because as the sound-waves broaden out in the horn they themselves are distorted. This is reduced by good design.

ERNEST LANGMEAD.

Repairing a Low-frequency Transformer



Low-frequency Transformer.
(*Igranic Electric Co., Ltd.*).

HOW many amateurs have thrown away low-frequency transformers as useless after they have given out!

One day whilst working on three valves, one H.F. and one L.F., I was interrupted by a scratching noise which rapidly grew in volume, succeeded by a loud final click and—silence. In fact, my L.F. transformer had ceased to function. At first I had visions of another £1 going on a new transformer, but I thought that I would have a look inside first just to see what could be done. First I connected the secondary of the transformer in series with a 1.5 volt battery and a pair of phones. A click was heard in the phones and another upon disconnecting, so, I thought, the secondary is O.K. I repeated the test with the primary, but no loud click. Subsequently I found that the primary windings had gone where the wire was started next to the iron core. As the wire is finer than hair I did not see how I could find the break, so with a small penknife I scraped away a little insulation from the visible portion of the wire nearest to the core, and with resin-cored solder soldered a length of fine copper wire on. I then tested with the phones and battery once more, using the new piece of wire as one terminal and the outside lead of the primary as the other. A welcome click was heard, which proved that I had established connection again, despite the fact that there were probably several dozen turns lying idle. The next thing to see was—would it work. I connected up as usual and switched on. In came the signals with a roar and rattle. A. G. W.

Notes for the Novice.—III

Some Simple Definitions

IN the last article mention was made of the rate at which electrical vibrations are set up in a transmitting aerial. This is commonly referred to as the "frequency" of the vibrations, or of the wave which they produce. This wave travels through space at the same velocity as light. There is, in fact, a great deal in common between wireless waves and light waves, although you can "see" one and not the other. One thing, for instance, which they have in common is their speed. They both travel at the enormous speed of about 186,000 miles per second! Moreover, that speed does not vary for different kinds of light waves (giving rise to the sensation of "red" or "blue" or "green," for instance), or for different kinds of wireless waves—"long" or "short" waves as they are called.

"Vibrating" the Aerial

Now it is not a very difficult thing to imagine this wave motion being set up in the space surrounding a transmitting aerial. We know what a wave on the sea looks like: a series of hills and hollows, ups and downs, and we can depict a wireless wave similarly. If you make a point on a sheet of paper with a pencil, and then from it draw a "waggly" line across the page, you may make these represent the transmitting aerial and the wireless wave set up by it when it is vibrated electrically. Now the hills or crests of this wavy line must be a certain distance apart, and this distance is usually called the wave-length. It may be defined as the distance between any two successive crests.

If the aerial is vibrated very quickly the successive crests of the resulting wave will be very close together—that is, the wavelength will be small. If the aerial is vibrated more slowly the crests will follow each other at longer intervals—that is, the wavelength will be longer. In other words, the greater the frequency the smaller the wave-length. This can be demonstrated quite easily. Assume that the wavy line runs from the pencil point to the edge of the paper and that there are 1,000 wave crests in this distance. If, now, you superpose on this another wavy line having only 500 crests extending over the same distance, it will be obvious that the distance between the latter crests must be twice the distance between the former. That is, when you halve the frequency you double the wavelength. Similarly, if you double the frequency you halve the wavelength, and so on.

Wavelength and Frequency

Suppose you want to set up a wireless wave having a wave-length of one mile. Well, since the wave, whatever its length, will travel at a speed of 186,000 miles per second, it follows that you will have to vibrate your aerial at a rate of 186,000 times per second in order to do so. Or, again, if you want to transmit on a wave of half a mile length you will have to vibrate your aerial at twice the former rate, that is, at 372,000 times per second. This can be expressed as a general law by saying that frequency $= \dfrac{186{,}000}{\text{wave-length.}}$, In working this as a formula, of course, the wavelength must be expressed in miles. In practice, however, it is more customary to calculate wavelengths in metres or feet.

It is also customary in practice to speak of "oscillations" instead of "vibrations." Instead of saying that you "vibrate" the aerial at a certain "rate," the phraseology of wireless ordains that you should say that you "oscillate" it at a certain "frequency."

Maintaining Oscillations

When you vibrate, or oscillate, an ordinary violin string you must take care that it doesn't come into contact with anything. If you touch it with a stick, or a book, or your finger, it will cease to oscillate. You must protect or shield it from anything which would tend to prevent it from oscillating. The same is true with respect to an aerial in which you want to maintain oscillations; it must be shielded from anything which might prevent it from oscillating also. This is usually referred to as "insulating" the aerial. "OLD HAND."

Whilst listening-in to an American broadcasting station, Mr. J. E. Samuel, of Aberystwyth, distinctly heard the clapping of hands of people in the room when an orchestral item was encored.

The directing of aircraft by ordinary wireless means is said to be giving better results than the system of transmitting signals from a cable laid along the line of route.

High-frequency Amplifiers

Transformer-coupled :: Resistance-coupled :: Reactance-capacity Coupled

THE object of using a high-frequency amplifier in a receiver is usually to increase the range and not the signal strength, although it does do the latter to some extent. Very weak signals may not have enough energy to make a rectifier function, and so they are not heard at all. If by means of a high-frequency amplifier these signals are magnified before reaching the rectifier, then they will have enough energy to make themselves audible.

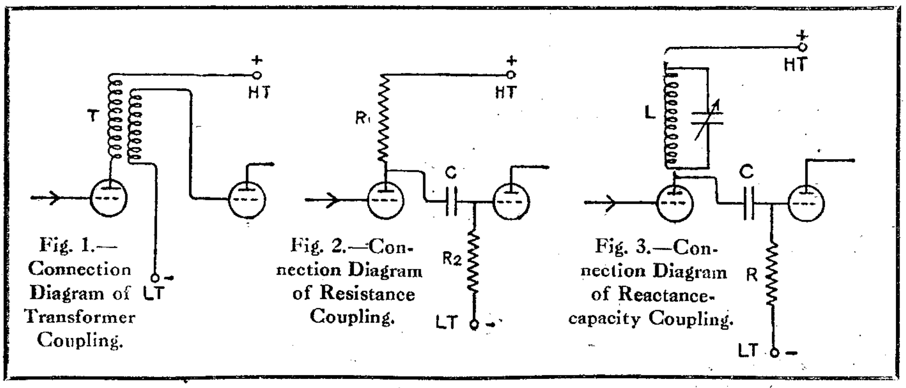


Fig. 1.—Connection Diagram of Transformer Coupling.

Fig. 2.—Connection Diagram of Resistance Coupling.

Fig. 3.—Connection Diagram of Reactance-capacity Coupling.

Types

There are three types of high-frequency amplifiers in common use: (1) transformer-coupled, (2) resistance-coupled, and (3) reactance-capacity-coupled. They all magnify signals before they are rectified, and it will therefore be understood that the magnification takes place at the frequency which corresponds to their wavelength. This is why they are sometimes called "radio-frequency amplifiers," to distinguish them from amplifiers of rectified signals called "audio frequency amplifiers" or "note magnifiers."

Transformer Coupling

In the first type the magnified radio-frequency impulses are conveyed to the next valve, which may be another high-frequency valve or a rectifier, by means of a transformer. This is connected up in the same way as a low-frequency transformer and is shown in Fig. 1. These high-frequency transformers have no iron core.

As the frequencies of incoming signals vary so greatly over even a small band of wavelengths, one transformer will only be suitable for receiving signals between certain limits of wave-length. It is therefore necessary to have a set of transformers, each wound with different amounts of wire, for receiving over a large range. They are usually made to fix into valve holders so that they may be changed easily and quickly when listening-in.

Owing to the number of transformers required for receiving on all wavelengths this type is expensive to buy and troublesome to make. When properly designed, however, they give very good results. If wound with resistance wire the transformers cover a slightly larger band of wavelengths, and signal strength is nearly as good. Some experimenters say that these transformers do not "transform" at all, but have an entirely different action.

Resistance Coupling

The second type makes use of a resistance in the anode circuit, as shown in Fig. 2. This resistance should be as large as possible for the H.T. voltage and is usually about 50,000 ohms. The condenser may be of about .0002 mfd. capacity and R_2 about 2 megohms. This type is not quite as efficient as the transformer-coupled type, and is of no use on wavelengths below about 1,000 metres.

Reactance-capacity Coupling

The reactance-capacity type is the most efficient and the most popular with experimenters. The connections are shown in Fig. 3. The inductance L is tuned to the exact wave-length of the incoming signals. The grid coupling condenser may be .0002 mfd. and R about 2 megohms. The advantage of this type is that a reactance from the rectifier may be coupled to the inductance L to produce beats for C.W. reception, without radiation.

The principle upon which it works is as follows: Although any inductance has some resistance, when tuned to a certain wavelength it has an infinitely high resistance to currents at that frequency, and in the case of an amplifier all the amplified impulses pass to the grid-coupling condenser and do not leak away through the anode circuit. In the resistance-coupled type these currents do leak away a little, and if the resistance is raised there is not sufficient voltage on the anode for the valve to function properly. The inductance, however, has a fairly small direct-current resistance.

Oscillation

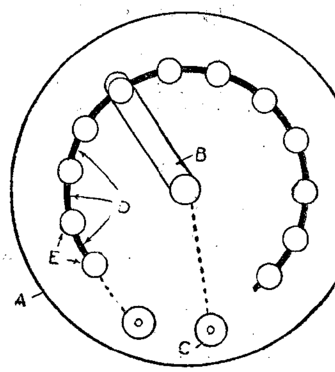
All types of high-frequency amplifiers are liable to self-oscillation and howling, due to an excessive negative charge on the grid or grids. This can be overcome by connecting all the grids in parallel and taking a lead to a potentiometer, so that they may all be given a small positive charge if necessary. The potentiometer is placed across the accumulator. The inductance for a reactance-capacity type amplifier may be a basket-type coil, with a tuning condenser of not more than .0003 mfd. capacity. As with the transformer type, different coils will be needed for different wavelengths, but they are easier and cheaper to make than transformers.

RADION.

Variable Grid-leak

THE accompanying sketch shows an idea for a variable grid leak which works very well. As will be seen, it consists merely of a circular base which may be ebonite or fibre, on which is mounted a switch arm that is connected to one of the terminals C. The leak D is an indian ink line and contact is made to it by the contact studs E which are screwed down tight. The farther round the switch arm is placed the longer leak is placed in circuit. The first contact stud, of course, is connected to the other terminal.

H. R.



Variable Grid-leak

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