Experimental Wireless

A JOURNAL OF RADIO RESEARCH AND PROGRESS

Vol. I, No. 2. NOVEMBER, 1923. 1s. net.

Experimental Topics.

Our Progress.

WE do not propose to take up very much space this month in talking about ourselves, but so many complimentary letters have reached us in regard to our first issue that it would be ungrateful on our part not to pen these few lines of acknowledgment and sincere thanks. In addition to compliments we have had suggestions and helpful criticisms which will be directly useful to us in shaping our course; for these we also tender our appreciation. It is quite obvious that EXPERIMENTAL WIRELESS has already made many good friends, and we shall hope to continue to deserve their friendship. Last month we asked our readers to suspend their final judgment on our programme till they had seen several issues. In the present number we get a little more into our real stride, and we are quite sure that as the months go on it will be found that our scheme of an "all-experimental" paper is not only practical, but is of real service to the wireless community in general, and that it possesses an individuality and an interest of its own.

The Broadcasting Report.

Everybody seems agreed that the Report of the Broadcasting Committee was excellent; but there is not quite the same unanimity of feeling in regard to the decisions of the Postmaster-General. Bound as he was by an agreement with the Broadcasting Company, he could at best only effect a compromise, and apart from a few minor points we think he has done wisely and well. The way has been cleared for the constructor to get busy with his tools, the olive branch has been held out to the "pirates," and the ordinary listener-in is cheered by the prospect of a reduction in prices of complete sets. No one suggests that the P.M.G. has provided a perfect solution to the licence problem, but his proposals will help the wireless industry to get busy again, and in the fulness of time a simpler and more generally acceptable licensing scheme may receive the official blessing.

Freedom for Experimenters.

In the first announcement of the Postmaster-General's decision it was stated that experimental licencees would be required to make a declaration that they would not use their apparatus for listening-in to broadcasting other than for experimental purposes. The futility of such a requisition is obvious, and we understand now that by paying an additional five shillings experimenters may enjoy the full service of the broadcasting stations with a clear conscience. Many experimenters will, no doubt, be quite willing to make this small supplementary contribution to the funds of the B.B.C. in return for the service provided, but there will be others who have no interest in broadcasting as an entertainment. Our own view is that the issue of the experimental licence should be jealously guarded, but once the experimenter has satisfied the authorities as to his qualifications and intentions, the cost of the licence should be made a minimum and the freedom of action a maximum. Amateur experimenters of the right type are exceedingly valuable auxiliaries both to the science and to the industry; they carry on their research for the sheer love of the work, and probably much of the technical progress achieved during the next decade will be due to their general co-operation if not to their individual effort. The experimenter will probably contribute to the improvement of broadcasting in other and, possibly, more important respects than his mere payments to the B.B.C. funds.

The Wireless Exhibition.

Every experimenter who can possibly get within reach of Shepherds Bush will want to attend the all-British Wireless Exhibition to be held there from November 8 to the 21st. The Exhibition is being organised by Messrs. Bertram Day & Co., Ltd., in conjunction with the National Association of Radio Manufacturers, and there is no doubt that there will be a very interesting and representative show of all that is latest and best in British wireless equipment. EXPERIMENTAL WIRELESS will be represented there at Stand No. 22, and we shall be pleased if as many of our readers as possible will pay us a call.

The Transmitting Tangle.

We expressed last month our views on the need for greater co-operation among amateur experimenters. We now return to the subject because the cleavage in the transmitting world has become more clearly defined, and the difference of opinion more acute, a state of affairs which, in the true interests of amateur transmitting, is much to be regretted. From reports which appear elsewhere in this issue it will be observed that the newly-formed Radio Transmitters' Society approached the Radio Society of Great Britain and offered to co-operate. This was apparently met with a flat refusal to negotiate, and each body is now determined to pursue its own policy to the bitter end. While we may suspect the underlying causes of this rupture, we do not think it desirable to express in print any observations which would tend to aggravate the position. We believe there is sufficient good sense existing amongst the leaders on both sides to enable them to appreciate the weakness of divided effort, and to find some honourable and mutually acceptable way out of the present *impasse*. The names associated with the formation of the new Transmitters' Society are sufficient to stamp it as a responsible and seriously minded body. They are not the kind of people to fly off at a tangent because of some imaginary grievance against the Radio Society of Great Britain; the fire which causes the smoke must have a real existence, and we suggest in all friendliness to both parties that negotiations for co-operation should be re-opened before it is too late. The Radio Transmitters' Society have expressed willingness and have been rebuffed; the next move is with the Radio Society of Great Britain.

A Note to Contributors.

We have to thank a number of our readers for sending us contributions on various aspects of experimental work. Some of these we have been able to accept; others we have had to return, either because the subject matter has not been sufficiently novel, or has not been sufficiently within our specialised scope. We shall always be glad to consider matter of the right kind, and, as so many of our readers must be doing original work well worthy of being recorded in our pages, we hope they will consider the possibility of sending us an article when they are trying out some new research. We make this suggestion—that, as their work progresses, they should make notes of calculations, quantities, diagrams, and other data, so that, at the completion of the research, they have the material already at hand for their article. With these notes at hand it is a comparatively simple matter to write up an interesting account of the work they have done; but if they have no exact data to go upon it means traversing the ground over again, and time for this may not be available. We pay promptly, and at good rates, for articles which are up to our standard, and are always glad to get in touch with new writers in any part of the world who have something worth while to report.

"Side-Band" Telephony.

By E. H. ROBINSON.

Much interest is now centred around the side-band system of telephony, owing to the trans-Atlantic test carried out some months ago. We understand that these tests are still being conducted, and in order that the reader may be familiar with the system we outline below the fundamental principles involved.

THE object of this article is to give a brief outline of a peculiar system of radio-telephony which, although it had its inception as far back as 1915, is little known except in highly technical circles, but which has probably revolutionised the possibility of commercial radio-telephone services. This system, or, at any rate, a modification of it, was used in the recent transatlantic telephony test which was so successfully and reliably carried out between Rocky Point and New Southgate.

In order to make clear the basic principle underlying the system about to be described it is desirable first to consider what happens in ordinary radio-telephony when we modulate the amplitude of a high-frequency sine wave (the carrier wave) in accordance with a low-frequency sine wave. Let the carrier wave be represented by A sin 2π Pt and the speech wave from the microphonic source by B sin 2π Qt, P being the frequency of the H.F. oscillations and Q the mean speech or modulating frequency. Arbitrary phase angles are left out for simplicity. Fig. 1 is a diagrammatic representation of the modulated carrier wave. A represents the maximum amplitude of the carrier wave when no modulation is taking place, that is, when pure C.W. is being emitted, but which is varied in accordance with the wave B sin 2π Qt when modulation occurs.

The modulated carrier is, therefore, represented by—

$$A\,(1+B \sin 2\pi\, Qt) \sin 2\pi\, Pt.$$

Which expression, by slight manipulation, simplifies to—

$$A \sin 2\pi\, Pt + \frac{AB}{2} \cos 2\pi(P-Q)t - \frac{AB}{2} \cos 2\pi(P+Q)t.$$

This shows that a modulated carrier wave may at any moment be considered as made up of three component waves corresponding to frequencies of P, (P — Q) and (P+Q). Since the audio frequency Q is usually small compared with the carrier frequency P, the three frequencies P, (P — Q) and (P+Q) will heterodyne each other in an ordinary receiver to produce a beat-note of frequency Q; that is to say, a sound whose tone and qualities correspond to that spoken or played in the microphone at the transmitter. This may seem a roundabout way of considering the action of radio-telephony, but it is actually what happens, and is a fact well known to all radio engineers.

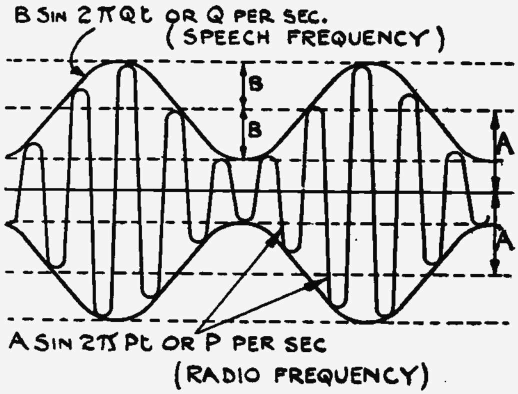


Fig. 1.—Diagrammatic representation of a modulated carrier wave.

Now it will be seen that only the side bands of frequency (P+Q) and (P — Q) are effective in carrying the telephonic message, the steady component P (represented by A sin 2π Pt in the above expression) only being of use to heterodyne the frequencies (P+Q) and (P — Q) at the receiving end to produce audible telephonic signals. Obviously from a point of view of economy it would be better only to transmit the side bands (P+Q) and (P — Q) and provide the heterodyning effect by a local heterodyne (consuming negligible power) at the receiver oscillating at a frequency of P. As a matter of fact it is only necessary to transmit one of the side bands, say (P+Q);

and the energy saving over the ordinary system would be very great in this case. Suppose, for example, that in an ordinary choke-control transmitter that the percentage modulation B is 100 per cent. (which, by the way, is not desirable), our steady carrier P will have an amplitude of A, while the business components (P+Q) and (P — Q) will each have an amplitude of $\frac{A}{2}$. As the energy of a wave is proportional to the square of its amplitude only a quarter of the radiated energy is carried in either of the modulated bands (P+Q) or (P — Q), most of the energy being wasted in the steady carrier P. As the percentage modulation is usually much less than 100, the usual loss is greater still. If some of the 10-watt transmitters could concentrate all their 10 watts into one of the sidebands, say (P+Q), they would have a signal strength and range about equivalent to that of a 50-watt radiophone transmitter working on ordinary lines, provided that "homodyne" reception (*i.e.*, a local heterodyne of frequency P) was used. At the same time the man next door with a crystal set would hear very little of them. Unfortunately side-band telephony would be difficult to perform on the short wave-lengths at present allowed for experimental work, but there is an open field here for the experimenter.

Methods of Separation of Side-Bands from Carrier.

The suppression of the carrier frequency and the selection of one of the side-bands cannot readily be effected on short wave-lengths by ordinary selective methods as the percentage difference is so excessively small. Suppose, for example, that telephony is being done on a wave-length of 300 metres ; this corresponds to a frequency of 1,000,000 oscillations per second. The mean speech frequency Q is of the order of 1,000 oscillations per second, so that the three waves emitted when modulation occurs have frequencies of 999,000, 1,000,000 and 1,001,000. The difference is only 0·1 per cent., and can hardly be detected on an ordinary tuned receiver. On a wave-length of 3,000 metres (frequency 100,000) the difference would be 1 per cent., but even here separation by ordinary tuning would not be easy. On 30,000 metres—that is, at a carrier frequency of 10,000 per second—the difference would be 10 per cent., and separation could be effected by ordinary selective methods ; but such low carrier frequencies as this are practically useless for direct radio transmission. It has also to be borne in mind that the speech frequency Q is not any one definite frequency, but is a very complicated mixture of frequencies ranging from about a hundred to several thousand per second. Hence the side frequencies (P+Q) and (P—Q) are really bands whose width is that of the audible range and which merge into the central carrier P. Q merely represents the mean speech frequency for purposes of argument.

A very ingenious method of suppressing the central carrier frequency and selecting one of the side modulated frequencies was invented by Carson* in 1915 and modified later by Hartley.† The schematic arrangement is shown in Fig. 2, and its method of functioning depends upon the fact that the input-output voltage characteristic of a three-electrode valve is not a straight line, but is a curve which may be represented by the equation—

$$E_1 = av + bv^2 + cv^3 + dv^4 \qquad (1)$$

where v is the input voltage applied to the grid circuit and E_1 the voltage set up in the output circuit ; a, b, c and d being constants depending upon the valve in use. Suppose now we have two valves V_1 and V_2 with identical characteristics arranged as in Fig. 2, with a common output circuit, but with the input circuits in opposition to each other. If v is the input voltage on the grid of one of the valves V_1, the voltage E_1 which V_1 tends to set up in the output circuit L_3 is that indicated by equation (1). But the other valve V_2 is connected so that the input voltage v produces an opposing effect in the valve V_2, which tends to set up a voltage of E_2 in the output circuit L_3, where—

$$E_2 = a(-v) + b(-v)^2 + c(-b)^3 + d(-v)^4 ;$$
$$i.e.,\ E_2 = -av + bv^2 - cv^3 + dv^4 \qquad (2)$$

The net effect in the output circuit is the sum of the two voltages E_1 and E_2 obtained by adding equations (1) and (2).

$$E_1 + E_2 = 2bv^2 + 2dv^4.$$

* J. R. Carson. Brit. Pat. 102,503.

† R. V. L. Hartley. Brit. Pat. 151,928.

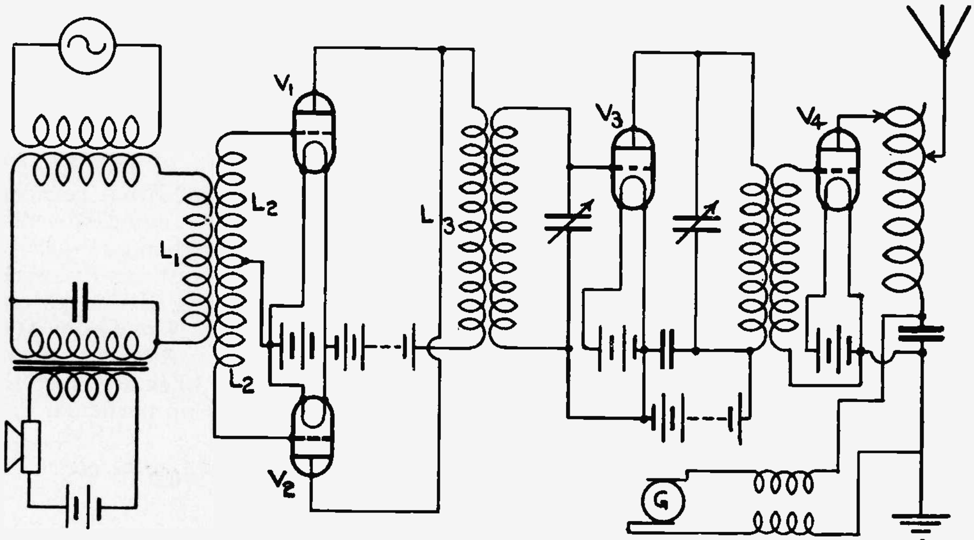


Fig. 2.—The Carson-Hartley system of radiating only the side-band component employs two opposed three-electrode valves to balance out the carrier frequency.

The term $2dv^4$ is, or may be made, negligibly small, and for practical purposes may be neglected.

Therefore—

$$E_1 + E_2 = 2bv^2 \qquad (3)$$

Hence all effects cancel each other in the output circuit L_3 except that which is proportional to the square of the input voltage. It is desirable, therefore, that the valves V_1 and V_2 should have a characteristic curve with a pronounced parabolic component. A little further consideration with reference to Fig. 2 will show how the arrangement illustrated therein serves to eliminate the carrier frequency. High-frequency oscillations from a master oscillator O and audio-frequency oscillations from the microphone M are induced into a common circuit containing an inductance L_1 coupled to the input circuit L_2 of the valves V_1 and V_2 so that the H.F. and L.F. potentials are both applied to the grids. L_2 is a centre-tapped inductance, the centre tap being connected to the common filament junction and the extremities being connected to the grids. This part of the apparatus must be symmetrically arranged if the desired balancing effect is to be obtained.

On each grid two sets of oscillations are being simultaneously applied, one at radio-frequency P, which may be represented by $A \sin 2\pi Pt$, and the other at audio-frequency Q, which may be represented by $B \sin 2\pi Qt$. The input voltage v at any moment is, therefore, given by—

$$V = A \sin 2\pi Pt + B \sin 2\pi Qt.$$

We see from equation (3) that the output voltage across L_3 is $2bv^2$; that is—

Output voltage

$$E = 2b(A \sin 2\pi Pt + B \sin 2\pi Qt)^2$$
$$= 2b(A^2 \sin^2 2\pi Pt + B^2 \sin^2 2\pi Q + 2AB \sin 2\pi Pt \sin 2\pi Qt).$$

Which by gentle manipulation becomes—

$$E = 2bA^2[1 - \cos 2\pi(2P)t] + 2bB^2[1 - \cos 2\pi(2Q)t] + 2bAB \cos 2\pi(P - Q)t - 2bAB \cos 2\pi(P + Q)t.$$

This last expression contains four terms, and shows that four frequencies are found in the output circuit L_3, namely :—

(*a*) A frequency of 2P; that is, twice the carrier frequency P generated by the oscillator O. This frequency, which is really a kind of second harmonic, is far removed from the working frequencies, and will not be passed on to any appreciable extent.

(*b*) A frequency of 2Q is equal to twice the frequency generated by the microphone M. This being audio frequency it will not affect the subsequent radio circuits.

(*c*) A frequency of (P+Q).

(*d*) A frequency of (P — Q).

It will be seen that the carrier frequency does not appear at all in L_3 if the circuits have been properly balanced. We have now only the frequencies (P+Q) and (P — Q) to deal with, and one of these, say (P+Q), is selected by the tuned circuit L_4, amplified by the power amplifying valves V_3 and V_4, and thence passed to the radiating system. Various details which would be necessary in practical working (such as grid potentiometers, etc.) have been omitted from Fig. 2, which is only intended to illustrate the principles involved.

In another method of eliminating the carrier frequency due to Osborn* a somewhat different principle is used. By the use of an auxiliary frequency intermediate between the speech frequency Q and the transmission frequency P the side-bands are sufficiently separated from the carrier to allow of the selection of one of the side bands by ordinary tuned circuits. Fig. 3 serves to show the general scheme of Osborn's method. Audio-frequency currents from the microphone M are made to modulate oscillations of frequency N generated by a low-power oscillator O_1. N is a comparatively low frequency which may be just at the upper limit of audibility, say 10,000 per second. As previously mentioned, it is quite possible with a frequency of this order to separate the frequencies (N+Q), N and (N — Q) by means of suitable tuned acceptor and rejector circuits (Q being the mean speech frequency). One of the modulated frequencies, say (N+Q), is selected in this manner, and is, in turn, made to modulate the output of a second oscillator O_2 working at the transmission frequency P, which may be of the order of hundreds of thousands per second. The usual analysis shows that three frequencies P+(N+Q), P and P — (N+Q) will be produced, and if N has been suitably chosen there will be sufficient difference to enable one of the bands P+(N+Q) to be selected from the rest and passed on to the amplifier A. Thus, if the transmission frequency P is 100,000, N 10,000, and Q 1,000, the three frequencies will be 111,000, 100,000 and 890,000, which differ by more than 10 per cent. and present no particular difficulty to ordinary tuning methods. A frequency of 100,000 corresponds to a wave-length of 3,000 metres, which is rather long, and if side-band transmission is contemplated on short wave-lengths it may be necessary to use a second intermediate frequency in order to obtain sufficient separation of the modulated bands from the carrier at the transmission frequency.

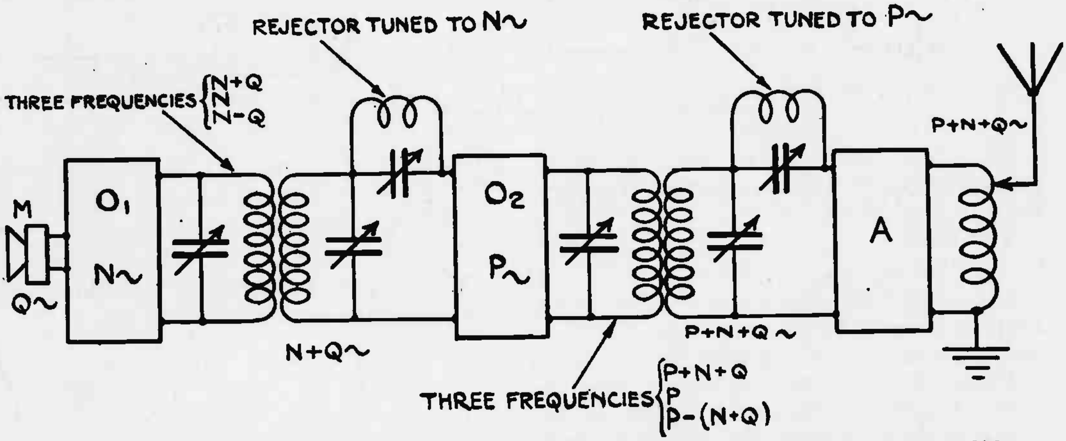


Fig. 3.—Osborn's method for eliminating the carrier frequency employs one or more intermediate frequencies, which enables sufficient separation to be obtained by means of tuned circuits.

It will be seen that in either Carson's or Osborn's method nothing is radiated while the microphone is not being spoken into. In each case the master oscillator, which is generating oscillations all the time, may be of very low power, say a few watts; since its oscillations, when unmodulated, are not passed on to the power amplifier nothing is radiated. In fact, side-band

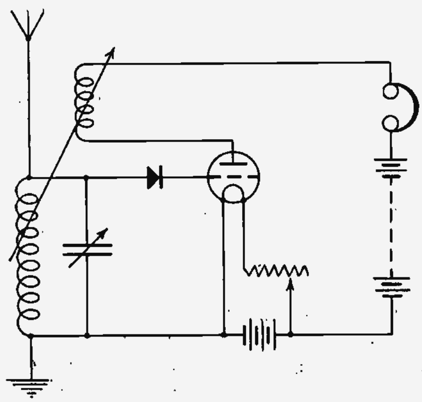
* H. S. Osborn. U.S. Pat. 1,361,488.

telephony is, amongst other things, a quiescent aerial system, and is the only quiescent aerial system which can be made free from serious distortion. If suitable intermediate amplification is used the final valve or valves associated with the aerial may be made to handle a power of several kilowatts.

Side-band telephony, when compared with the ordinary radio-telephony to which we are accustomed, presents some very peculiar features. First, it is inaudible, or, at any rate, quite unintelligible, in an ordinary receiver unless heterodyned; this, of course, is quite the reverse to ordinary telephony. The necessary local oscillator must be tuned exactly to the frequency P of the master oscillator *a*, the transmitter, so that it heterodynes the incoming frequency (P+Q) to give a beat note of the original speech frequency Q. This is known as "homodyne" reception, and allows us to avail ourselves of the advantages which beat reception, as is common knowledge, will bring in a weak station that cannot be heard unheterodyned. A second point is the enormous saving in power made possible by the fact that large amounts of energy need only be drawn from the power supply by the power valves when and as required by the speech; also a great deal of the heating up of the valves may be eliminated owing to the quiescent intervals. A third feature, and one which presents great advantages, is the reduction of interference due to the fact that the band of frequencies monopolised by the transmission from a width of over 2Q to a width of Q. Thus in a given band of wave-lengths we could crowd in twice as many stations working on the side-band system as we could stations working on the ordinary system.

In spite of its advantages, side-band telephony is not likely ever to be used for broadcasting purposes owing to the extra complications involved and the necessity for an extremely accurately adjusted homodyne at each receiving station. The effect of a slightly mis-tuned homodyne would be something like a gramophone running at the wrong speed, only it would be worse, as the relative pitches of different notes would be all wrong. The utility of the system lies mostly in the direction of commercial telephone services on long wave-lengths, but the whole subject presents a fascinating and practically unexplored field for the experimenter who is limited to short wave-lengths.

Crystal-Valve Circuits.



The use of a crystal rectifier connected directly to the grid of a subsequent amplifying valve is well known, and has been described in the pages of this journal. The circuit shown here has been used for some considerable time by Mr. H. Nicholson, and there seems to be some doubt as to the mode of operation. Reaction is obtained magnetically in the usual manner, and the circuit may be made to oscillate. The circuit has not yet been examined for grid current, and it is not known whether the valve or the crystal acts as the rectifier. The functioning of the circuit is wholly dependent upon the adjustment and direction of the crystal, and we should be glad to hear of readers' experiences with it.

The Principles of Choke Control.

BY L. E. OWEN (2VS.).

While the system of choke control is very popular amongst experimenters it seems that many are not fully acquainted with the mode of operation, and consequently they cannot operate their apparatus efficiently. The following simple article should remove all difficulties.

TO the experimenter who has studied various methods of control for the purpose of impressing speech frequencies on to the output circuit of a continuous wave generator, it is proposed to offer the following resumé of the practical experience gained in three years of experimental work carried out by the author.

Many experimenters may be heard discussing the merits of choke control, both at debates of the local societies and also during the rather infrequent periods when those of the cult are allowed to make the ether horrid or otherwise, and the general trend of opinion seems to be that theoretically it is electrically a very beautiful circuit, but that "Jones and myself get much better modulation on such-and-such a form of control."

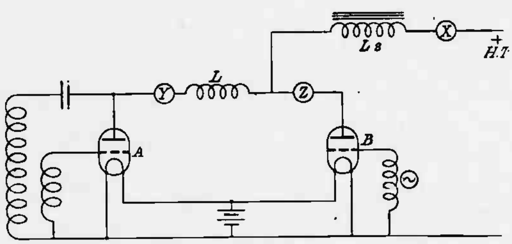


Fig. 1.—The fundamental choke control circuit.

This is quite probably the case, as there is no system of control so hard to get to a really efficient state, and at the same time be it remembered there is no system capable of giving better results from all standpoints than the constant-current choke control. The author will attempt, therefore, to explain the technical and other difficulties that must be overcome in order to obtain good speech and a large percentage of control without sacrificing the quality which seems generally to be lacking in many such operated stations to be heard in the free periods between broadcasting.

Firstly, it should be understood that it is better to modulate properly a large percentage of a relatively small high frequency aerial output, than to have a carrier wave which strikes the listener-in with a horrid thud and having a very small percentage of modulation. For this reason it is better to employ a valve for controlling having a rated output of at least one-and-a-half times the value of the valve used as an oscillator, as any attempt to overload the control valve results in poor speech, the magnification of parasitic noises generated in the microphone system, and other sources of an undesirable low frequency genus.

Consider diagram No. 1. It will be noted that the circuit is purely a diagrammatical one, showing the anodes grids and filaments of two valves A and B being connected through the radio frequency choke L, and fed by a source of high voltage, which passes through an iron-core choke L2 ; the valve B is shown to have a source of alternating potential, available across its grid filament system. Three milliammeters are included, as shown at X, Y, and Z.

Let us consider the function of the various parts of the circuit beginning at the choke L2. This choke being iron cored presents a definite impedance to sudden changes in the feed current which passes through it to the valves, and its function is to prevent any more current passing to the valve system than that amount which normally passes to each valve when A is in a state of oscillation and B in a quiescent state, *i.e.*, is not being modulated by low-frequency pulses in its grid circuit.

It follows, therefore, that if the grid of the control valve B is made more positive at any given instant an increase of current will take place in the plate circuit of valve B. Now the plate current of the valve A, owing to the valve being in a state of oscillation, is absorbing a definite amount of current, and were it not for the fact that the iron-cored choke L2 offers impedance to changes in the flow or currents, this extra current would naturally come from the high voltage supply. We have seen that the impedance of the choke prevents this, and therefore the extra current has to be absorbed from the plate circuit of valve A.

Conversely, if the grid of valve B is made more negative at any instant, the result will be a *decrease* of its plate current and a corresponding *increase* of current in the plate circuit of the oscillator valve A, the choke L2 again acting as a time switch (or impedance to the change in current) which prevents the unwanted currents from the plate circuit of the control valve from flowing back to the source of high voltage energy.

To sum the position up briefly, at any instant any deficit of current in the plate circuit of the control valve occasioned by increase of the positive grid potential must come from the available current in the plate circuit of the oscillator valve. Conversely, any rejected anode current from the control valve must be forced into the plate system of the oscillator valve. These additions and subtractions of current derive their impetus from the differences of potential set up across the choke L2 while exerting its function in the circuit. It is from the action of the choke L2 that the circuit is given the name of the constant-current choke control. We shall next consider the position of the three milliammeters X, Y, and Z. The milliammeter X will register a total feed current, and for the reason that the circuit is a constant current one, *i.e.*, the total current supplied to the valves is always the same, it follows whether modulated by speech or otherwise the reading should not vary at all; this point is mentioned as the author has quite often seen variation of this current alluded to quite gleefully as a sign of good modulation. Modulation it is, certainly—that is, the grid circuit of the control valve is affecting its plate circuit, but the changes in current so produced are doing exactly what the aim of the circuit is to prevent, and merely shows that choke L2 is not functioning as it should.

The milliammeters Y and Z should register as follows :—If we take as a basis of argument, two valves of the same dissipation capacity, it is obvious from a theoretical view-point that the best proportion of current should be half for the oscillator valve and half for the control valve, when valve A is in a state of oscillation and valve B in quiescent state, so that when speech is impressed on the grid circuit of the valve B, it either absorbs practically all the available energy from valve A and in that case causes it almost to cease from oscillating, or again gives up all its energy to valve A and therefore to increase the amplitude of oscillations. Such magnitude of control would produce very poor quality speech, and also the control valve would be greatly overloaded, and it is, therefore, best in practice to cause the oscillating valve A to take about two-thirds when on the proper point of its characteristic curve, and the control valve one-third, this wattage being approximately one-third to one-fourth of the normal working load of the valve. For the 10-watt set the author would recommend a proportion of the following order :—

Input volts on load, 800 ; constant current milliammeter X, 12·5 ma; sub-feed to oscillator at 8·5 ma; sub-feed to control, 4 ma.

The R.M.S. input to the plate would therefore be somewhere in the nature of 8 watts, provided that the control valve is worked at the proper point of its characteristic curve.

Owing to the fact that the frequency of the speech may be about 1,000 cycles, the ammeters Y and Z would not indicate the control, except on certain persistent vowel sounds such as "O" and "E" when the addition or subtraction effect on the meters Y and Z should be just visible; if it is desired to see the effect of modulation, an electrostatic voltmeter of low capacity should be connected across the plate filament circuit of each valve. Alternatively, a neon tube may be connected by one of its terminals to the anode of the oscillator.

The secrets of the choke control system are these: First, proper design of the choke, and, secondly—and most difficult—to induce the control valve to work on the most efficient point of its characteristic curve.

We will now consider the question of the control valve characteristic curve. Take, for example, Fig. 2. We have here anode current—grid volt curves of the same valve at different anode potentials. On curve A, if the base line of the grid is zero volts it follows when modulation occurs by the grid potential changes, owing to the zero line being near saturation, increment modulation will be obtained, *i.e.*, an increase of plate current in the oscillator, with a tendency for decrease of the grid current in the control valve. Again, at the curve C the reverse will be found to occur. Now at B fairly good modulation will be obtained, owing to the fact that both decrement and increment of the plate current of the oscillator is taking place; the one disadvantage being that grid current on the control valve of a high mean order will occur in one half cycle this causing poorness of quality by distortion, but, on the other hand, fairly full modulation of a sort will be obtained.

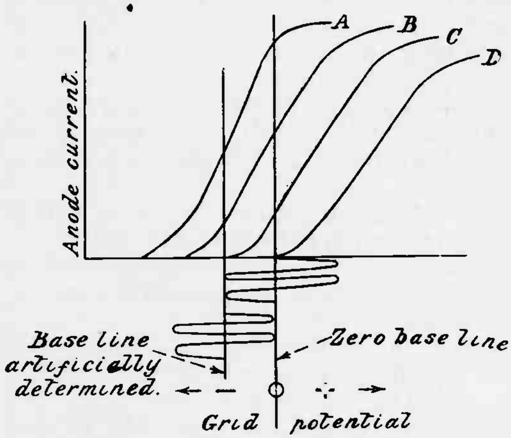


Fig. 2.—The family of curves indicates the correct operation point for proper modulation.

Next consider curve D. This shows that practically no modulation can occur and is usually the condition that the valve is working under when very broken speech is radiated; decrement modulation of the oscillator being present to excess.

It is therefore fairly obvious that the best possible speech will be obtained if the base line of the control valve grid be artificially determined on a curve, so that the valve be worked in a manner so as to produce equal decrement and increment modulation, while keeping the grid current at its lowest mean possible value. This can best be obtained by giving the control valve grid sufficient negative potential from a battery so as to indicate the conditions found in curve B on curve A; modulation will then be obtained under the best possible conditions, *i.e.*, full modulation without distortion due to excessive grid current.

Lastly, it is proposed to offer a few suggestions on the choke L2. The impedance of any given iron-cored inductance is obtained in practice by the following method. A known current is passed through the choke, and the potential drop across the choke is read off on a meter adjusted for the particular frequency. This inductance is then given by

$$L = \frac{E}{2\pi f I}$$

Now in this case what is required is a choke which will offer its maximum impedance at the R.M.S. value of speech frequency, which may be said to be for all-round purposes 1,000, allowing that a man's voice will be a slightly lower R.M.S. frequency—say, 850.

Now knowing our feed current, say, a maximum of 15 milliamps., we have to design a choke which will impede any change in this current at 850 cycles, after allowing for the losses in iron and losses in the winding of the choke. Now the inductance required for those figures is, viz.,

$$L = \frac{800}{6{\cdot}28 \times 850 \times {\cdot}015} \qquad L = 100 \text{ Henries.}$$

Therefore, we take a core ½″ diameter, with about 5″ winding space, for which 15,000 turns of 38 gauge silk-covered wire will be required. This choke will be found to give very clean and full modulation on the power we have discussed, *i.e.*, 10 watts, and may have a D.C. resistance of about 1,000 ohms. The drop of volts across this choke will be—

$$\begin{aligned} E &= RI \\ &= 1{,}000 \times {\cdot}015 \\ &= 15 \text{ volts.} \end{aligned}$$

This will not be worth worrying about.

It has not been the purpose of the author to design a choke control set, but rather to show the fundamental principle employed in its operation, and it is hoped that this article may be the means of giving a clear insight to those who have had difficulty in making a success of this interesting method of control.

Magnetically-controlled Valves.

By H. ANDREWES, B.Sc., A.C.G.I., B.I.C.

The magnetic control of valves seems to be a subject which has received very little attention amongst experimenters. Below will be found a brief outline of the manner in which a magnetic field can be made to influence the electronic emission in an ordinary three-electrode valve, and some interesting experiments are suggested.

As long ago as May, 1921, and this is a long time from the radio point of view, magnetically controlled valves were introduced to radio engineers, but, as far as the radio experimenter, or "amateur" as he is called for some unknown reason, is concerned, very little seems to have been published in this interesting field of research.

This last fact is, I think, partly due to the belief that any experiments on these lines required special valves and special apparatus. The object of this article is to remove to a certain extent this belief, and show that a large number of interesting experiments may be performed with the apparatus usually available to the experimenter.

Let us first consider very briefly the work which has been done. In May, 1921, A. W. Hull, of the G.E.C. of America, delivered a lecture to the American Institution of Electrical Engineers on a new vacuum tube device which he had invented and called the Magnetron.

The magnetron* consisted essentially of a symmetrical diode, *i.e.*, a cylindrical anode with a central straight filament to which a magnetic field was applied, parallel to the axis of symmetry, in this case the filament.

In its simplest form the action of this tube is then simply a "valve" or relay. If no magnetic field exists a current will flow from cathode to anode, its magnitude depending on the temperature of the filament and the anode potential, the direction of flow being of course radially outwards from the filament. If now a magnetic field is applied, and if it is weaker than a certain critical value no effect is produced, but if stronger than this value a proportion of the electrons emitted from the cathode will be deflected and prevented from reaching the anode. If the field is sufficiently strong the anode current may be completely stopped, the action corresponding with the closing of a valve or the opening of a relay.

It is obvious then that curves may be plotted, characteristic of the tube, between anode current and the magnetic field applied. The shape of such a curve is shown in Fig. 1.

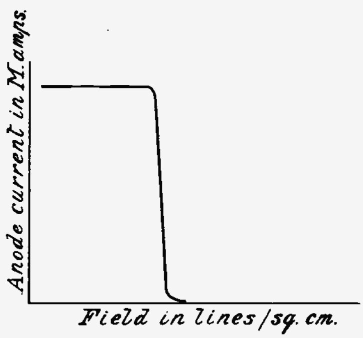


Fig. 1.—Here it is seen that at a critical field strength the anode current is reduced approximately to zero.

It will be seen that this curve is very steep at the critical field strength. The field strength required to stop the anode current depends, of course, upon the diameter of the anode, that is to say, the length of the electron path. It has been found that the field strength required varies inversely as the anode diameter.

The value of this critical field may also be calculated from the formula :—

$$H = \frac{\sqrt{8\frac{m}{e}V}}{R}$$

or putting in values for e.f.m. the charge and mass of an electron

$$H = \frac{6{\cdot}72}{R} \sqrt{V}$$

In the case of a V24, this value of H works out at about

96 lines/cm^2

taking an anode voltage of 25.

* *Journal A.I.E.E.* Vol. XL, No. 9. Sept., 1921.

Now it is obvious that this principle, that is to say, the application of a magnetic field. may be applied equally well to a triode as to a diode, provided the symmetry is kept. Hence we see that provided a suitable means of attaining the necessary flux density can be found, an ordinary valve, those such as the Ora and V24 may be experimented with.

With a view to finding out how practical this idea was the author has carried out a few experiments with the Ora valve.

Experiments with the Ora.

As the valve used is a triode it is obvious that diode magnetron curves cannot be obtained as the potential of the grid will affect the shape. Hence curves where taken for anode current—field strength with different grid potentials.

The circuit used for these curves is shown below in Fig. 2. The field coil used was of an extremely rough and ready nature. A photograph of the arrangement is shown in Fig. 3.

The coil used was really very unsuitable but was the only thing available at the time. The turns on the coil were in two sections of 5,000 each, the two sections being placed in parallel to reduce the D.C. resistance.

In this way about 1,200 ampere turns were obtained.

Fig. 4 shows the curves obtained for different grid voltages.

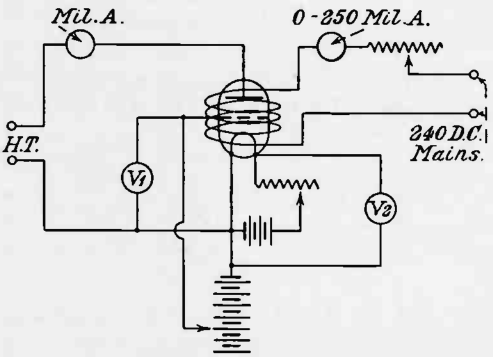


Fig. 2.—The circuit used to obtain the curves shown in Fig. 4. The field strength was varied by means of a resistance in series with the field coil.

These curves show several very interesting points. Perhaps the most obvious thing that one notices is that as the grid is made positive, we see that the cut-off of anode current is much more rapid, that is to say, the curve becomes much steeper. This is rather what might be expected, for as the grid becomes positive grid current commences, the negative space change is reduced, and hence the grid is acting with the magnetic

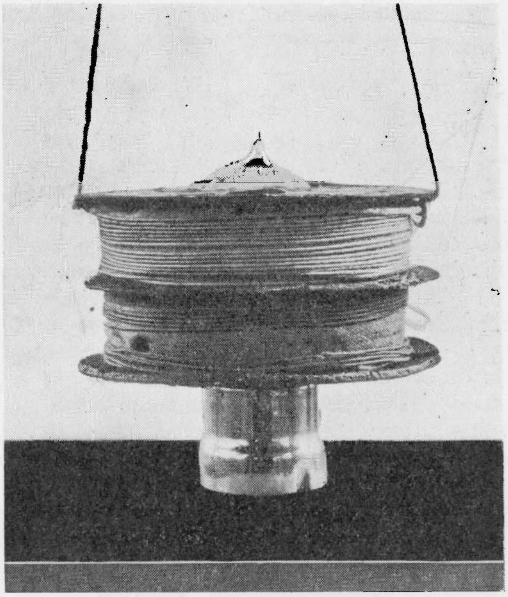


Fig. 3.—The field coil consisted of two sections of 5,000 turns connected in parallel to reduce the resistance. These were connected to 240-volt mains, and a strength of about 1,200 ampere turns was obtained.

field in stopping electrons emitted from the filament (which do not actually hit the grid) from reaching the plate.

The reader will perhaps excuse this not very conclusive explanation, as it is not proposed to delve deeply into the theory of the magnetron since it is much too complicated for a brief explanation such as could be given in a short article.

Applications.

Turning now to possible application of this device, obviously such an arrangement can be used in the same manner as a triode, as a rectifier, or as an amplifier of H.F. currents.

Rectification can be obtained by using the bend in the curve shown in Fig. 4. If, for example, the curve corresponding with +7·2 Vg. is used and a polarising field of 500 amp. turns was used, by coupling a coil carrying H.F. to the field coil, rectification could be obtained. Again, by working in the centre portion of the curve amplification of H.F. currents could be obtained in a similar manner.

Unfortunately, with such conditions, neither of these arrangements would work very well, as bad distortion would be introduced due to grid current. This current is, of course, necessary to obtain a steep curve and good amplification. Obviously, to obtain good distortionless amplification a diode valve must be used, and such an arrangement is given in the original paper by A. W. Hull.

The magnetron may also be used as a generator of H.F. (or L.F.) currents. This may be done either by using a feed back arrangement between the anode current and magnetic field circuits or by using the grid as well and obtaining an effect similar to the

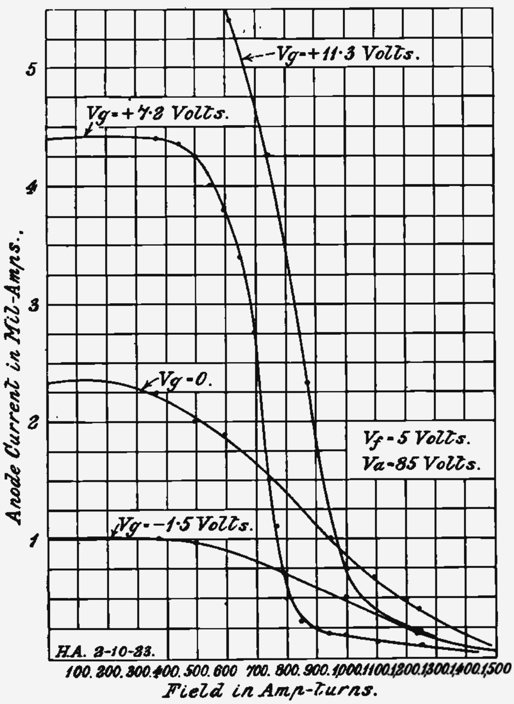


Fig. 4.—Some characteristic curves obtained with an ORA valve. The curve obtained with a grid voltage of 7.2 volts is suitable for rectification.

"negatron." Using the magnetron as an H.F. oscillator it is found to be very efficient and may be used for the control of large amounts of H.F. energy.

Another application which has occurred to the writer is its use in telephony. As we may regard the magnetic field as a second control electrode, it would be possible to use one control electrode to produce the necessary H.F. currents and modulate with the second electrode, obtaining the same effect as in a double grid valve. The best arrangement is probably to use the magnetron oscillator circuit and modulate the grid potential, but the other arrangement is shown in Fig. 5, in which an Ora valve is used as a master oscillator to control a main power valve, modulation being obtained by varying the flux of the magnetic control.

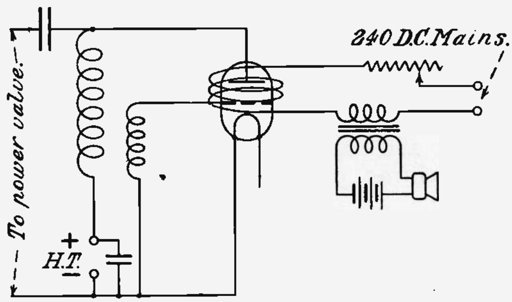


Fig. 5.—The valve is here used as a master oscillator, and controls the main power valve of a telephony transmitter. The valve is further controlled by a magnetic field in the manner previously indicated, modulation being effected by varying the field by microphone potentials.

Although the magnetron originally was a highly evacuated tube, it is interesting to note that similar gaus-ampere curves may also be obtained for "soft" valves.

The author has even succeeded in obtaining similar curves, using the now famous neon lamps.

It should also be possible to obtain very interesting results using a valve, such as the Cossor, so that the field could be applied parallel and not at right angles to the electron flow.

Finally, the writer would like to point out that this article is intended in no way to be the last word on the subject, or to "tell you all about the magnetron." It is intended to be more an incentive to experimenters to work on this device as high hopes may be entertained for the results obtainable. It is to be hoped that other experimenters will help the writer by criticising or confirming the results which he has so far obtained.

The Construction and Manipulation of Wave-Meters.

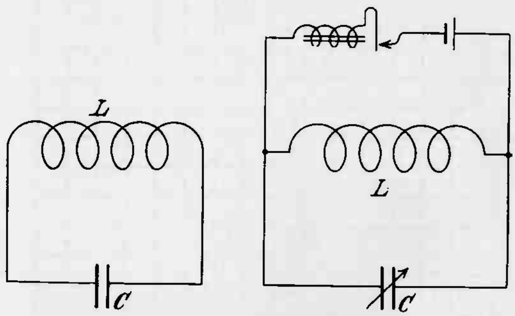
By LEONARD A. SAYCE, B.Sc., A.I.C.

For some unknown reason wave-meters seem to have received little attention by many experimenters. Below will be found a general discussion on the subject, including simple methods of calibration and constructional data.

It is surprising how few amateur stations include a wave-meter amongst their equipment and how few amateurs realise what they are losing by dispensing with this most useful accessory. A wave-meter is easy to make and once made is in constant use whenever a new piece of apparatus requires to be tested or a transmitting or receiving set adjusted. By its aid condensers and inductances may be measured and experiments may be performed with scientific precision. In the remarks that follow an attempt has been made to show how some of these operations may be carried out and some constructional hints are given.

A wave-meter consists essentially of an oscillatory circuit that may be set into oscillation at a known frequency. Such a circuit, Fig. 1, consists of a condenser C and and inductance L. Its wave-length may be altered either by altering C or L, but, although the variable inductance method is successfully applied to the well-known Townsend wave-meter, there are certain disadvantages to this method and it will usually be found more convenient to employ a variable condenser, varying the inductance in steps if a long range of wave-length is to be covered.

Wave-meters are of two kinds—"Buzzer" and "Heterodyne"—and these correspond to spark and C.W. transmitters, respectively. If a buzzer, together with a cell to work it, is connected to the oscillatory circuit in the manner shown in Fig. 2 a train of oscillations is set up in the circuit LC every time the buzzer circuit is completed by the vibrating armature and the frequency of these oscillations is dependent upon the values of C and L. The wave-meter is said to be calibrated if we know the frequency or wave-length corresponding to every setting of C. But a variable condenser and a single inductance would provide only a limited range of wave-length, so it is convenient to have a number of interchangeable inductances and arrange them so that the minimum wave-length with one coil is well below the maximum obtained with the size smaller, so that we may have no gaps in our range. Thus, if we use a ·001 mfd. condenser and honeycomb inductances, the No. 50 coil will give a range of 250 to 800 metres and the 150 coil a range of 700 to 2,000 metres. It is thus evident that very few coils are necessary



Figs. 1 and 2.—On the left is a fundamental oscillatory circuit, which on the right is seen excited by a buzzer.

to cover a very large belt of wave length, far fewer than would be required to tune an aerial circuit through the same range because in that case we have to contend with the invariable and rather large capacity of the aerial to earth. Little need to be said as to the actual construction of a buzzer wave-meter; it is so simple that it is hard to go wrong. The buzzer should, however, be such as to give a quiet and high-pitched note and should be muffled in a small felt-lined box so that it is inaudible. It is very advisable, too, to shunt its windings with a non-inductive resistance and a flash-lamp bulb is very convenient for this purpose for it provides, in addition, a useful indication of the correct adjustment of the buzzer. The variable condenser, buzzer, flash-lamp bulb, dry cell—to drive the buzzer—and a small switch should be mounted in a suitable box. The socket for the plug-in coils may be on the box too, but it is much better to connect it to the box by a flexible coupling, for this enables us to induce our wave-meter signals separately into the various circuits of our receiver.

The calibration of our buzzer wave-meter is done as follows:—With your receiving set tune in all the stations whose wave-

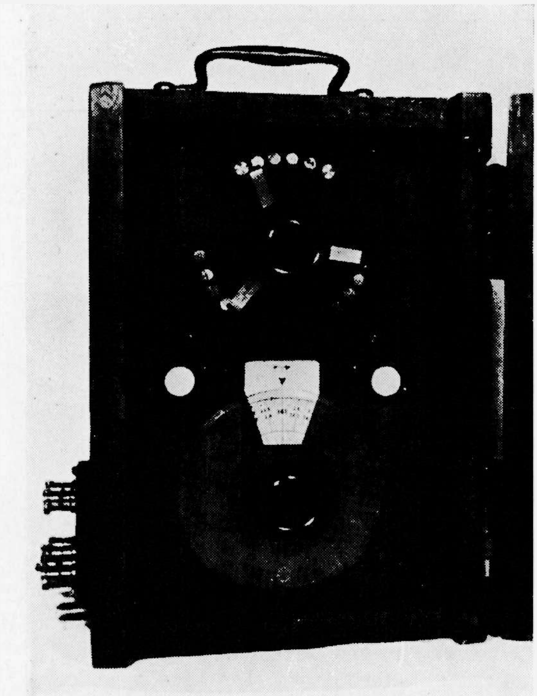


Fig. 3.—A general view of the heterodyne wave-meter.

lengths you know, both C.W. and spark, being very careful that it is the fundamental and not a harmonic that you are hearing and that C.W. stations are tuned in to their "silent points." Suppose, for instance, that you have tuned in the Paris "U.R.S.I." signals as accurately as possible. Keeping the receiver at this setting, start the buzzer and hold the wave-meter coil near the earth lead. If this coil is of suitable value the note of the buzzer, as heard in the 'phones of the receiver, will increase to a maximum intensity and then die away again as the condenser knob of the wave-meter is turned. The setting at which the intensity of the buzzer note is a maximum is when it is emitting waves of the length to which the receiver is tuned—in this case 2,600 metres—and a table should be made out as follows:—

Coil No.	Condenser Degrees	Wavelength Metres
250	45	2,600

The above procedure should be repeated on as many wave-lengths as possible. There is no need to go much above 3,000 metres, for on high wave-lengths it becomes impossible to judge the "maximum" at all accurately owing to the increasing decrement of the circuit.

Having now made as many entries as possible on our table, we must take a sheet of squared paper, dividing the horizontal axis into condenser degrees and the vertical axis into wave-lengths in metres up to about 3,000 metres. Taking all the entries for each coil in turn, plot them upon the squared paper and join them by even curves, taking a separate curve for each coil. Any irregularity in the curves will be due to the fact that many stations do not keep to their correct wave-lengths and an allowance must be made for this. To most experimenters the range from 150 to 450 metres is of great interest, and the curves for this range should be drawn on a larger scale than the others. The broadcasting stations give a number of points between 350 and 425 metres and their first harmonics a number between 180 and 210 metres, so there are quite sufficient to give quite a good curve throughout the whole range, for any inaccuracies in wave-lengths are shown up when recorded graphically.

When we have calibrated the wave-meter we are in a position to measure the wave-length of any station within its range or to tune our receiving set to any desired wave-length. Suppose, for instance, that we are 300 miles from 2LO and wish to tune him in on a very selective circuit (and we *do* need selective circuits on the North-East coast!). Of course, we might use "stand-bi and tune" switches, but it is quicker to use a wave-meter. Suppose that the circuit is as shown in Fig. 4. The wave-meter is made to emit wave trains of 369 metres and its coil is first placed near circuit A. The latter is tuned until the wave-meter signals

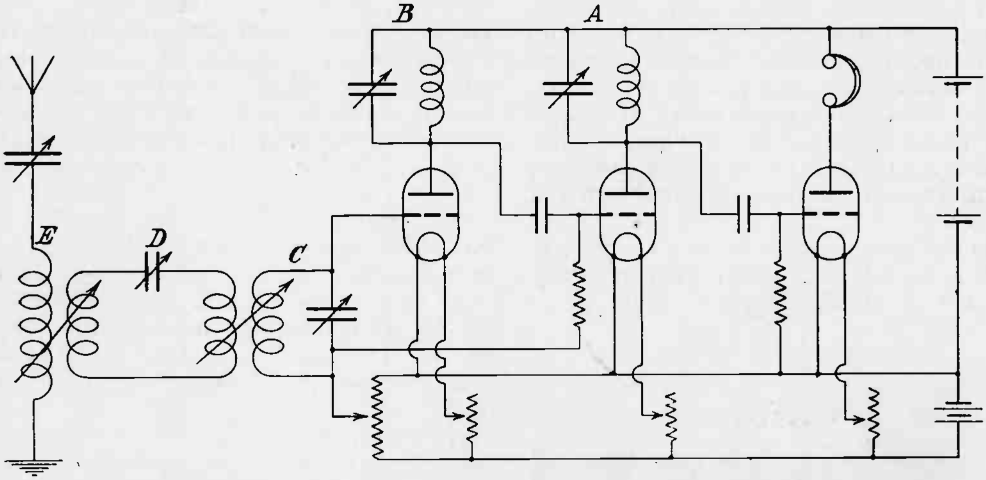


Fig. 4.—Illustrating the manner in which the multiple-tuned receiver is adjusted. The circuits are each brought into resonance with the wave-meter in the order indicated.

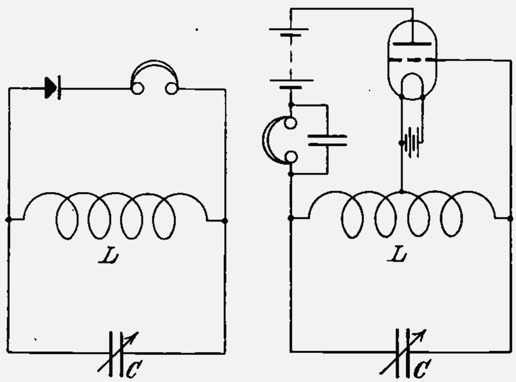
are heard with maximum loudness and then B is treated in exactly the same way. The remaining circuits C, D and E are tuned similarly and in the order given. The final adjustments and the coupling of the circuits are done with the wave-meter coil placed near to the earth lead. Always commence with the tuned circuit nearest to the telephones and do not place the wave-meter coil too near the circuit to be tuned. It is much easier to judge the "maximum" if the signals are *just* audible and if the coupling is too close there will be a serious disturbance of the wave-length.

In the rarer event of a wave-meter being required to tune a spark or telephony transmitter, the buzzer and cell are replaced by a crystal detector and telephones, thus giving the circuit shown in Fig. 5. The wave-meter has now become a calibrated crystal receiver and the inductance may be regarded as a small frame aerial. If used in connection with a 10-watt transmitter it is generally necessary to place the coupling coil quite near to the earth lead. In addition to measuring the wave-length emitted, this arrangement enables one to hear one's own telephony and so check any faults in modulation as soon as they occur.

A buzzer wave-meter is extremely convenient, but it suffers from two disadvantages: First, it is difficult to calibrate it accurately unless access can be had to a standard wave-meter, and, secondly, its accuracy, apart from the correctness of its calibration, depends on the "sharpness" of its point of resonance, and this again is an inverse function of the decrement or damping of the circuit. Even if the decrement is kept as low as possible by winding the coils with spaced litzendraht, it is not very much use at a higher wave-length than three or four thousand metres.

A heterodyne wave-meter, on the other hand, can be calibrated, if necessary, from a single reliable calibration wave, through a range of 50 to 50,000 metres. Its accuracy, particularly if it is applied to oscillating circuits, leaves nothing to be desired. It can be used both as a transmitter and a receiver and in the former capacity makes a "separate heterodyne" for receiving long waves efficiently and for using the Armstrong "supersonic" circuit on short waves. The basic circuit of a heterodyne wave-meter is shown in Fig. 6. It is only one of many possibilities, but is certainly the simplest of all. The oscillating circuit LC is exactly the same as before, but it is excited by a triode instead of a buzzer. The two ends of the coil are connected to anode and grid respectively, whilst the filament is connected to a point at, or somewhere near, the middle of the coil. An H.T. battery and pair of telephones are connected in the anode lead, but as the latter are not often needed their terminals may normally be bridged across. The H.T. battery should be about 30 volts.

Considerably less than this will serve, but alterations in the H.T. voltage vary the impedance of the valve and consequently alter the wave-length. If the voltage is fairly high, however, small changes are not so important. (In this connection, it is interesting to note, in passing, that under



Figs. 5 and 6.—In the buzzer wave-meter the buzzer is replaced by a detector and telephones, while in the heterodyne wave-meter, telephones are inserted in the anode circuit of the valve.

favourable conditions stable oscillations may be maintained without any high tension battery, provided that the positive pole of the accumulator is connected to the middle tapping of the coil.) If a four-volt accumulator is used for heating the filament no rheostat is needed. Almost any receiving valve is suitable, but a "V24" does not maintain oscillations quite so readily as an "O.R.A." or a Marconi "R." It is not advisable to use a long flexible lead for the coils, as in the case of the buzzer wave-meter, so they may be mounted in the same box as the rest of the instrument. The middle tappings of all the coils may be connected together, thereby simplifying the switching arrangements. A simple wiring diagram for a heterodyne wave-meter to cover a very large belt of wave-length is shown in Fig. 7. It is self-explanatory with the possible exception of the three-arm switch. This is an ordinary switch-arm bearing two additional arms on the same spindle clamped together in electrical contact but insulated from the spindle and the original arm by two mica washers and a small piece of ebonite tube. The coils must be of such a size that there is a fair overlap between the wave-length band of each coil and that of its neighbours. In calculating the values of suitable coils it must be remembered that the wave-length corresponds to the circuit composed of the *whole* coil and the condenser, and that the valve and its associated wiring produce minor alterations due to capacity and impedance.

The wavemeter shown in the photographs has a range of about 250 to 9,000 metres. A "polar" condenser is used, and it has a maximum capacity of ·001 mfd. A celluloid protractor, 4 ins. in diameter, is used as a dial, because the dial sold with the condenser is not of much use in the present case. The range switch is mounted on an ebonite base above the condenser dial, and the two white knobs placed half-way up the panel are respectively for adding a small mica condenser to increase the range, if this is ever needed, and for switching the valve filament on and off. The "front door" of the instrument has a small block of wood screwed to it to press in the left-hand knob and so switch off the filament, in case the door is shut whilst the valve is alight.

Four coils are used, and these are constructed as follows :—

The two lower-range coils are wound upon a cardboard former 3⅛ ins. diameter and 3 ins. long. The former for the third coil is built up from three shellaced discs of thick cardboard 3⅛ ins. diameter, and has two grooves, each 3-16ths in. wide, made from discs of three-ply wood 1 in. diameter. The fourth coil is similarly built up, but its two grooves are each 3-32nds in. wide. The windings for the coils are :—

(1) 34 turns No. 24 D.C.C. wire in a two-layer banked winding.
(2) 100 turns No. 28 D.C.C. wire in a three-layer banked winding.
(3) 380 turns No. 28 D.C.C. wire, 190 turns in each groove.
(4) 950 turns No. 36 D.S.C. wire, 475 turns in each groove.

Each coil is tapped at its middle turn. The two slab coils, Nos. 3 and 4, were placed one at each end of the cardboard cylinder holding Nos. 1 and 2, and a 2 B.A. brass rod was passed through all the coils. The projecting ends of this rod enabled the coils to be secured to the panel by two brass brackets. The above windings will be found helpful in making a similar instrument, but will probably have to be slightly modified when tested for the presence or absence of shellac on the coils, the exact width of the slabs, and the proximity of the coils to one another are all factors which make considerable differences in wave-length.

As already stated, a heterodyne wave-meter may be completely calibrated from the observation of one reliable calibration signal. Such calibration signals are transmitted by the Air Ministry (GFA) every morning. At 0750 G.M.T. a wave of 900 metres is sent. Tune in this upon a one or two-valve receiver, without H.F. amplification, adjusting the latter to the exact point of zero beat frequency, *i.e.*, the "silent point." Now leave the receiver severely alone but continue to wear its telephones. Switch on the wave-meter, using its smallest —No. 1—coil. The instrument should be within a few feet of the receiver, but not too near. On rotating the condenser of the wave-meter, a number of little whistling notes will be heard. Near the zero of the scale the notes will occur near together and be rather faint, but nearer the maximum they are louder and are spaced further apart. These are all harmonics of the 900 metre waves that the receiver is generating. The "fundamental" also will probably be found on No. 2 coil. It is much louder than any of the harmonics and with it the "silent point" may extend for several degrees of the condenser. This is because the impulses induced in the receiver by the wave-meter are strong enough to force the former into resonance over quite a considerable belt of wave-lengths. When tuning in the fundamental, therefore, the wave-meter must be taken further away from the receiver until the silent point is perfectly definite. The wave-meter is now tuned exactly to 900 metres, and the setting of the condenser is carefully noted. Next, still leaving the receiver tuned to 900 metres, the wave-meter is reduced in value until the first harmonic is tuned to its silent point. It is now emitting a wave of 450 metres, *i.e.*, 900/2. Again note its setting and proceed to take the condenser settings at which the second harmonic, 900/3 metres, third harmonic, 900/4 metres, etc., are in tune. It would be quite easy to go as far as the tenth harmonic, corresponding, in this case, to a wave-length of about 80 metres, if the condenser had a low enough minimum capacity. A graph should be made showing the condenser settings plotted against wave-lengths and the points will be found to lie on an even curve.

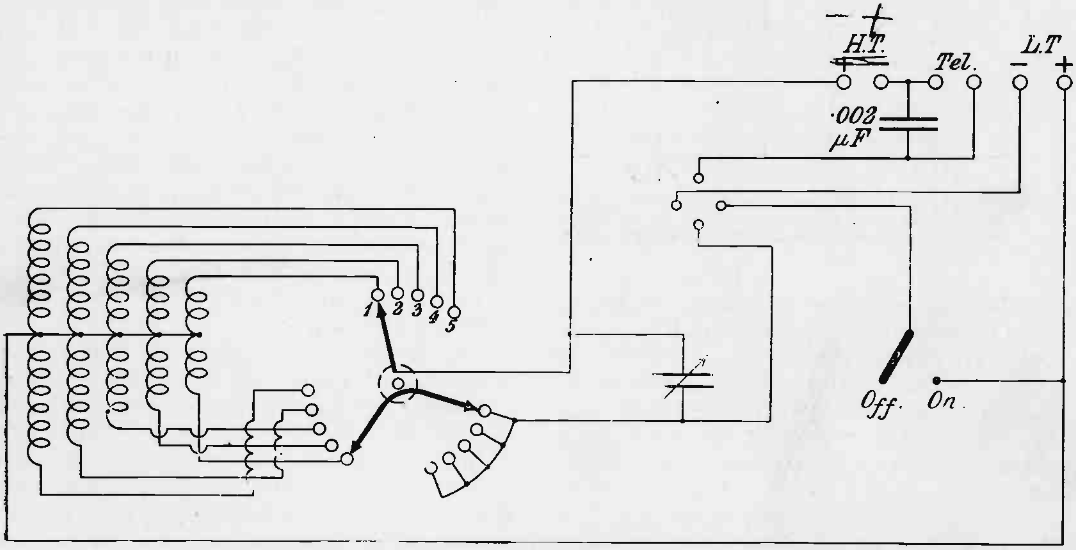


Fig. 7.—The internal connections of the heterodyne wave-meter, illustrating the special switch consisting of three arms on the same shaft, two being electrically connected, and insulated from the third.

To calibrate the wave-meter above 900 metres proceed as follows:—Set the wave-meter once more to 900 metres and gradually raise the wave-length of the receiving set. At 1,800 metres a CW note will be heard. Go higher still and at 2,700, 3,600 and 4,500 metres the wave-meter will be heard again. Tune in carefully on 4,500 metres and, leaving the receiver at this setting, calibrate the wave-meter on the harmonics of this wave-length, *viz.*, 4,500/2,

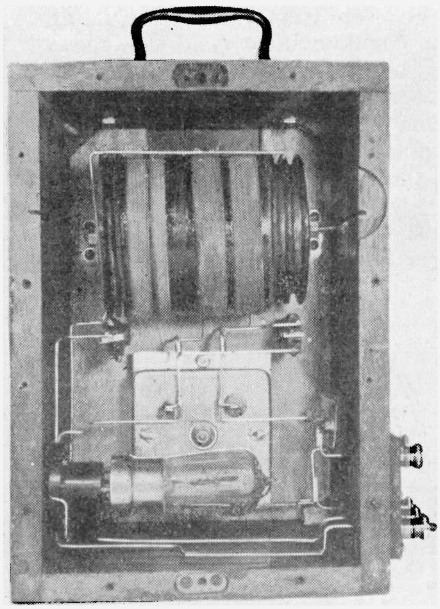


Fig. 8.—The internal wiring of the wave-meter, showing the banked winding.

4,500/3, etc., exactly as before. The fourth harmonic will, of course, be identical with 900 metres, but the 5th, 6th, 7th and 8th, will give four new points on the curves for coils No. 1 and 2, at 750, 650, 562 and 500 metres and will check their accuracy.

In a similar way we can go to still higher wave-lengths by setting the wave-meter at 4,500 metres and increasing the wave-length of the receiver as before. In fact, there is hardly any limit to the number of calibrations we can make. Every one of them is, however, dependent on the accuracy of the original 900 metres calibration signal and so, in order to check this and to correct any errors of experiment, it is advisable to refer to all the other available calibration waves and to the "URSI" signals.

After what has already been said, the chief methods of using the calibrated wave-meter will be sufficiently obvious. In all cases where it is used in connection with a receiving set the telephone terminals of the wave-meter are short-circuited, but if it is used to check the transmission of an experimental transmitter the telephones are included in the circuit and the instrument then becomes a simple autodyne receiver of which the coils act as little frame aerials.

The wave-meter is very useful for receiving on the very long wave-lengths. In the ordinary way the receiver is detuned in order to give a beat-note with the incoming signals of, say, 1,000 per second. On long wave-lengths this detuning represents a very serious loss of efficiency and if the aerial circuit is tuned to exact resonance the beats may be produced by the wave-meter and greatly increased signal strength and selectivity are the results.

So far we have considered how the wave-meter may be used in conjunction with oscillating circuits, we must now consider how it may measure the wave-length to which, say, a crystal set is tuned. The wave-meter, to which a pair of telephones is connected, is placed near to the crystal set and its condenser is rotated. As the emitted wave-length approaches that to which the crystal set is tuned the latter is suddenly forced into resonance and, because it commences to take energy from the wave-meter, a loud "click" is heard in the telephones connected to the latter. After the wave-meter condenser has been rotated past the point of resonance a time comes when the crystal circuit suddenly breaks away from the control of the wave-meter and a second click is heard. If the two clicks are far apart on the condenser scale the distance between the two instruments should be increased. The clicks will then become fainter but nearer together and half-way between the positions at which they occur is the wave-length of the crystal set.

The above remarks are intended merely as an introduction to the subject of wave-meters, but enough has been said to show that every experimenter would be well repaid for the cost and trouble of making one or both of the types described.

Amateur Radio Work in Holland.

By J. WESTERHOUD.

Perhaps one of the most interesting features of experimental work is the examination of methods and practice other than our own. One of our Dutch representatives gives below a summary of amateur work in Holland, and readers will no doubt find many new ideas and circuits.

We can divide the amateurs here, just as everywhere else, into the real experimenters and the broadcast listeners, the number of whom is greatly on the increase, especially since the foundation of the English and French broadcast stations. The real amateurs, however, do all they can to get as much as possible out of their sets, and they are always at work trying new circuits and endeavouring to solve the various problems that present themselves. The Dutch amateur is second to none of his colleagues in other countries as regards the work he does and the results obtained, notwithstanding the Dutch Government impeding his growth in no mean degree.

Receivers.

The most usual aerial here is decidedly the twin wire. Formerly this was made as long as possible, as we were not tied down to a prescribed length. But now the amateurs have realised that with short aerials fine results are to be obtained. Sometimes the cage antenna, with five or six wires, is used here, but generally only where, owing to local conditions, they must make the most of the length available.

For receiving, most Dutch amateurs use the common honeycomb-coil receiver, while for short waves the same set is used, but with spider-web coils. However, to keep the same receiver intact, a kind of double vario-coupler is also often applied, which is put in the honeycomb coil holder instead of the honeycomb coils. The primary coil has thirty-five turns of 0·35 mm. wire, on a 4·5-cm. size coil ; the secondary has thirty-two turns of 0·7 mm. size on a coil of 7 cm. ; and the reaction coil, same as primary coil, with forty-five turns of the same wire.

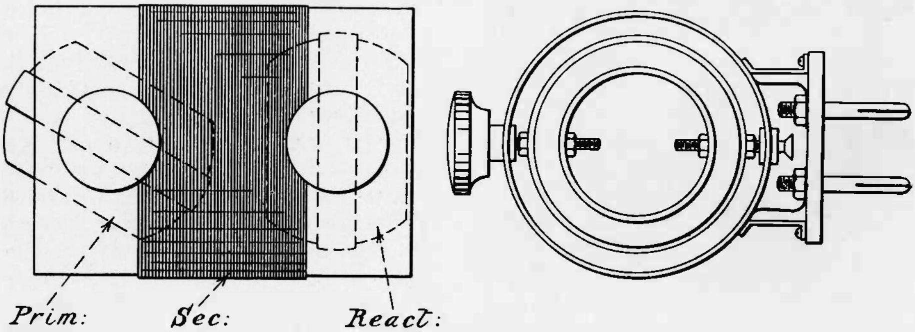


Fig. 1.—A loose-coupled tuner with reaction is too well known to call for comment, but the arrangement as a plug-in unit is certainly novel.

During the Transatlantic tests several amateurs got fine results with it, because it works in an exceptionally sensitive manner at a wave-length of 150-250 metres.

For receiving, the "Philips'" radio-valves are used ; likewise the German "Telefunken" valves. Much German material is used by Dutch amateurs, so a Dutch receiver is composed of 80 per cent. German material, made of the German army stocks. Parts of receivers, transmitters and valves are very cheap here ; some English amateurs who paid us a visit last Easter can bear us out in this.

To obtain one-valve high-frequency amplification in a simple manner the circuit shown in Fig. 3 is often used by us. The coil 1 is the aerial inductance, coil 2 the secondary, and coil 3 the reaction coil.

Before the detector the high-frequency amplifying valve is placed, which is connected with grid and filament to the antenna condenser. By application of high-frequency amplifying coil 3 can be taken out, or a honeycomb coil with a few turns can be

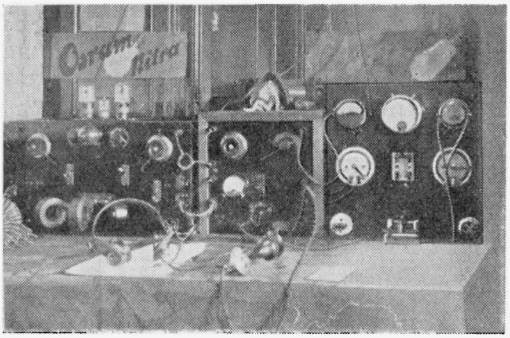


Fig. 2.—The receiver and transmitter of 0OX installed on a houseboat.

put in the place of it. When the first valve is taken out the set works again as a common honeycomb coil receiver. The high-frequency amplification obtained with it is strong. This circuit is used by us to receive the British broadcast stations. Before the establishment of the broadcast stations the amateurs had to rely more on long waves, and they applied themselves especially to amplifying the signals of weak long-distance stations. For this the note magnifier of Dr. Koomans is used with success, which is switched between a low-frequency amplifier and the receiver, so that they form together a note magnifier. Especially for weak stations and much jamming this apparatus is of great use, and is employed by us when listening to our Indian stations, such as Malabar and others.

This circuit is used to obtain selective reception. To the 'phone connection of the receiver is first connected a tuned circuit L1 C1, in which the coil L1 and the condenser C1 are so great that the circuit has an audible frequency, and will be tuned preferably to a frequency of 1,000, corresponding to a wave-length of 300,000 metres. This we get, for example, with a condenser of 0·01 mfd. and a coil of 2·5 henries. The reaction coil L2 must be of sufficient size to make the system oscillate. The heterodyne beat note of the desired signals is adjusted so as to be the same as the tone frequency of the circuit L1 C1. The reaction coil L2 is now adjusted so that the circuit is just on the point of oscillation, and therefore rectified oscillations, due to the desired signals, will be more strongly amplified than others, since the circuit L1 C1 L2 forms a critically-tuned reaction rejector circuit. L1 has 1,350 turns of 0·55 mm. size wire, wound on a coil of 10 cm. size and 5 cm. length. Coil L2 is wound on a tube of 2 cm. size and 5 cm. long, wound to an outside diameter of 6 cm. with wire 0·4 mm. size. Condenser C is a variable of 0·0005—0·003 mfd.

For receiving, the four electrode-valve is also used by many amateurs. These valves have the advantage of possessing a high vacuum, and by this a perfectly constant behaviour, while they require very little plate tension. In this respect they are even superior to low-vacuum valves. For the Dutch " Heussen " four-electrode valve a plate tension of 8—12 volts is sufficient. The common detector circuit is shown in Fig. 5. The so-called extra grid is branched off from the high tension. The strength of signals using these valves is the same as the three-electrode valves. The advantages is the low plate tension they require.

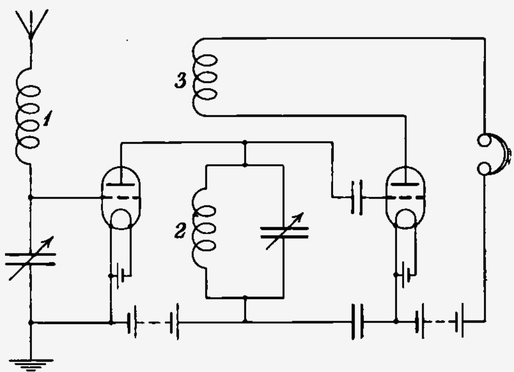


Fig. 3.—Potentials are taken across the tuning condenser. The detector valve being soft requires no grid leak.

During the Transatlantic tests of 1921 the Dutch amateurs had little success, but, encouraged by the success which some English amateurs had already that winter, they exerted themselves to the utmost to get better results in 1922, in which they accordingly succeeded. The whole week our amateurs listened during the night, and had the satisfaction to be able to note the calls of several American stations. We had very much trouble at the time, owing to the known fading effect.

As for the receiving of the English broadcast stations, it may be said that these

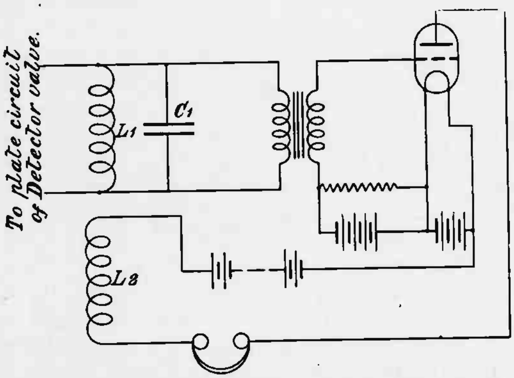


Fig. 4.—The circuit L1 C1 L2 forms a reaction rejector circuit across the intervalve transformer, and serves to reduce jamming.

stations are received very well by most amateurs here. With one valve as detector, and using one or two valves as high-frequency amplifiers, speech and music are very good. Regarding the quality of speech and music we have nothing but praise, everything being received very clearly, and it is a pleasure for us to listen for the British wireless orchestras. Sometimes we have trouble here by fading when receiving 2LO, while this is seldom noticed with the Newcastle station. We do not listen often for the French and German broadcast stations, because we have much jamming by private telegraph stations on this wave. It is likewise a great pity that the music of 2LO is sometimes jammed by ships on the wave-length of 400 metres.

Our broadcasting is still in embryo and far from perfect. For a long time we have been able to listen to music and speech from PCGG (the Hague), but it is difficult to receive the music clearly and without any disturbing sounds. Perhaps the listeners of *The Daily Mail* concerts which used to be given have noticed this already. The percentage of modulation of PCGG is great, but when the purity suffers by it a smaller and clearer modulation is preferable. Of late tests have been made by the Ned. Sein toestellenfabriek, Hilversum, in that direction, to obtain a pure transfer of speech and music. There are intentions here to start a Dutch broadcast company. A meeting of the principal Dutch radio firms has been held already in order to come to an arrangement.

Transmitters.

There are several amateurs here who apply themselves to transmitting tests, and it seems to be so much more tempting for us because it is prohibited to have one part of a transmitter at home. The severest fines are imposed if we are caught, and yet, in spite of that, there come more and more amateurs in the air. Especially on the short waves of 150—250 metres Holland has most representatives. The "nought" stations

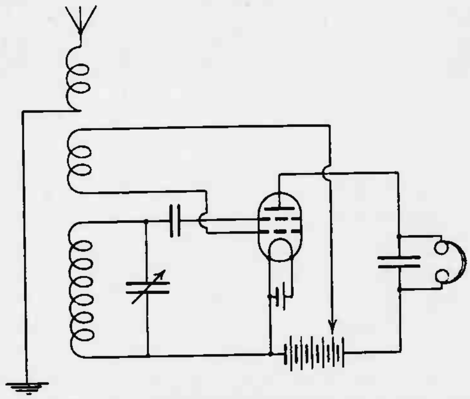


Fig. 5.—The four-electrode valve circuit shown above is used by many Dutch experimenters.

are known by most English amateurs. We have placed the "nought" before our call because we would not enter into conflict with transmitting stations in other countries which also have a figure before their call. In that manner we took the nought, knowing for sure that this figure was not in use anywhere at that time; everybody hearing our call understood that we were not officially classified. We have repeatedly asked our Government for their consent, but we have always received a refusal from our Minister, who, we maintain, is wrongly informed by his officials. After this introduction concerning our oppressed transmitting experimenters, a description will be given of the transmitters most in use, with which very good results are obtained.

The circuit of Fig. 6 is used by the station oMX, and gives very fine results. Other circuits have been tried, but this circuit was always found to be the best. The inductance C is wound on a 15-cm. size tube, with forty to fifty turns of 3-mm. size bare copper wire. To every other turn pieces of copper of the same size are soldered for taps and connections made by means of clips. The condenser across the inductance is 0·001 mfd., double spaced variable, because the whole of the high tension is on it. The grid condenser is a variable Murdock of 0·0005 mfd. To regulate the modulation this variable grid condenser is indispensable. The grid-leak is a variable of 10,000 ohms. For C.W. transmission the modulation transformer is used as a leak. The modulation transformer consists of four to five layers of 0·7-mm. size copper wire on the primary, and 10,000 turns of 0·1-mm. copper wire on the secondary. The filament of the transmitting valve is lighted by a step-down transformer. Most transmitting valves used here are the "Telefunken," 20 watts. The lighting transformer has a secondary voltage of 12 volts,

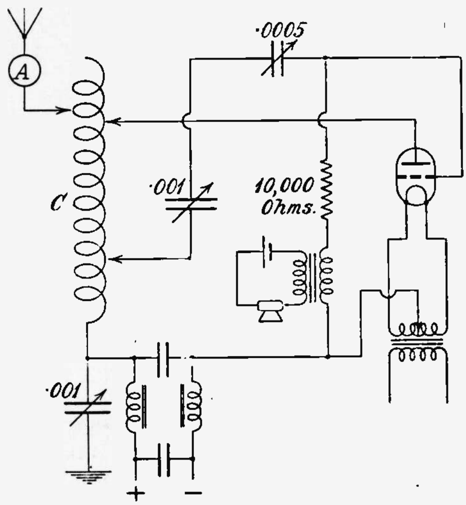


Fig. 6.—The circuit of oMX. The ·001 condenser should be between the grid condenser and filament.

and a tap is brought out from the centre of this winding. Two meters are used, aerial ammeter and a plate milliammeter. The filter circuit is made of the usual condensers of 2 mfd. and inductances. The high tension of 1,250 volts is obtained from a separate transformer, from which the alternating current is rectified by two "Philips'" rectifier valves. With this transmitter, and using a 20-watt transmitting valve, an aerial current is obtained of about 1·3 amps., using a cage antenna of five wires 24 metres long and 18 metres high.

All is done to obtain a fine pure note, as it is proved more and more that only with a pure note are great distances to be reached.

Fig. 7.—A general view of oMX, who is well known to many British experimenters.

In the photograph we see the receiver-transmitter of oMX (formerly PÉ). The left half of the set is the transmitter and the right half the receiver. As a receiver the honeycomb coil circuit is also used here, with variable grid condenser and a switch for series-parallel of the primary condenser. The transmitter consists of a variable grid condenser, a variable condenser across the inductance, and a switch for the different taps on the inductance. In the middle of the set are the ammeter and the plate milliammeter. With this set excellent work is done with the key and with 'phone. At full power, with 1·3 amps. in the aerial, the signals were heard QSA by several English and French listeners. One night 2JF and 2ZS at Liverpool reported the speech and music of this station all over the room.

With the coming Transatlantic tests it will be tried, by putting transmitting valves in parallel, to obtain a greater energy, hoping to reach the Americans with this.

Another circuit used here by the stations oDV, oAA, oNY and others is shown in Fig. 8. The peculiarity of this circuit is that, using it with a long aerial, the short wave of 200 metres is to be reached as well, though, of course, not with such profit as with a specially made aerial for short waves. For the coils 1, 2 and 3 common spider-web coils are used, with an inside size of 8 cm. and a wire size of 1 mm². The antenna coil 1 and coil 3 have seven to ten turns, and the grid coil has ten to fifteen turns. The antenna current obtained with this circuit and a 20-watt transmitting valve is about 1·2 amps. As a telephony system the common 'phone transformer is generally used by us, as shown in the circuit of oMX. This system is easy to handle. The system of PCGG is also used here by some amateurs, as shown in the circuit of oDV. Across the microphone is a variable shunt. It is difficult with this system to find the exact shunt, and likewise the exact resistance, of the microphone. With the circuit of oDV, also, very good results are obtained, but it is not so easy to handle as that of oMX.

Last winter the Dutch amateurs began, for the first time, with tests on the short wave, and they immediately met with success, both with transmitting and receiving English and French amateurs. The English stations 2KF, 2OD, 2NM, 2KO, 2JF and 5MS were heard here last winter the strongest of all. Of the French amateurs the stations 8BM and 8AB were strongest, but with a bad note, and, owing to this, very difficult to tune.

Excellent work is done by oMX on several Sunday mornings from 2 till 4 o'clock. As

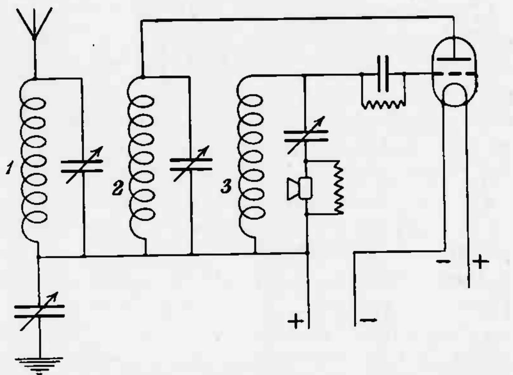


Fig. 8.—A peculiar circuit used by several Dutch stations. The grid circuit is connected to the positive high tension, a high value leak being employed. Note the system of modulation.

it is very quiet in the air at this time it is possible to work with several English stations which have 0·25 amp. and even less in aerial. In this manner he worked with English 5WR, who had 150-volt dry cells on the plate and 0·1 amp. in the aerial. The signals of this station were audible with one valve, though very bad fading impeded the reception. In the same manner 5LZ and others worked with oMX, several with 0·25 to 0·35 amp. in the aerial. The signals were received here very distinctly with one valve on the common honeycomb coil receiver.

Up to this moment we have had connections with thirty-two English transmitting stations and with four French stations, and we hope to double the number this winter.

Detecting the Presence of Oscillations.

When experimenting it is frequently desirable to find if oscillations are being generated in a circuit. Probably the most convenient method is the finger test. The finger is placed on the grid of the valve connected with the circuit to be examined and the nature of the click produced in the telephones indicates the condition of the circuit. The appended table summarising the results is due to J. H. Morecroft.

Nature of Circuit.	Finger on Grid.	Finger Removed.
No Grid Condenser, no Oscillations	No click.	No click.
,, ,, Oscillations	Click.	Click.
Grid Condenser, no Oscillations	Click.	Probable click.
,, ,, Oscillations	Click.	Click.

London's Experimental Ether.

By THE CRITIC.

FROM time to time notes have appeared in the popular wireless Press concerning the various amateur transmitting stations. These remarks have dealt in the main with stations working on 440 metres, special mention being made of various people's telephony and gramophone records. It is not surprising that many now taking up radio on hearing the usual 440 metres babble after broadcasting and reading such notes as I have mentioned, say that all this amateur transmission is all very well and interesting to those concerned, but what good does it do to anybody? Music can be transmitted far better than they do it, and they appear to spend their time asking "How do I come in now?" Unfortunately this is quite true. There is undoubtedly a large number of transmitting stations now working who do no real experimental work of any value, and just fill the overcrowded ether with ghastly reproductions of ancient and hoary gramophone records. But, on the other hand, there are quite a number of experimenters carrying out tests of real scientific value on the shorter wavelengths, from 150 to 200 metres.

In these notes I propose to mention a few of those who can be picked up very often in the evenings. These examples will show that there are some who are justified in having licences, and, perhaps, it may tempt some of the 440-workers to descend to the "QRM-less" region of 200 metres. Incidentally, it may be mentioned that 200-metres work can be carried out during broadcasting hours without interference to any "receiver" in the vicinity worthy of the name.

Possibly the best example of what a real experimenter can do is 2OS. His signals are not overstrong, as he is 25 miles out, but I heard him say that his transmitter was putting ·02 amp. into the aerial when he was not speaking and ·8 amp. on speech. This in itself is excellent "quiescent aerial" work, and more especially when the fine speech quality is noticed, but his transmitting valves cost 3s. 6d. each—he uses ordinary "Osglim" neon tubes throughout! This is surely an achievement. 2OD and 2OS sometimes work excellent duplex also; the speech of the former station is of marvellous quality and purity. His C.W. also seems to pierce a long way—he can be heard working 8AB of Nice, over 600 miles away, quite often.

2NM, 2KF, and 2DF, among others, can also be heard late at night working over very long distances, and doing very interesting work. 2SH's well-known 500-cycle A.C. disappeared recently, and soon after a weak voice was heard using a couple of receiving valves. Rather a come-down in the world. I heard him working over 25 miles not long ago, using a single R valve, 4 volts on filament, 240 on plate, and ·4 amp. in a 4-ft. indoor frame aerial. Signals were reported R4! 5GF also can be heard on a loop sometimes. He works to Epsom on it quite often. 2VW is one who never has the same things up two days running—he seems to be doing "indoor" work at present. Last time I heard him he was complaining bitterly about Mullard's glass. He said he was trying some special stunts with filamentless valves, and had been round to 2SH pinching burnt-out bottles from him. When he tried them he found Mullard's glass wouldn't mix well with what he wanted to seal on to it! He'd better write and ask them to change their glass! 2TA, who gets such good aerial current and ranges, using only 240 volts on the plates of a battery of valves in parallel (·9 on 10 watts), "packed up" his counterpoise the other day, as the household couldn't walk across the garden. Last time he was on he complained bitterly that since this his aerial resistance had risen to four times its previous value. He gave it up and went to Switzerland to look for the lost amps.!

There are, of course, many other stations working on the short waves doing really interesting true experimental work, and I recommend anyone who has not done so to get his receiver down to short waves for something really interesting to listen to.

Radio Station 2TA.

Amateur transmission stations usually show a marked dissimilarity in circuits, systems, and apparatus employed. This is due no doubt to the fact that many experimenters build their sets as a result of their own investigations. In order that experimenters may become acquainted with the work of others, details of stations embodying novel methods and circuits would be welcomed in these pages.

THIS station is situated on the top of Highgate Hill in the north of London. The antenna system consists of a twin flat-top cage aerial and a counterpoise. The cages of the aerial are of six wires, each on 1-ft. 6-in. hoops, and are supported on spreaders 11 ft. apart. The height of the aerial is 50 ft. at the distant end (a tree) and 60 ft. at the lead-in. The counterpoise consists of twelve wires in fan formation underneath the aerial, with a caged lead-in to the house. A general view of the receiver and transmitter is shown in Fig. 1. The receiver consists of one H.F. detector and one L.F., mounted on panels, with separate condenser and tuner panels. Although mounted up in a box this receiver can be dismantled in quite a short time, each unit taking apart, so that variations of circuit can easily be made.

A better view of the transmitter can be seen in Fig. 2. This transmitter is essentially of the experimental type, and many circuits were tried before the final one was adopted.

The circuit is a modification of the standard Colpitts, and is shown in Fig. 3. This circuit can be very strongly recommended, and is, in the opinion of the author, much the simplest and most efficient for 200-metre work. Only one tuning inductance is necessary, with three clips. The aerial ammeter (0—1·5 amps.) is mounted on the top of the

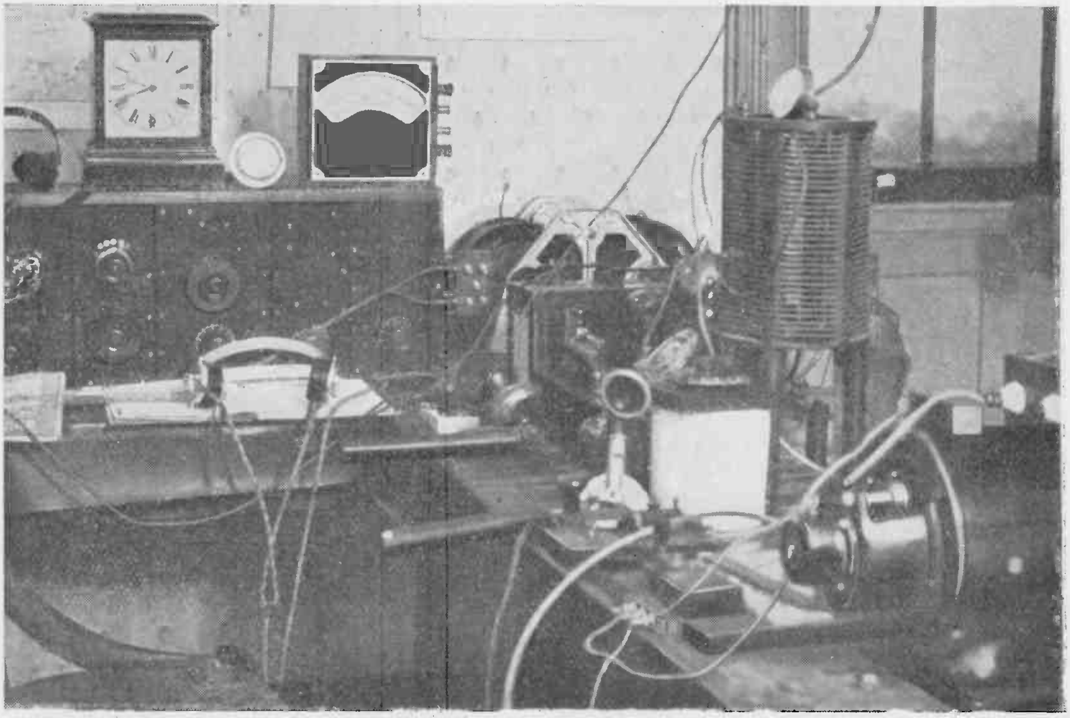


Fig. 1.—A general view of the receiver and transmitter. The receiver, although built on the panel system, can be quickly dismantled for experimental purposes.

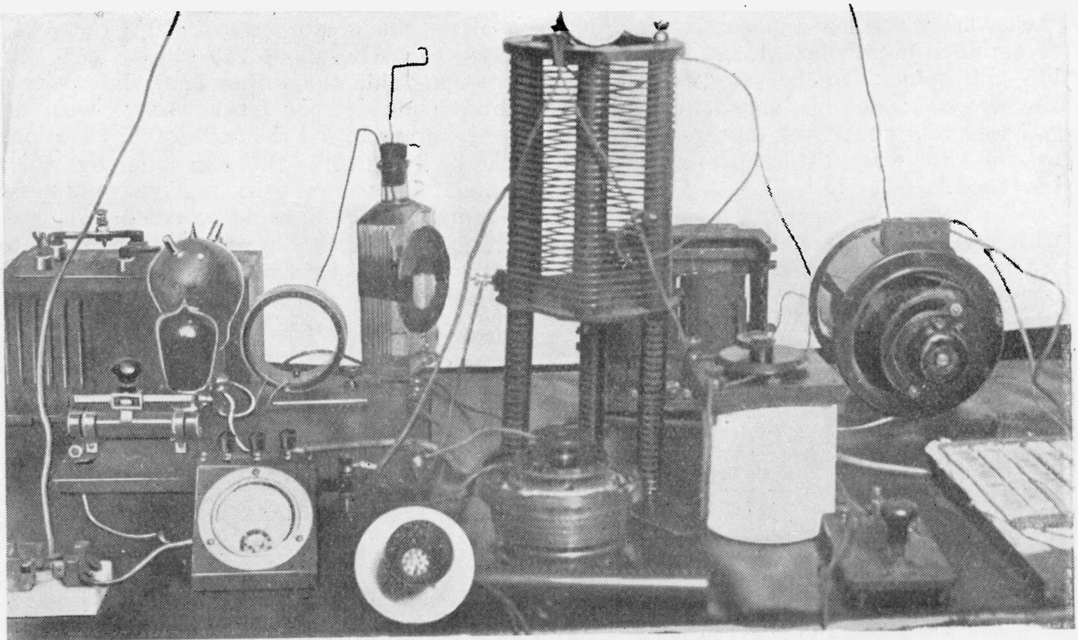


Fig. 2.—It will be seen that the transmitter is essentially of the experimental type. Note the water grid leak with the choke tied to the side of the bottle.

helix, the antenna clip being the centre one. At the back may be seen the anode-feed radio-frequency choke and the variable water grid-leak. One important point in this circuit is the inclusion of an H.F. choke in the grid-leak circuit. This makes an enormous difference to the efficiency of the circuit. Modulation is obtained either by the inclusion of a microphone transformer in series with the grid-leak, or by the ordinary choke-control method.

Two methods of H.T. supply are available either from the 240 volt D.C. mains or from a rotary converter, seen on the right in Fig. 2. Since the photo was taken, an H.T. step up transformer has been installed for using a 48 jar chemical rectifier, a very satisfactory D.C. supply at 1,500 volts has been obtained.

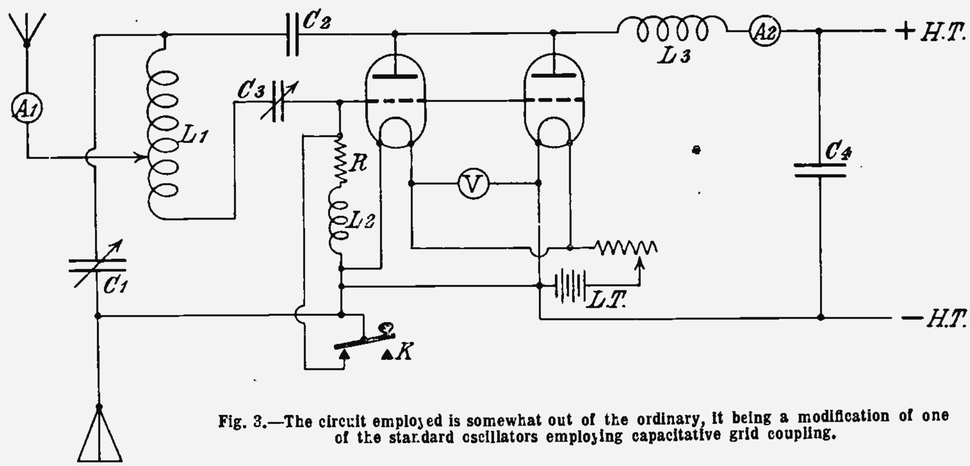


Fig. 3.—The circuit employed is somewhat out of the ordinary, it being a modification of one of the standard oscillators employing capacitative grid coupling.

This method is not always used, as a high H.T. voltage and low anode circuit are found to be much more efficient. A filter system has, of course, to be used for phone. Keying is done by short-circuiting the grid-leak and choke, as this method seems to cause the least disturbance in the neighbourhood.

As regards the efficiency of this station with slightly lower aerial, the best radiation obtained has been ·9 amp. with 10 watts input. This was done using a French transmitting valve and a Mullard "A" valve in parallel, with 240 D.C. on the plates. The greatest transmitting range has been to oMX, about 280 miles. On the receiving side the author finds three valves quite sufficient for most work; with an acceptor circuit all the broadcasting stations can be heard while 2LO is in action five miles away. For distant work an Armstrong super heterodyne set is being installed. In conclusion, the author would much appreciate cards and reports from any station hearing either C.W. or speech from this station.

H. ANDREWES.

The Month's "DX."

Recorded by HUGH N. RYAN (5BV).

The increasing efficiency of amateur transmitters and receivers is resulting in the creation of many new long-distance records which are undoubtedly worthy of mention. It is proposed to record month by month work in this direcion, and the Editor will be pleased to receive details for inclusion in these pages.

MANY of the keenest and most able of our transmitting experimenters devote their efforts entirely to DX work, or the covering of the greatest possible distances with their transmitters. There are many others who, while spending some of their time on shorter-range telephony and kindred work, also carry out DX when they consider conditions to be favourable. It is, I think, generally felt by both classes of experimenter that DX has not received the attention it deserves in radio periodicals. One hears a great deal about the telephony men whose gramophone records are heard in remote parts of our islands. Most of us are kept fully aware of our musical neighbours who strike up with their ± ten watts, without previously listening in, pump out a series of records, and switch off without subsequently listening in for the report we should so much like to give them.

But the DX station does his work chiefly in the small hours, and is generally an obscure sort of individual. The worst of it is that he is generally despised by the lordly telephony men, who regard him as a reactionary who is still dabbling with the departing relics of an obsolete system. Some of our newest telephony stations are even displaying a lamentable difficulty in understanding the "obsolete" code used.

As yet, the DX man has only come into his own for a brief period yearly, when he burns the midnight amps in his efforts to receive Americans on the fewest possible valves, and the gramophone men wonder how he does it.

But the best DX stations are working all the year, and these notes are an attempt to chronicle, month by month, the results they are obtaining.

At present, very little European DX is in progress. Everybody seems to be spending the day-time in building that transmitter which the Yanks simply can't help hearing, and the night in teaching the receiver to catch the Yanks' replies. One or two stations are already making their initial attempts to get across. The best I have heard yet is 2JF, who seems to be in the fore of most good things in DX. 2KW, a confirmed optimist, has been heard to call at least one Yank with 0.1 in the aerial. The London contingent appears to consist, so far, of 5NN, 2SZ, 2SH and 5BV. I am afraid that none of the latter is in form yet, judging from the reports I have received from the North. Quite a number of stations have started work on the receiving side. The two most striking features of reception so far are the great number of Americans who are received considering the time of year, and the great number of stations who are confining their attentions to single-valve receivers. 5 NN has been doing very well with a Reinartz. 2ZS of Liverpool tells me that he has logged about 70 Americans this month on one valve. By the way, 2ZS's signals come in remarkably well in London considering his aerial current is only 0.12. My own log is about 35 so far this season, on one valve. Our old American friends of last year seem conspicuous by their absence. 2FP and 1BCG are very strong, as usual, and I have had one report of 2EL, but what has happened to all last year's favourites, 1XM, 1BD1, 2BML, and 8AQO? Has anyone heard them? I think that very few of the best Americans are working at present, as although we hear so many American amateurs, we seem to hear a different batch every time. With the exception of 2FP and 4FT, I have never heard any of them on two different nights. Perhaps the best of them are giving their transmitters a rest while they are busy improving their reception. They certainly were not at all pleased with their results last year, and intend doing much better this time. We hear a lot of complaints from our men that we can never get over while the Americans use such inefficient receivers. There is no need to be so pessimistic. I cannot believe that there are really no first-class receivers over there. Our transmission leaves much to be desired at present, and it is up to us to improve it.

You have no doubt noticed how very quiet the French stations are now. It seems likely that they are preparing their transmitters for the winter's work. They are allowed 100 watts in the aerial, and, as very few of them use anything like this power, they have plenty of room for increasing this factor in their transmissions. 8AB will probably use the same power as last year. Certainly he is strong enough to carry anywhere. 8AQ tells me that he is installing a 350 cycle alternator to replace his present 50 cycle supply. He hopes to increase his power considerably, and also to improve his note. Dr. Corret of 8AE and 8AW is using notepaper headed "Comité des essais transatlantiques." which is a good sign, though I do not know quite what he proposes to do. 8BV seems very keen on American work. 2ZS has been heard loudly on one valve by 8BF, when using two watts. There is no doubt about the efficiency of some of the low-power stations in the North.

I do not know what the Dutch stations are doing this year, but the strength of PCII has greatly increased recently; I believe he has about 6 amps. in the aerial.

Those who stay up in the small hours have probably noticed how well the American broadcasting stations are coming in now. WGY and KDKA are exceptionally good, and on a good night WGY is comfortably readable on one valve. 5NN has been getting good loud-speaker results on three valves.

This month's notes have been necessarily confined to a few stations, as only a few are working DX at present. During the coming month, given favourable weather, things should become much more lively. I try to keep in touch with all that is happening in DX, but it is impossible to hear everything. This may perhaps be a blessing in disguise at times, but if any stations get any very good results on DX transmission or reception, we shall be very glad to hear about them. In America they publish a monthly list, known as the "Brass Pounders League," of the stations who have handled the most messages during the month. Fortunately message-passing does not enter our work, but it would be interesting to know who receives the most American stations each month. The best log I have heard of this month is 70 different stations, received by 2ZS. This record will, we hope, be beaten many times in the coming month, and may it be on single valve sets.

A Primary Cell H.T. Battery.

BY N. K. JACKSON.

Experimenters are apt to overlook the necessity for an anode battery which is capable of supplying a considerable discharge current for many hours without tending to polarise. Multi-valve receivers employing power amplifiers soon exhaust the conventional high-tension battery, and one very practical solution of the difficulty is found in the small Leclanché cell. Below, the author has developed the necessary details for a suitable battery for general purposes.

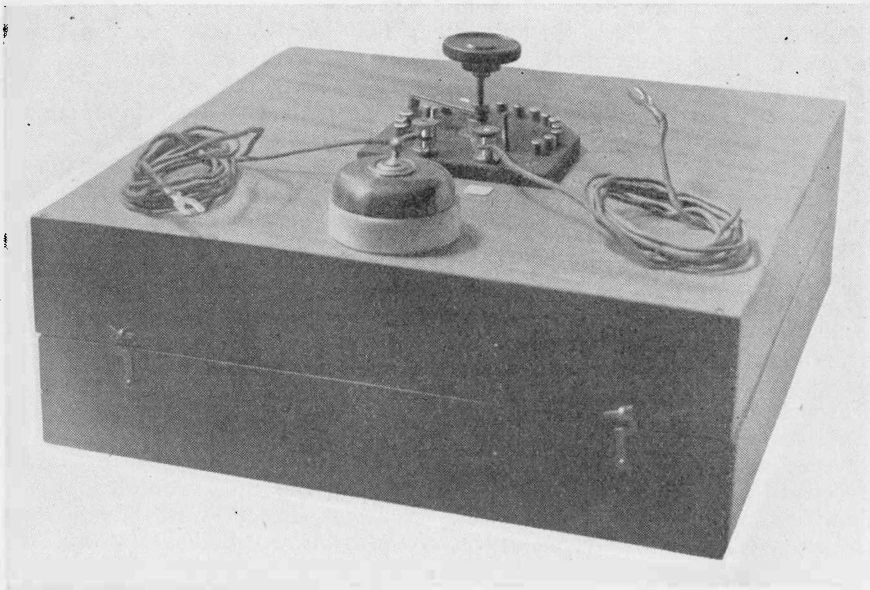
THE problem of the maintenance of the high-tension battery is one which every radio enthusiast sooner or later comes up against; one hears continuous complaints of trouble experienced, and of frequent need for new batteries, or of the considerable drop in voltage after use for a quite short time.

With the idea of solving this problem the writer constructed his H.T. battery from primary cells—in this case, the small sac Leclanché cells now on the market, as shown in Fig. 1, and these seem to give excellent service. As will be seen from the figure, these cells consist of a small glass jar, a zinc plate with connecting wire, and a positive sac element, and the top is sealed with a disc of cork-like substance; they are charged by filling with a solution of sal-ammoniac and water.

It will be seen from the photographs and drawings that the cells are arranged in a flat box, with the switches, terminals, and leads mounted on the lid.

The arrangement of the cells was such as to give 12 volts at each "live" stud of the rotary switch, with a total voltage of 96.

As each cell is assumed to give 1·5 volts, this means a total of 64 cells, which are all connected in series, *i.e.*, negative to positive, right through the whole 64 cells, and tappings were taken off and connected to one of the studs of switch at every eight cells, so giving 12 volts at each tapping.



A general view of a 96-volt battery capable of delivering several milli-amps. for long periods without voltage drop.

Of course, any number of cells may be used to total the voltage required.

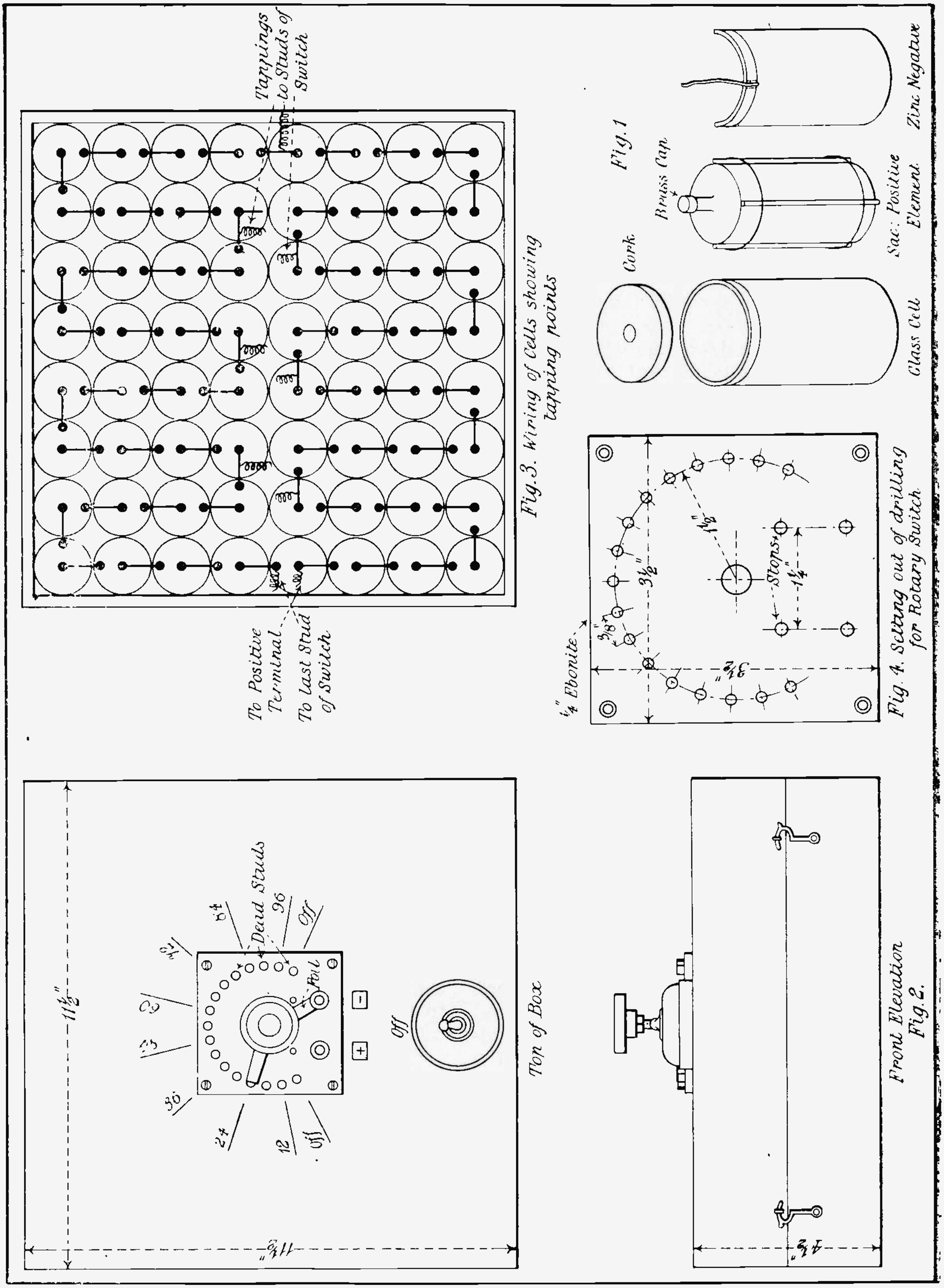


Fig. 1

Fig. 2. Front Elevation

Fig. 3. Wiring of Cells showing tapping points

Fig. 4. Setting out of drilling for Rotary Switch

A tumbler switch was put in the positive lead to enable the battery to be switched off without altering the position of the rotary switch.

The various voltages can be marked on the lid in black ink and varnished.

The box was constructed of ½" mahogany to the dimensions given in Fig. 2, hinges and hooks and eyes for fastening being fitted, and the whole varnished or polished; a hole was cut in the lid to clear all the studs and terminals in the rotary switch, which was mounted on ¼" ebonite, and was made up from standard parts, consisting of switch arm and knob and contact studs, a point to be remembered being that between every "live" stud to which a tapping from cells is connected, a "dead" stud must be put in.

The ¼" ebonite is to be dressed up square on edges and to the dimensions given in Fig. 4, and set out and drilled for studs, terminals, switch arm spindle, and fastening screws.

The switch arm should move smoothly over the whole of the studs; see that these are all of the same height, as they sometimes vary.

A stop-pin is screwed in at each end of the travel of switch, and a piece of brass foil is used under the switch arm to connect between it and the negative terminal.

The complete switch is now to be screwed down in opening in lid, with brass countersunk screws.

A tumbler switch is screwed to lid of the box as shown, and a lead taken from the underside of the positive terminal, and connected to the switch, and from the switch back to the positive element at starting cell in the battery.

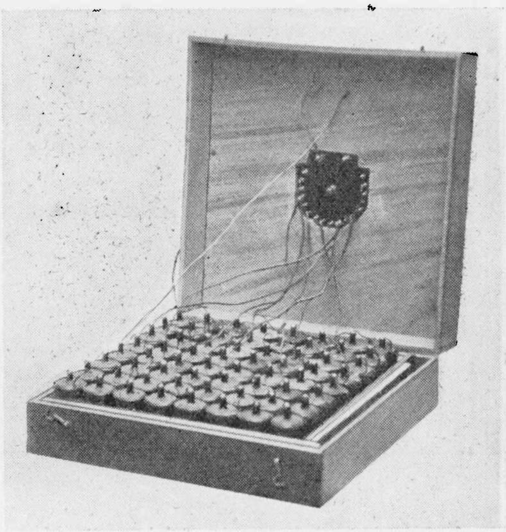
Two leads are made up of single flex, for connection to the radio set, and will be seen coiled on the lid of box in the photograph.

Before fitting cells into the containing box they are to be filled with sal ammoniac and water in the proportion of 4 ozs. of sal-ammoniac to 1 pint of water; allow the sediment to settle after mixing the solution.

Let the sac element stand in the solution in glass cell without cork or zinc, for eight hours, then carefully insert zinc element, which is in the form of a bent plate, and put in the cork, which has a hole in the centre through which protrudes the end of the sac element, nipping the connecting wire from zinc between the cork and glass jar.

Carefully wipe away any spilt solution, and seal the tops of the cells with hot paraffin wax by means of a camel-hair brush.

Scrape the ends of connecting wire from the zincs of all cells which are coated with black enamel, and clean and tin the brass caps of positives, ready for soldering.



The internal arrangement of the battery facilitates easy inspection and permits any cell to be examined individually.

The cells may now be assembled in the box and connected in series, as shown at Fig. 3.

Solder each connecting wire from zinc (negative) to the brass cap of next positive element, in the direction shown in Fig. 3; this is to be continued right through the whole of the cells, and will leave one positive element and one negative element unconnected.

The positive is to be connected to the tumbler switch as before mentioned, and so to the positive terminal, the negative being connected to the last stud of rotary switch.

For tappings single flex was used, stripped of its outer silk covering, leaving the rubber insulation intact, the two ends being bared and soldered to stud and tapping point of battery respectively.

The construction of the battery has proved time well spent, and can be confidently recommended to anyone who has had trouble with the ordinary dry cell type of H.T. battery.

The Patent Aspect of Experimental Work.

When the experimenter invents a new circuit or develops a new principle, his first thought is to protect the idea, but he is very frequently at a loss to know how best to approach the subject. Further, it may not always be desirable to patent an idea, and the pros and cons and methods of procedure are carefully discussed below.

WHEN one spends a good deal of time experimenting one is apt to get ideas and inspirations about things which might be of commercial value if only they were pursued on the right lines. Discoveries and inventions not only attend well-organised experiments made with some definite end in view, but are frequently the result of dabbling with things at random. Moreover, ideas have a disconcerting way of occurring unexpectedly at all sorts of odd times and places, such as when one is in bed, on a 'bus, or even in one's bath.

No matter how trivial an invention may seem, it may be worth patenting, provided that :—(1) It really will work ; (2) that it is new and not anticipated by someone else. Large companies with plenty of capital patent all their ideas and most of those which occur to their employees. With the individual inventor acting on his own behalf, a patent is more or less of a speculation. It costs him about £5 to get Letters of Patent granted him for his invention, and if he makes use of the services of a patent agent there is also the agent's fee to consider. He may be able to sell the rights of working the invention for a very profitable figure, or license the rights of working on a royalty basis, or the invention may prove an unsaleable "dud." A valid patent gives the owner or owners a monopoly of the invention concerned throughout this country for a period of 16 years, provided that the requisite fees are paid at stipulated periods. After the expiration of this period the invention becomes public property and anybody may work it commercially for profit. Thus, after 1930 most of the basic thermionic valve patents will have expired, and anyone will be able to manufacture valves at competitive prices without being prevented from doing so.

Anyone may use a patented invention experimentally for the purpose of improving or modifying the invention where no profit is involved.

The patent laws are principally intended to enable an inventor to derive the first commercial benefits of his invention, and to prevent the fruits of his own genius or labours being unfairly exploited by other parties. At the same time the legislation has the object of encouraging home industries and protecting the public interests. The rights which a patent confers are not intended to enable the patentee to withhold his invention from the market, or to market it at any exorbitant price he likes ; in a word, the patent laws do not comprise a profiteer's charter. If it is considered that a patentee is using his rights in a way contrary to the public interest, refuses to license rights of working to other parties, or demands unreasonable prices for such rights, then appeal may be made to the Comptroller at the Patent Office by any parties interested in the matter. This aspect of patent law seems frequently to be lost sight of by the public.

What can be Patented.

Any new method of manufacture, chemical process, modified mechanism, manner of working something or production of some effect is patentable, provided that it is of a concrete and not abstract nature. Written matter, sequences of words, music or artistic designs cannot be patented, but come under the respective headings of Copyright and Designs. The Patents Rules state that nothing which is contrary to law or morality can be patented. The latter aspect does not concern us here, as the highly moral nature of wireless is above question.

To be patentable an invention must be new, and the application for a patent must be made by "the first and true inventor," or if the application is made jointly by more than one person "the first and true inventor" must be one of the applicants. An invention cannot be patented once it has been :—

(1) Patented before;
(2) Sold or worked for profit;
(3) Exhibited at an exhibition recognised by the Board of Trade without notifying the Comptroller; or,
(4) Described in a foreign specification open to public inspection at the Patent Office or in a registered journal published in this country.

Thus, if you wish to patent an invention, keep as close as an oyster about it until you have filed a Provisional Application. If you do not want the trouble or expense of patenting your invention and do not want anybody else to patent it, submit a description of it to EXPERIMENTAL WIRELESS for publication.

The most valuable inventions are by no means always the most intricate ones, or ones involving much technical genius. A man may make a fortune out of a slight improvement in braces or contact studs, while the man who invents a 17-valve atmospheric eliminator may live and die obscure and poverty-stricken. Inventions dealing with improvements in details of manufacture which can only result from research or practical experience may be very paying if judiciously worked. Take, for example, the case of the American G.E.C.'s 1,000-kw. transmitting valve. The key to the construction of a valve to handle such enormous powers was the evolution of a satisfactory method of sealing metal to glass, thus making it possible to construct a valve with a metal envelope instead of a glass one. This copper-to-glass seal has probably done more for high-power wireless transmission than any other invention during the last three years, and has placed the thermionic valve on an equal footing as regards power with H.F. alternators, the arc and the timed spark.

Procedure for Obtaining a Patent.

If an inventor has not had any experience of patent work it is safest for him to act through a patent agent. This involves extra expense, of course, and if the inventor wishes to act for himself he will not find much difficulty in doing so if he pays careful attention to the Patent Rules.* The first thing he should get hold of is the pamphlet entitled "Instructions to Applicants," supplied gratis at the Patent Office on application. The officials at the Patent Office are always courteous and ready to assist by giving information when required.

It is not possible to give full details of procedure here, but the most important steps in obtaining a patent are indicated below.

Provisional Specification.

The applicant may file a Complete Specification straight away and obtain a full patent within a month or two, but this is not advisable and is seldom done. It is best to file a Provisional Specification first and draw up the Complete at leisure. In order to obtain a Provisional Patent a clear and concise description (the "Specification") of the principal involved in the invention must be written or typewritten in duplicate on foolscap-size paper (one side only), leaving a 1½-in. margin on the left-hand side of each page. Each of these descriptions must be accompanied by a Patent Form 2† filled up in the prescribed manner. The original MS. or typescript must also be accompanied by a Patent Form 1. Never pin a Patent Form 1 to a carbon copy by mistake, as this distresses the officials more than anything. Before the application can be filed the Patent Form 1 must be stamped at the Patent Office, and for this purpose the form, along with £1, must be taken to the Stamp Room and handed across the counter. The form is stamped and returned, but, of course they keep the £1. The stamped form, accompanied by the original and duplicate specifications, are now handed in at the Enquiries Department of the Patent Office, where a receipt is given bearing

*The prospective patentee will find all the information he is likely to want in the following publications on sale at the Patent Office, 25, Southampton Buildings, London, W.C.2:—"Patents and Designs Act, 1919," 3d., by post 4½d. "Patents Rules, 1920," 1s., by post 1s. 2d.; and also "Patents Simply Explained," Percival Marshall & Co., 10d. post free.

†Blank forms unstamped are supplied gratis on application at the Patent Office.

the date and number of the provisional application. A patent bears the date at which the first application was filed. All patent business at the Patent Office must be transacted between 10 a.m. and 4 p.m., so that it is no good trying to file an application before breakfast or after tea. If everything is in order the applicant will in due course (and certainly not before) receive a communication accepting his application. If the specification is returned for some error or omission to be rectified, the matter should be attended to at once and the papers returned to the Patent Office as soon as possible. The application will retain the original date of filing if no unreasonable delay is made.

A Provisional Patent protects the applicant for nine months in such a way that he can publish details of his invention, improve it, or work it for profit without sacrificing his chance of obtaining a full patent for it later. The provisional protection costs only £1, so that if the invention proves to be a failure the loss over patent expenses is not heavy. Articles manufactured under a Provisional Patent must not bear the word "Patent," but may be marked "Patent Pending" or "Patent Applied For." Damages or restraint for infringement cannot be obtained on the strength of a Provisional Patent, and even when full Letters of Patent have been granted no damages can be claimed for infringements which took place while the invention was covered only by a Provisional Patent. It is, therefore, to an inventor's advantage to file his Complete Specification as soon as possible after the Provisional, if his invention is proving marketable.

Complete Specification.

If the applicant started by filing a Provisional Specification he must file a "Complete Specification" within nine months of the first date of application, otherwise his application will be "deemed abandoned." The Complete Specification must contain a description of the invention involved, worded clearly and giving sufficient detail for anyone acquainted with the art to make or work it for himself. At the end of the Complete Specification definite claims must be made for the features of the invention which are maintained to be novel. These claims should be numbered and should be clear and concise. The subject matter of the Complete Specification should agree substantially with that of the Provisional, but it may be more detailed and reasonably extended. It is important to note that a Patent can only cover one invention. The Examiner often holds up an application on the grounds that it comprises two or more distinct inventions. Drawing should always accompany the Complete Specification where they are likely to make the description clearer. Details as to how these drawings should be prepared are given in the Patents Rules, 1920.

An original manuscript or typescript of the Complete Specification, along with the original formal drawings in black ink, must be accompanied by a Patent Form 3 duly filled in and stamped (£3 this time). This must also be accompanied by a duplicate copy of the Complete Specification and Drawings pinned to an unstamped Form 3; the lot is handed in at the Patent Office, as in the case of the Provisional Application. The Complete Specification, its copy and all sheets bearing drawings must bear the signature of the applicant; this applies to the Provisional Specification as well.

After the Complete Specification has been filed an official search is made to ascertain whether the invention claimed has been anticipated. If it has, the applicant is notified, and he will either have to modify his specification so as to clear the anticipation or he will have to abandon his application altogether. No search of this kind is made in the case of the Provisional Application, and the fact that an inventor gets his Provisional Specification accepted is no guarantee that his Complete Specification will be accepted. If the search reveals no anticipation the specification is accepted provided that all other details are in order. The complete specification must be accepted within 15 months of filing the original application, otherwise the Patent will lapse. When the Complete Specification has been accepted the applicant is notified, and in order to clinch the matter he has now to pay the Sealing Fee of £1 to have his patent "sealed." He does this by filling in a Patent Form 12, paying £1 at the Stamp Room to have it stamped and handing it in at the Enquiry Department at the Patent Office. In due course the applicant receives his sealed "Patent," which is an artistic and highly legal-looking document, with words on it and bearing the large red seal* of His Majesty's Patent Office; a free copy of the printed specification is also enclosed.

After the sealing fee has been paid there is nothing more to be paid until the fourth year from the date of the Patent, before the end of which year £5 must be paid for the continuance of the Patent during the fifth year. Before the end of the fifth year £6 must be paid for the sixth year, and so on until the fifteenth year, when £16 must be paid in respect of the sixteenth year. After the sixteenth year the Patent expires and the invention becomes public property. It will be seen, however, that for a total of £5 a patent can be held for four years, which is quite long enough to enable the patentee to decide whether his patent is worth preserving during the remaining twelve years.

Any Patent Forms, ready stamped, may be bought not only at the Patent Office, but also at several of the more important London Post Offices, and in the chief Post Offices in most of the large provincial towns. Stamped forms must be paid for in hard cash or currency notes at the Patent Office—they won't look at a cheque. It is highly important to pay all fees promptly within the periods set forth in the Patents Rules, 1920.

Patent work has many ramifications such as foreign applications, convention dates, extension fees, opposition to grants, etc., which only concern applicants under special circumstances and cannot be dealt with here.

*The seal is only made of red glazed paper, but it carries authority and is appended in the right spirit.

The Patent Office Library.

Attached to the Patent Office at 25, Southampton Buildings, is a large free library open to the public. There is a complete collection of Patent Specifications, and anyone can look up almost any invention ever patented; the public also has access to a very good collection of books and papers on every technical subject. The place is a gold-mine of information, but it is expressly stated that you must not use the place for word competitions, and you are not expected to eat your lunch there.

A great deal of useful information can be gained about wireless by the study of its patent history. The Patent Office Library reveals many interesting things that do not make their way into current publications.

The Patent Office has a Sale Branch where one may buy copies of Published Specifications, the weekly *Patent Journal*, Abridgements and other publications dealing with Patent matters.

E. H. R.

"Experimental Wireless" Laboratory.

Mention was made in our first issue of the laboratory and free calibration service, to which we refer our readers. Other details will be found elsewhere in this number.

Our readers will, no doubt, be interested to hear that our laboratory is nearing a state of completion, if such can be said of any laboratory. Perhaps we should say that our calibration department is complete, and we are pleased to note that readers are taking full advantage of the free calibration service. A very large number of instruments has been received during the month, and we have to apologise for the slight delay which was caused by the initial flood of condensers, wavemeters, inductances and resistances which found its way to our editorial offices during the first two weeks of October.

We have to thank several manufacturers for their co-operation in the equipment of the laboratory by the supply of scientific instruments on special terms. Amongst these are Messrs. Gambrell Brothers, Messrs. Radio Instruments, Ltd., Messrs. Chloride Electrical Storage Co., Ltd., and Messrs. The Dubilier Condenser Co., Ltd., who presented us with a set of standard condensers.

Valve Receivers on D.C. Mains.

By ALEXANDER J. GAYES, M.J.Inst.E. (*late Durham Bursar*).

Although multi-valve receivers have been used by experimenters for some years, most have been content to derive their power from secondary cells. It is surprising that little has been done to utilise existing domestic supplies, which is certainly a most economical method of working. We give below full details for working from direct current mains.

IT is not unusual to find the owner of a perfectly good receiving set is unable to use it to the extent he would wish for fear of the accumulators running down. In these days of continuous nightly broadcast programmes, the drain on the batteries becomes a serious setback, particularly in the case of multi-valve circuits, where the size and weight of the accumulators render their transportation to and from the charging depot a somewhat strenuous undertaking, unless one is fortunate enough to subscribe to one of the excellent battery service schemes now in operation. Even where a lighting supply is available, the expense of charging one's own accumulators, which are often from 60 to 120 ampere hours' capacity, is very considerable, unless a transformer-rectifier is provided in the case of an A.C. supply, or a motor-generator in the case of a D.C. supply, and these represent an appreciable capital investment.

The thought occurs, therefore, why should we not endeavour to utilise the lighting supply direct to operate our valves, and, to proceed further, why not let it also replace our H.T. batteries and our grid batteries? One might argue that if it were too expensive to use the lighting supply to charge accumulators, would it not also be too expensive to use it direct? The answer is in the negative. In fact, as this article will show, it is possible to operate a multi-valve circuit without any batteries whatever, and not add more than a fraction of a penny to the weekly electric light bill.

Filament Lighting.

To explain the principle, we will consider first an ordinary crystal set with single valve amplifier. For simplicity, assume that the ordinary dry cell H.T. battery will be retained, and the electric light used only for the filament lighting. If the crystal set has a separate primary and secondary tuning circuit, no complications arise, and all that is necessary is to connect an adaptor on a twin flexible lead in place of the accumulator and insert it between the contacts of the electric light switch after the cover has been removed. A suitable adaptor can readily be constructed on the lines indicated in the sketch (Fig. 1). Care should be taken to see that the switch in question controls only one, or at the most two, lamps, otherwise the valve might be burnt out by an excessive current, and, as a precautionary measure,

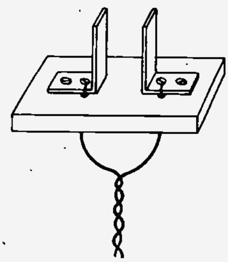


Fig. 1.—A suggested design of a clip for connection to an ordinary tumbler switch.

it is advisable to connect a filament resistance in parallel with the valve before attempting the experiment. In the case of an A.C. supply, a parallel resistance with a mid-point connection will be essential to prevent unpleasant humming noises; even with D.C. it is useful, as it is then possible to select the most effective point for the connection of the transformer return lead for the grid circuit. This point is made clear in the diagram (Fig. 3).

Electric lighting systems in various districts differ so much that it is difficult to outline the most suitable procedure in every case, but before making any experiments with valves on lighting circuits, it is an excellent plan to conduct a few tests to determine which side of the circuit, if either, is earthed, and also to test individual switches to determine whether they are on the "live" or "earth" side of the lamps. The sketch (Fig. 2) shows how a lamp, which should be of the correct voltage for the supply, may be used to test the switch contacts. A full light

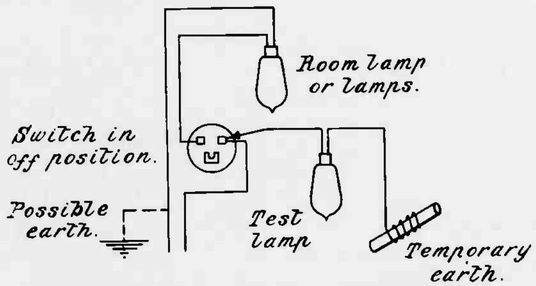


Fig. 2.—The earthed main should be found as indicated.

will indicate a live contact ; a dull light, a live contact through a lamp or lamps in the house—these will also glow dimly—and no light at all will indicate a more or less effective earth. Switches should *not* be on the earth side of a lighting circuit, but they frequently are, and for wireless purposes such switches offer distinct advantages, and every endeavour should be made to operate valve filaments from the "earthed" side of a circuit.

The amount of current required for a valve will depend upon its type, but unless it be of the dull emitter type, it will probably require 0.6 to 0.7 amperes, which is approximately the current passed by two 60-watt lamps on a 200-volt supply.

Particulars of the supply voltage and the size of the lamps (in watts) will, from a knowledge that *current* (amps.)=*total watts* ÷*supply voltage*, enable one to estimate the current which will pass through the valve filament when in series with the lamps at the switch contacts as previously explained. There is, of course, a slight voltage drop across the lamp terminals, but with the present day metal filament lamps, the insertion of the valve or valves makes no appreciable difference in the amount of light, hence the lamps can still be used for illuminating purposes.

The diagram (Fig. 3) shows a simple form of circuit which gives excellent results, and as the H.T. battery will last many months, it can be enclosed in the set, and the whole built up into a compact, self-contained unit which will practically banish all battery cares.

An extension of the idea is to add a second amplifier (Fig. 4), which, it will be observed, can readily be done by arranging the two valves in series, and incidentally, on a D.C. supply, this circuit arrangement permits the use of a negative bias on the grid of the second valve by taking advantage of the voltage drop across the first, but obviously the current must flow in the right direction, as indicated in the diagram. There is also no difficulty in providing a bias for the first valve, as all that is necessary is the addition of a non-inductive resistance (R1) of from 4 to 6 ohms in series with the negative lead feeding the first valve. Various refinements can be added, such as an adjustable resistance of a comparatively high value, bridging each filament so that each valve may be regulated

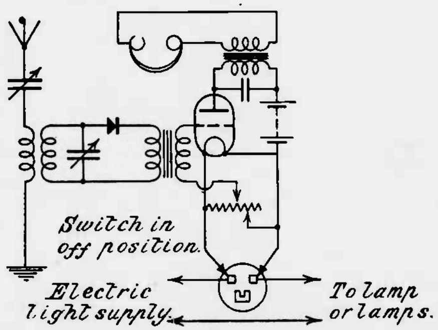


Fig. 3.—Here the filament is heated by D.C., and a resistance is connected in parallel, from which the correct grid bias is obtained.

independently, and, if desired, a noise eliminator consisting of inductances and condensers, could be added to the filament circuit should the greater magnification due to two valves bring commutator ripples, etc., into too great a prominence. The writer finds, however, that by exercising care in the selection of the particular points on the filament circuit at which tappings are taken for the secondary tunings and transformer returns, these extraneous noises can be reduced to a negligible quantity without complicated noise eliminators, although, when using the electric light supply in place of the

H.T. battery, a simple form of filter circuit or " noise killer " may be added to the plate circuit with distinct advantage.

Eliminating the H.T. Battery.

The preceding remarks are based on the use of a dry battery for supplying the anode potential, but there is no reason why the lighting supply should not be utilised for this purpose as well as for filament lighting. In the case of an A.C. supply, certain complications exist, and although for high power valves A.C. is very convenient, its use necessitates the introduction of additional rectifying valves and other apparatus, and, therefore, it is proposed now to confine our attention to D.C. working.

Before the electric light supply can be used for the anode or plate circuit, it is

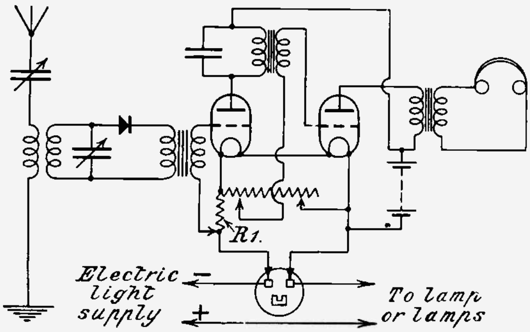


Fig. 4.—The grid bias for the first valve is obtained from a resistance R1 in series with the filament circuit.

essential to know which wire is positive. This can be detected by noting which of two strips of lead turn brown when inserted in acidulated water. If the wire on the brown strip (*i.e.*, the positive) happens to be on the live side of the circuit, all is straightforward, but should the positive be the " earthed " side, the valve filaments and associated apparatus must be at the plate voltage above " earth." Indirectly this is an advantage, as the capacity effects of one's hand on the adjustment of tuned anode circuits is thereby reduced, and further, the possibility of shocks from the receiving portion of the set is minimised. Care must be taken to avoid contacts between the aerial tuning circuit and the remaining portion of the set, although if the aerial condenser is inserted on the earthed side of the inductance, such contacts are of minor importance.

To obtain the desired voltage for the anode circuits, a potentiometer should be arranged by connecting two or three lamps in series. The current for these lamps will be of small magnitude, but it can be taken in such a way

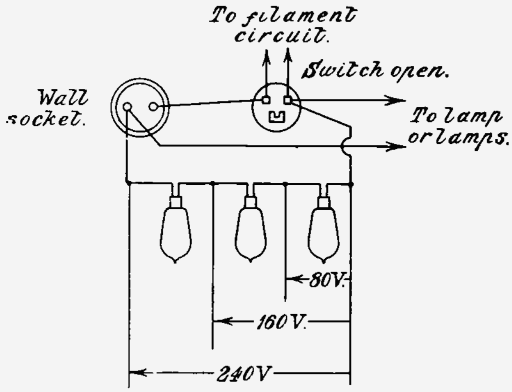


Fig. 5.—The anode voltage is taken from lamps arranged as a potentiometer.

as to augment the current flowing in the filament circuit (see Fig. 5). By altering the number of lamps in series or by using lamps of larger or smaller capacity, the amount of current taken by the potentiometer can be adjusted to any desired degree. This is an important feature, and can often be used to advantage to secure the fine adjustment so

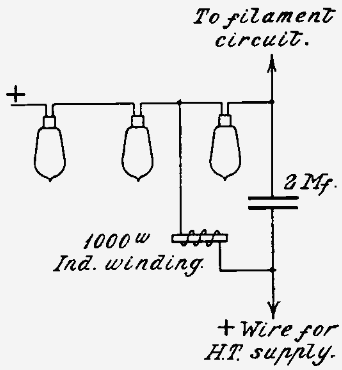


Fig. 6.—A filter circuit to reduce commutator ripple.

desirable in the filament circuit if the very best results are required.

The number of lamps necessary in the series circuit of the potentiometer will depend upon the plate voltage required, and upon the voltage of the supply. As an example, three lamps of equal capacity used on a 240-volt supply will enable one to tap off approximately 80, 160 or 240 volts as required. The latter value is hardly likely to be required, and, moreover, it would not be advisable to tap it in this manner. Modifications of this plan will suggest themselves whereby lamps of unequal capacity may be used in series to obtain intermediate voltages, remembering always that the larger the lamp (in watts) the lower the voltage across its terminals.

Having arranged the potentiometer circuit and selected the point at which the H.T. connection will be made, a simple form of "noise killer" should be constructed. This may consist of a highly inductive winding of about 1,000 ohms resistance with an iron core, such as an old telephone transformer or an old inter-valve transformer—so long as one winding is still undamaged—connected to a Mansbridge 2 mf. condenser, and arranged in the H.T. supply wire (see Fig. 6). This noise killer is not essential, and where loud speakers are used, possibly the slight hum usually present when the noise killer is absent will not prove objectionable, but it is a minor complication, and is certainly well worth fitting.

If desired, several tappings can be taken off the potentiometer, and the most suitable value selected for the H.T. voltage for each valve in the circuit, but unless valves of various types are used, this is hardly necessary, since by correctly adjusting the negative bias on the grid, as previously mentioned, it is possible to work each valve at its maximum efficiency. Those unacquainted with this method of control will be pleasantly surprised at the purity of tone obtainable, and, incidentally, the scheme of operating valves from lighting mains as put forward in this article gives extraordinary facilities for accurate grid adjustment.

A diagram (see Fig. 6) shows a three-valve circuit which gives very good results on a loud speaker. In this case the supply is 230 volts D.C., with the positive earthed. The circuit consists of the usual one-valve H.F. with tuned anode, crystal rectification, and two valves L.F., the unusual feature being, of course, the method of supplying the necessary current. The two lamps on the filament circuit are used for ordinary illumination, and the only additional current taken from the mains is the potentiometer current, which is considarably less than one-tenth of an ampere.

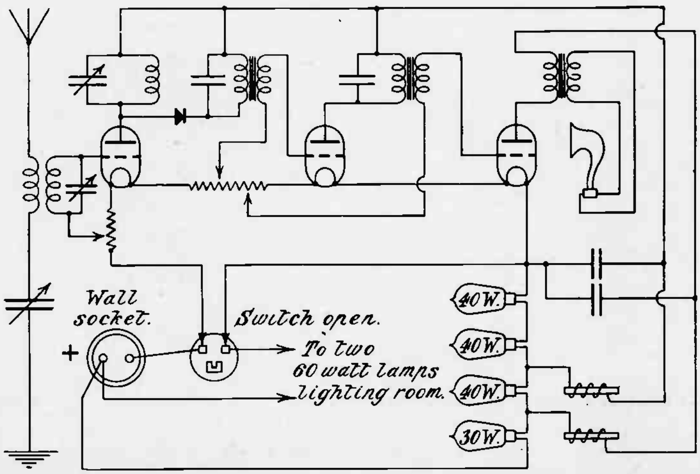


Fig. 7.—A complete loud speaker circuit operated entirely from direct current mains. The method of obtaining the correct grid biases should be noted. The H.T. is obtained from lamps arranged as a potentiometer, and passed through a smoothing circuit.

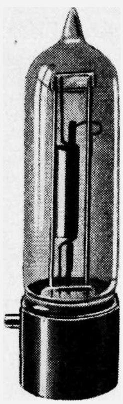
We should be obliged if holders of transmission licences, whose names do not appear in our "Radio Call Book," would kindly forward particulars of their call and location.

Dull Emitter Valves.

Owing to the great interest which has recently been aroused in dull emitter valves it seemed that some collective data would be of value to our readers. Accordingly we have tested some eight representative types and the summarised results will be found below, together with certain details of manufacture.

DURING the last eighteen months the number of dull emitter valves has gradually increased until at the present time it is possible to purchase some ten or eleven different types. The development of the dull emitter has been a more closely-guarded secret than any other manufacturing process connected with radio engineering, and consequently it is extremely difficult to set down any really extensive and useful data. Moreover, in dealing with dull emitters in general, it must be remembered that there are at least three different types of filaments, and here, again, it is very difficult to make comparative remarks.

In the ordinary triode the electronic emission is obtained by heating to incandescence a fine wire made of tungsten or similar metal. It has been found that, in order to secure a sufficiently dense emission, it is necessary to make the wire filament very bright, and this, of course, requires a considerable number of watts. The object of the dull emitter is to obtain the same filament emission with only a fraction of the energy previously required to render the ordinary filament sufficiently incandescent.



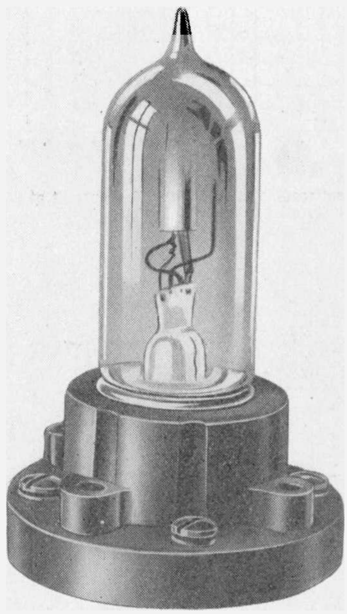


Fig. 1.—The Weco peanut, on the left, and the UV199, on the right, are the smallest dull emitters. It is understood that the latter type will shortly be placed on the English market under another name.

The ordinary thermionic valve was, therefore, taken as a basis of working, and experiments were conducted on various filaments. It was well known that certain oxides of the "earthy" elements would emit copious streams of electrons when heated only to a very low temperature, and consequently an attempt was made to utilise these. The obvious procedure was to incorporate some thorium compound, for example, into the ordinary filament, and then gently heat it

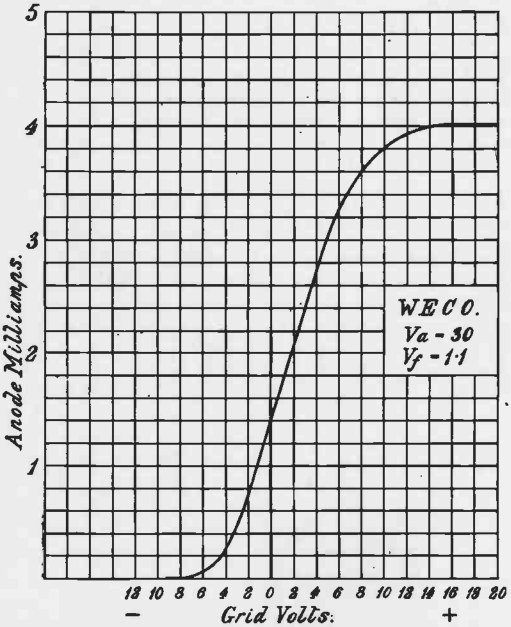


Fig. 2.—Although a spot reading gives a saturation current at 4 milliamps., it is not advisable to work above ·8.

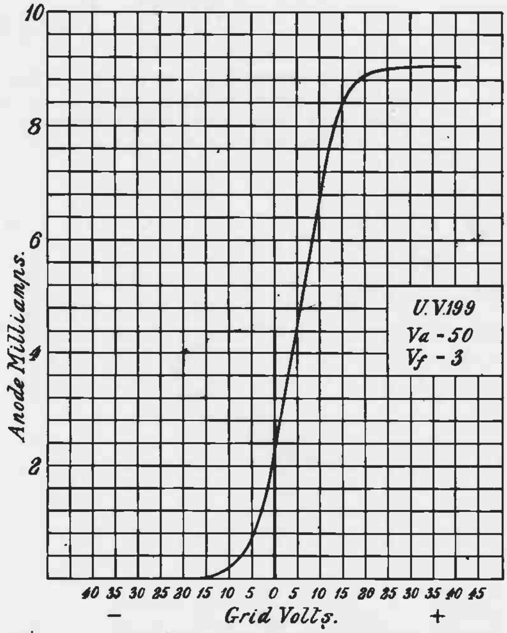


Fig. 3.—At zero grid volts a large current is obtained with an anode potential of 50 volts.

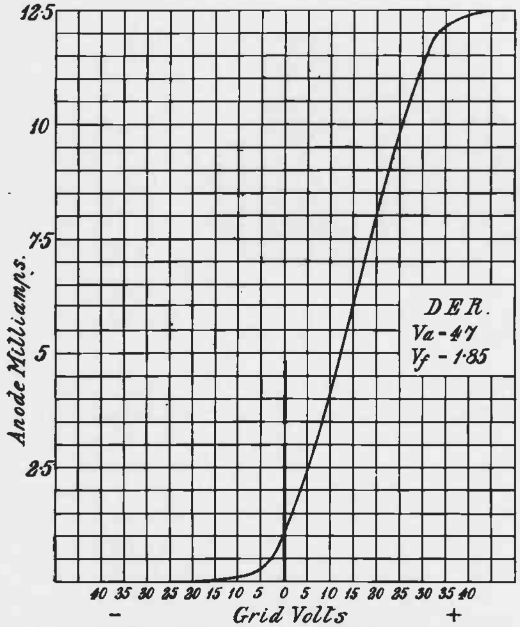


Fig. 4.—The DER is suitable for general purposes, and is comparable in performance with the R type.

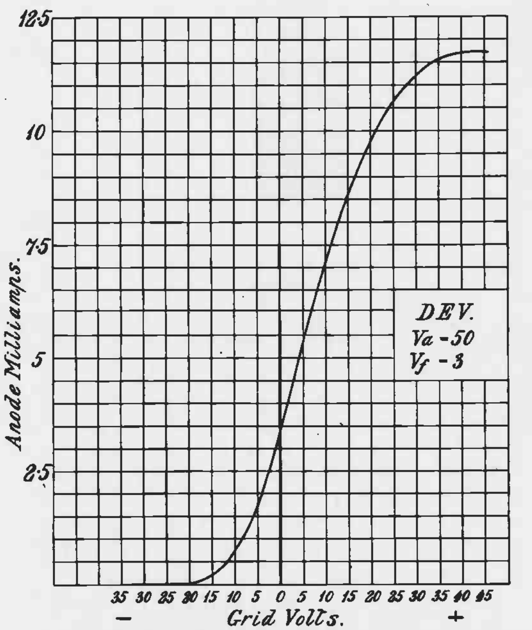


Fig. 5.—The DEV is specially suited for H.F. work, and has a very high input impedance.

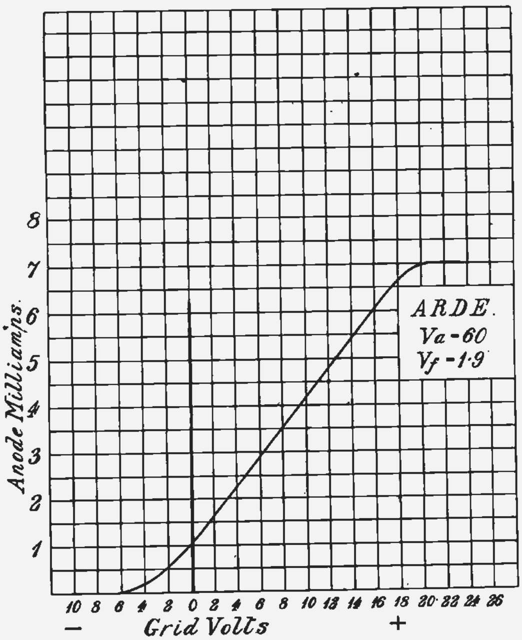


Fig. 6.—The ARDE is a useful general purpose valve, and shows good characteristics.

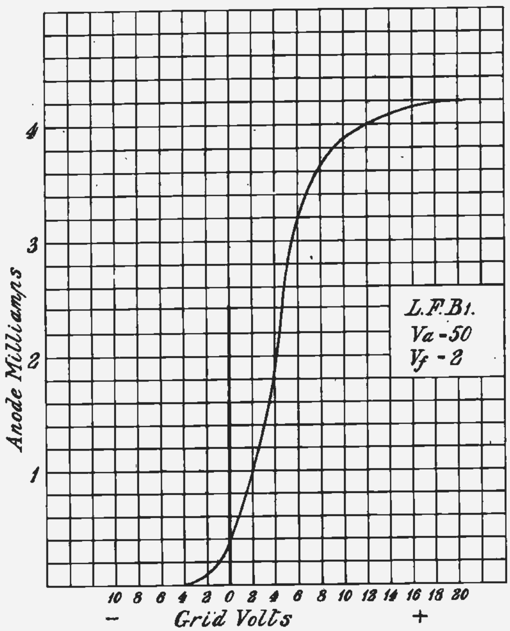


Fig. 7.—The L.F.B1 is a general purpose valve somewhat similar to the O.R.A.

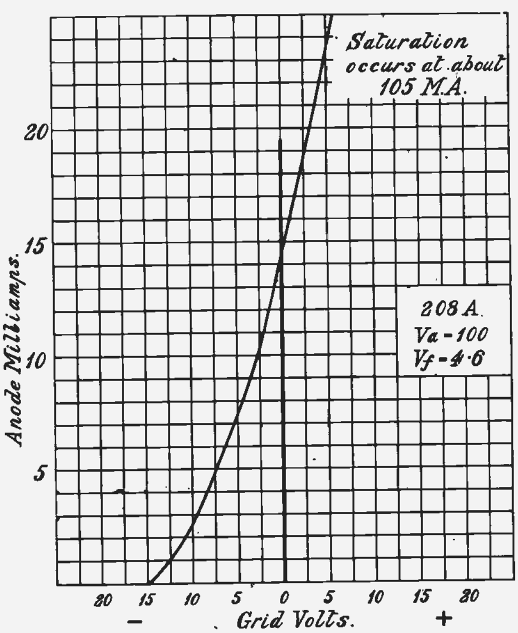


Fig. 8.—The 208A has a very large emissivity and is an excellent amplifier.

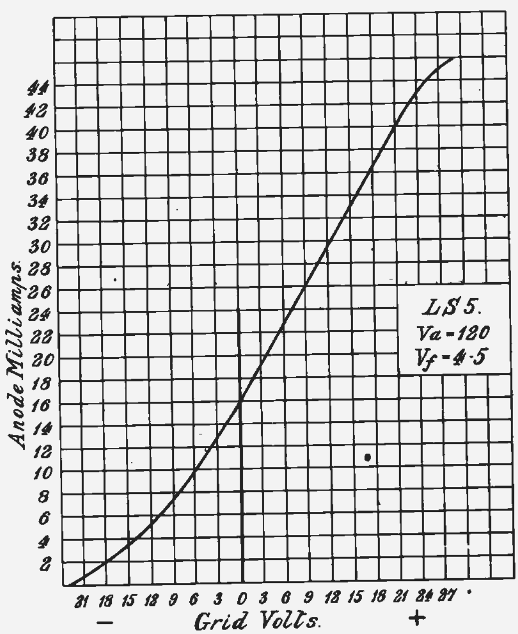


Fig. 9.—The low impedance of the LS5 at a low anode voltage makes it extremely useful.

until sufficient emission was obtained. This, of course, is a very fundamental and almost crude explanation of the principle involved, and considerable experimental work was necessary before the idea became practicable. Of this class of filament there are really two types, the coated platinum strip and the thoriated tungsten wire.

A filament of the latter type is used, for example, in the DER, and contains about 5 per cent. of thorium and thorium compounds. When it is heated to a low temperature a type of diffusion occurs, and it is believed that there is always a layer of pure thorium on the surface of the filament which has a very great emissivity. As the layer is very unstable every precaution has to be taken to remove any residual gases, and consequently a very high vacuum is employed. This feature is very beneficial, as it results in a much higher grid filament. As a further precaution, the inside of the tube of some thoriated filament valves is coated with a "getter" or a substance which combines more readily than the filament with contaminating gases.

There is always a danger of over-running a thoriated filament, which breaks up the thorium layer. Originally this defect was cured by heating the filament for about half an hour with the anode voltage cut off. A more recent method is to apply a high voltage for a short period to the filament, but it is certainly not a procedure to be recommended to the amateur. Should the anode become heated and residual gases released they are likely to attack the filament, which can be rectified by the above method. Partly on account of this, too high an anode voltage must be avoided unless, of course, a negative bias is applied to the grid. It is believed that the life of a valve of this description is of the order of 1,500 hours if carefully handled.

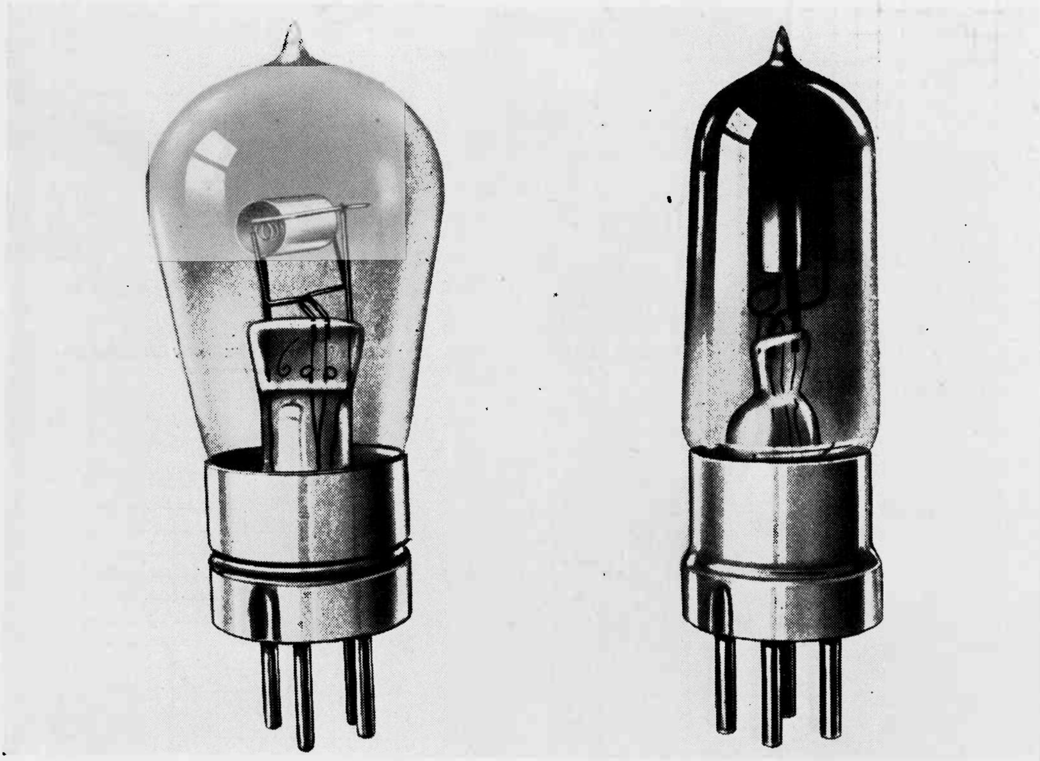


Fig. 10.—The DER is now being made with horizontally disposed electrodes, while the ARDE is a tubular valve with a vertical filament.

Mention has been made of another form of filament consisting of coated platinum, and this type is employed, for example, in the "Weco" peanut tube and the "208A" amplifier, of which mention is subsequently made. This type of filament probably has its origin in the Wehnelt lime-coated filament, which dates back to 1903. When the thermionic valve was applied to line tele-

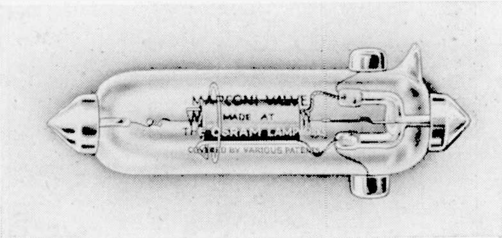


Fig. 11.—The DEV, in appearance, is almost identical with the V24.

phony, a valve requiring a low wattage, and capable of giving a large emission, was found necessary, and consequently experiments on the coated filament were recommenced. In

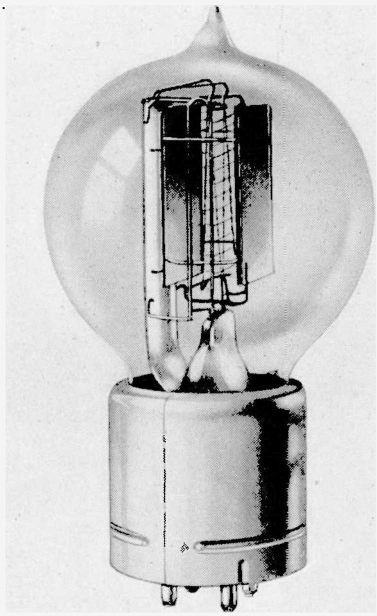


Fig. 12.—The 208A Amplifier is of very rigid construction, and has a substantial strip filament.

its present condition the filament is prepared from a platinum alloy drawn into a fine wire, which, in large valves, is rolled flat to give a greater surface. In the original Wehnelt filament the coating was not very tenacious, but the difficulty has been overcome by the following method of manufacture:—Barium and strontium oxides are each mixed with a "carrier" consisting of wax or resin, and are applied alternately to the filament in thin layers, and are then baked on to it. In addition, between the successive applications of oxides, the filament is flashed at a high temperature for a short interval, and finally, after about sixteen layers have been applied the filament is baked at a high temperature. The coating is so secure that it has to be scraped from the wire with a sharp knife before electrical connection can be made to the ends.

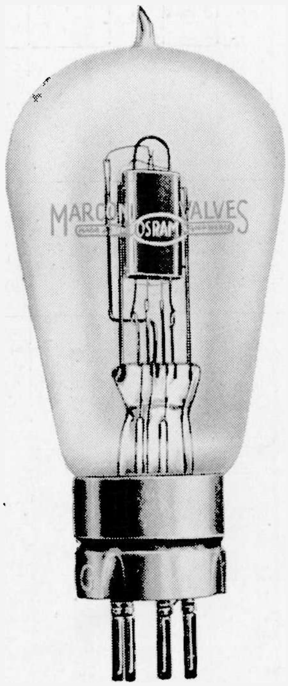


Fig. 13.—In the LS5 a flattened cylindrical anode and a carbonised filament are employed.

Originally, the core of the filament was a platinum-iridium alloy, but the platinum alloy employed at the present time has a greatly increased thermal efficiency. It was also found that by employing only barium oxide for the coating a greater thermionic activity was obtained, but the life of the filament was reduced.

Dull Emitter Valve Data.

Type of Valve.	U.V. 199.	W.E.C.O. (Peanut).	D.E.R.	D.E.V.	L.F.B.I.	A.R.D.E.	208A.	L.S.5.
1. Anode Potential in Volts ..	50	30	47	50	50	60	100	120
2. Filament Voltage	3	1·1	1·85	3	2	1·8	4·6	4·5
3. Filament Current in Amps...	0·06	0·25	0·4	0·245	·25	·3	1·28	·8
4. Saturation Current in Milli-amps.	9·2	4	12·5	11·75	4·3	7	105	50
5. Current at Zero Potential ..	2·52	1·4	1·2	6·5	·4	1·1	15	16
6. Grid Potential at Zero Current	—17·2	—8	—18·2	—22·8	—4	—6·4	—15	—24
7. Slope of Curve	5 : 2	1 : 0·6	5 : 1·2	5 : 1·5	2 : 0·5	4 : 1·25	2·5 : 3	3 : 3·2
8. Purpose of Valve	G.	G.	G.	H.F.	G.	G.	P.A.	P.A.
9. Filament	Thoriated	Coated	Thoriated	Carbonised	Thoriated	Thoriated	Coated	Carbonised
10. Manufacturer	G.E.C. of America	Western Electric	M.O. Valve Co.	M.O. Valve Co.	Mullard Valve Co.	Ediswan	Western Electric	M.O. Valve Co.

The above data has been derived from the curves accompanying these notes, and should be self-explanatory. Column 7 defining the slope, such as "5 : 2," indicates that, on the straight part of the curve, a charge of 5 grid volts produces a charge of 2 milliamps. in the anode circuit. The letters in Column 8, indicating purpose of the valve, are as follows:—G, General Purpose; H.F., H.F. Amplifier; P.A., Power Amplifier.

It must be remembered that the above data is merely representative, it having been obtained under suggested working conditions, but the various voltages are all capable of slight variation.

A valve containing a coated filament requires exhausting to a very high degree of vacuum, partly because a hard vacuum is required, and partly because it is impossible to obtain the same "clean up" effect as with a tungsten filament. Full emissivity is obtained at a temperature of about 1,000° C., but it is interesting to note that the valve will sometimes function at a black heat; that is, when the heated filament is invisible in a dark room.

Mention has also been made of the carbonised filament, which is used, for example, in the L.S.5 valve. Unfortunately, it is not possible to give any details of manufacture at the present time.

Having now considered the various filaments which are employed, brief mention will be made of the several types of dull emitter valves which are available to the experimenter. Owing to the dissimilarity of the various valves, and the purposes for which they are intended, it is not possible to make any comparisons, and accordingly a table of data has been prepared and grid volt anode current curves have been plotted under working conditions recommended by the makers. It will be noticed that all the curves have been taken to saturation by means of spot readings, but the small dull emitter should not be used at such high current densities. The zero grid volt ordinate is shown on each curve, and this should certainly be taken as the cut-off limit.

The Amateur Transmission Movement.

So much interest has been aroused in experimental circles by Radio Transmitting Societies, that we think our readers will welcome the following details of the various organisations and the objects it is hoped to achieve. We also present a summary of an excellent lecture delivered by Captain Round at the same meeting.

Transmitter and Relay Section of the Radio Society of Great Britain.

A NEW section of the Radio Society of Great Britain has been formed, to be known as the Transmitter and Relay Section. This new section has been planned because the British Wireless Relay League has been merged in the Radio Society of Great Britain. The objects of the Section are (1) to promote inter-communication between experimenters, and thus assist them to improve their apparatus; (2) to join hands with similar organisations overseas; (3) to investigate the quality of the transmissions in various directions at different hours; (4) to establish a collection of wavemeters and other useful apparatus for loan within the Section. In supporting the Section, the Radio Society will protect the principle of "Freedom for Experiment." All persons holding experimental licences are eligible for election to the new section in one or other of two classes, according to whether they are members of the Radio Society or an affiliated society, or not. We hope to publish further details when available.

Radio Transmitters' Society.

At a meeting of the above newly-formed Society, held on Wednesday, October 10, the chair was taken by Captain Ian Fraser.

In opening the proceedings, the Chairman said :—

Gentlemen, you will recall that at the inaugural meeting there was a very sharp division of opinion amongst members as to what should be the attitude of our Society with regard to the Radio Society of Great Britain. Some held that we should form no new society at all, but, rather, should allow the Radio Society to develop a Transmitters' Section. Others held that we should have nothing to do with the Radio Society. Finally, it was agreed that the matter should be left to be handled by your Committee, and that we should start by forming an independent society with a committee consisting of transmitters. Well, we have formed this Society, and, in spite of the division of feeling amongst our members, or our potential members, at one of our Committee meetings I suggested a conference with the Committee of the Radio Society. I arranged one, and went with our Secretary, Mr. Marcuse, and our Treasurer, Mr. Walker, to meet three of their members. We asked if some means could not be found whereby competition in the matter of seeking for membership might be avoided. One of the members of their party who met us was good enough to say that he appreciated our reasonable attitude, and we were convinced that no possible blame could be laid on our side if peace and harmony, and some joint arrangement, were not come to. However, I had a letter to-day from the Secretary of the Radio Society, in which it was stated that, in view of the similarity between our objects and the objects of their newly-formed Transmitters' Section, their Committee did not see their way to discuss further the question of affiliation or any other means of co-operation.

Now I should have thought, personally, that the fact that our aims and objects were similar was a reason for co-operation and not a reason against it. Be that as it may, we know that we, as a Society, are not wanted by the Radio Society. That may be good or bad—I reserve my opinion upon that—but we are at the parting of the ways. We are either to go on and endeavour to rally transmitting opinion around us, endeavour to lead transmitters to see that a Society exclusively concerned with their interests and not serving other communities as well, that a Society with a Committee of persons who have some knowledge of transmission, that a Society having a membership extending throughout the country, is a good thing for them ; or else we have to pack up. Even if we pack up to-morrow we have stirred matters up amongst transmitters, and we have led to great activity in another quarter, which will, I hope, produce good results.

However, it rests in your hands whether we die or not. Personally, I think we can render useful service, and when one considers that the Broadcasting Company, to serve its public properly, must extend its hours of working, when one knows that an extended range of wave-lengths is under consideration for application to their work, when one realises that we are extraordinarily scattered, and that we transmitters, as a whole, throughout the United Kingdom have not any Society apart from this one which is solely concerned with our interests, when transmitters, as a whole, have it pointed out to them that whatever committee at present exists representing, or aiming to represent, them has to serve other masters, whose interests are not always theirs, I think we ought to be able to make out a case to amateurs all over the country for joining us.

If it is felt that we should go on it will be the intention of the Committee immediately to send a letter to all amateurs whose names we have throughout the country to ask them to become members of our Society at an annual subscription of 5s. We intend to develop relaying work and long-distance transmissions. We hope, perhaps, to be able to serve the Broadcasting Company, should they require observations from different points widely scattered, by people who are competent to make those observations. We hope generally to render a service to the community, for if we do not, then we are bound to be closed down. I think it must be our aim to organise in such a way that we can demonstrate to the powers that be that we do render some service in regard to research, in regard to the fact that we were available, those of us who were in the movement before the war, and would be available again in any emergency if we were needed. We must point this out to them, and we must try and rally them round us and seek to get a sufficient membership of transmitters to carry on a flourishing Society. If your Committee feels that you are with them in that project we shall go ahead.

In the letter which we propose to send round it is our intention to enclose a form which we are going to ask amateurs to fill up, saying that they support the following resolution and letter. If you approve of these I think your Committee can take it that you approve of our actions up to the present, and our general plans for the future. (Hear, hear.)

A vote was then taken upon the resolution and the following letter, and they were unanimously passed.

RESOLVED that the following letter, which has been read to, and approved by, seventy-nine amateurs holding licences for the transmission of wireless telephony and/or telegraphy, present at a meeting of the Radio Transmitters' Society, held at 6.30 p.m. on the evening of Wednesday, October 10, 1923, at the London School of Economics, be despatched to H.M. Postmaster General, and that he be asked, in the name of the above-mentioned persons, to give it his consideration, and grant the request made therein.

To H.M. POSTMASTER-GENERAL :—

SIR,—On behalf of the Radio Transmitters' Society we have the honour to send you the resolution enclosed, and this letter, which is referred to therein.

You will be aware that the Radio Society of Great Britain have for some time past represented to you the views of the amateur movement, and that in the absence of any other organisation the views, opinions and claims of amateurs throughout the country have in the main been brought to your notice through this body.

We have now to inform you that the desire of a number of amateur transmitters to have a Society representing their special interests, and controlled by a committee of persons, themselves amateurs with practical experience in transmission work, has resulted, after two meetings, at each of which approximately 100 such persons were present, in the formation of "The Radio Transmitters' Society." A copy of the constitution approved by these persons at an inaugural meeting is enclosed for your information.

The members of our Society, and many other persons who have the requisite qualifications for membership, and who have intimated their approval of the Society, but who have not yet, owing to the fact that our organisation has only been in being for two or three weeks, become members, desire us to call your attention to the foregoing facts, and to ask you to give representatives of our committee an opportunity of interviewing your officers with a view to discussing with them the position of the amateur transmitter in general, and what steps, if any, can be taken to ensure the maximum of freedom for experimental work and the minimum of interference with broadcasting and other National services.

In particular we are desired to point out that we note with pleasure your decision to appoint a representative Board whose function it shall be to advise you upon all matters affecting Broadcasting in the United Kingdom, and that amongst the interests to be represented special mention is made of Radio Societies.

We venture to express the opinion that it is in the public interest that the amateur experimenter, properly controlled and licenced to utilise relatively low power for transmission work, should be encouraged in his research and experimental work, and that the best method of securing this without causing interference with or inconvenience to other interests is that our particular section of the amateur world should be represented upon your Advisory Board.

While we recognise that the number of persons holding transmitting licenses is a small one compared with those having various types of receiving licenses, we venture to submit that our qualifications for serious experimental work are, in virtue of the severe tests you have rightly put upon us before granting our licences, of such a nature as to make our contribution to the progress of wireless technique worthy of special consideration.

Further, we hold by your permission the power of interfering with other transmissions to a more or less extent, and we submit that it is in the public interest that we should be placed in a position in which proper representation of our interests can lead to co-operation and mutual understanding.

We enclose a list of our committee and officers, and would venture to call your attention to the fact that the majority are experimenters of long standing.

We might add that a copy of this letter and resolution is being sent to all transmitting amateurs in the United Kingdom who were not present at the meeting referred to, and that we have every expectation that the response we shall receive will be of such a nature as to indicate that in the important matters referred to in this letter we have a substantial backing.—Yours faithfully,

(Signed) P. P. ECKERSLEY.
IAN FRASER.

Captain Round's Lecture.

The Chairman then introduced Captain Round, chief of the Research Department of the Marconi Wireless Telegraph Co., Ltd., and said that it was a great honour for an audience of amateur transmitters to have a lecture by one who was probably the most eminent radio-engineer in Europe.

The lecturer opened with a description of some observations during experiments on a duplex wireless telephone system between England and Holland. It was noted that, under certain conditions, the speech received was considerably distorted ; and in further experiments in reception over land from one of the stations the speech was so distorted as to be unintelligible. As the wave-length was 100 metres, and the effect had not been noticed on longer waves, it was thought that the shorter wave-length had some influence. The effect was more noticeable with a frame aerial receiver than with a vertical aerial. The phenomenon was chiefly observable at night, and this has been called a night effect.

The lecturer then turned to the consideration of night effect and broadcasting. He had observed slight night effect from 2LO at Cheltenham in January of last year, using a frame aerial. Not many other complaints of night effect, as distinct from fading, had been reported by listeners. The equipment at 2LO last winter consisted of a master oscillator driving a main valve, so that carrier wave-length change was an impossibility.

In the summer of this year, for certain reasons, a simple self-oscillating system was resorted to, which, of course, would allow wave-length change due to any minute changes in the constants of the high-frequency circuits.

Lately a great many complaints had been received from listeners that the quality of 2LO *at a distance*, particularly the Norfolk area, was very poor, and not to be compared with either the quality near to, or the quality of other broadcast stations possessing a master oscillator. The lecturer himself, by imitating the conditions of reception at a distance, had observed the poor quality, and had, furthermore, shown that the point of tune chosen on the receiver influenced the quality—an effect observable with grid control, which is a type of control relying upon wave-length change.

Captain Round went on to point out that there was evidence that the deep modulation at present in use at 2LO might, with the high-frequency circuits in use, exaggerate the wave-length change.

Combining the well-known theories and experiments of T. L. Eckersley on the night effects produced by the Heaviside layer, the duplex experiments, and the recent circuit experiments at 2LO, the lecturer promulgated a newer theory to show that this speech distortion at night was due to carrier wave-length modulation being connected with amplitude modulation by the interference bands existing over the earth's surface at night.

The solution of the problem will lie in designing a method of control that will not tend to change the wave-length—the master oscillator is no real cure because bad quality will be produced near by, certainly by a system which is trying to change wave-length but cannot.

Very slight changes day by day are being made in the circuit at 2LO to eliminate, as far as possible, this wave-length change. Certain distant observers' reports are being used to determine the effect of the changes.

The lecturer turned next to the question of quality, the design of microphones, and the theory of corrections. He explained that probably the best arbitrary arrangement was to get the maximum of overall control at the transmitter by trying to give every sound frequency equal amplitude of control. This gives on ordinary telephones and loud speakers a fair result. He had, however, taken curves representing the amplitude of a diaphragm over a large range of frequencies necessary to give equal audibility, and he found that the amplitude of the lower frequencies had to be hundreds of times greater than the higher ones. It would be impossible to give an electrical modulation proportional to this amplitude to the transmitter, as the overall control would be extremely weak, being limited by the maximum allowable for freedom from over-control; hence the arbitrary basis of equal amplitude for equal audibility for all frequencies. Correction must then take place in the receiver. He had taken curves of various loud speakers and 'phones, and these showed a marked resonance in the middle register, which resulted in a further diminution of the bass sounds. It was possible, however, with a given pair of 'phones, to apply an overall correction. The results were extraordinary, and an approach to true duplication of the original quality had been made. Some loud speakers now on the market had been adjusted by the makers so as to approximate to good quality over some part of the frequency scale, and, in consequence, they were curiously more difficult to correct to really perfect quality than a bad resonant loud speaker having one single pronounced fault.

Captain Round's lecture was received with great enthusiasm by the transmitters present, and a discussion on various points was carried on after, when many questions were asked by amateurs and answered by Captain Round.

The Chairman then announced that Capt. P. P. Eckersley had been asked by the Committee of the Radio Transmitters' Society to become president of the Society, and had accepted this office. The amateurs present expressed their delight at this, and requested the Chairman to invite Capt. Round to become honorary vice-president of the Society. Capt. Round accepted this position, and a vote of thanks to him for his interesting lecture was proposed and carried.

Any person shall be qualified to be a member of the Society who is the holder of an experimental licence from the licensing authority of the country in which the person or persons reside for the transmission of wireless telephony or telegraphy, or any person regularly operating a transmitting station on behalf of such a licencee, or any person who, in the opinion of the Committee, is qualified to hold such a licence.

Full particulars of subscription, etc., may be obtained from the Hon. Secretary, Mr. Gerald Marcuse, Coombe Dingle, Queen's Park, Caterham, Surrey.

THE EXECUTIVE OF THE RADIO TRANSMITTERS' SOCIETY.

The following officers and committee have been elected :—

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Vice-President .. Capt. H. J. ROUND.
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Correspondence.

Tuned Anode Receivers.

To the Editor of EXPERIMENTAL WIRELESS.

DEAR SIR,—I must congratulate you most heartily on your first issue, which seems to me to be the first effort to approach its subject in a true technical manner, at any rate among journals available to the general public. I have been for years waiting for such a paper.

Nevertheless, my joy at patience rewarded makes me all the more critical towards the contents ; and, while the articles appearing are all of exceptionally high quality, I wish to join issue with the author of "Tuned Anode Receivers." This distinguished officer is evidently a firm believer in the tuned anode circuit as against the transformer, but his arguments do not seem to me to be convincing.

In the beginning, with the words "It is one of the most efficient . . . and probably the most practical method," he begs the whole question : we want evidence please.

Early on page 34 he states of the transformer, "an extra tuned circuit is necessitated for full efficiency." I claim that this statement is erroneous. I have always regarded it as generally accepted, and it can certainly be demonstrated by analysis, that when two circuits are closely coupled, the capacity loading of either may be regarded as transferred to the other ; in other words, the two circuits can be completely and efficiently tuned by a condenser across one of them.

When we compare such a close-coupled tuned transformer with the "tuned anode," we find one tuning adjustment in either case. In one circuit we have an extra coil ; in the other we have a grid condenser and leak. I think, personally, there is little to choose as regards complication.

Naturally, where the second of the two valves is being used for grid rectification—and a leak and condenser will be used in any case—the tuned anode is appropriate ; but there is now an increasing body of opinion to the effect that this highly efficient detecting system is prone to distortion. Where rectification is effected otherwise, or is not wanted, my own experience has been that the transformer, with its direct grid connection, is easier to handle, as would be expected.

I have not space to go into details over the step-up question and prove the point, and can only state that it can be shown that step-up is possible. Even if it were not, the transformer is on the *same* footing as the tuned anode, not one bit worse. I will quote the author against himself (on p. 33), " . . . the principles involved are the same, both . . . operating on the principle of self-induction."

As regards selectivity, this is, of course, a matter of the efficient design of the circuits. I have as yet seen no evidence to upset the theoretical result that, with sufficient care in design, the two systems will be identical. Summed up, my opinion (for what it is worth) is that Capt. St. Clair Finlay, in his admiration for a circuit of admitted excellence, has been led astray into condemning a rival circuit which is equally good, either circuit surpassing the other according to conditions of design and use.

"VERITAS."

SIR,—The writer is glad to see "Veritas's" trenchant criticism of his article on "Tuned Anode Receivers," as he regards free constructive discussion amongst experimenters as of the utmost value, and some such criticism is by no means unexpected. Are we not in this case, however, perhaps a little at cross-purposes ?

To reply to his points *seriatim :*

(1) This does not appear to be a very revolutionary statement. Since both the efficiency and practic-

ability of tuned anode coupling for short waves is now generally recognised, and is not in doubt, surely elaborate evidence on the point is uncalled for in an article not intended to be a technical treatise on the subject. As to "begging the whole question"—that is not what the Editor said when confronted with the MSS.!

(2) Here "efficiency" in the general sense is intended. In coupled circuits where the value of k is made such as to commutate capacity-loading as applied to either, the transfer of energy will be largely, and maybe predominantly, capacitive, in which case the inductive characteristics will be submerged. "Selectivity" in inductively coupled circuits may be said to vary inversely as the square of k and is obtained in practice by limitation of Xm in transformers, since

$$\frac{Xm}{\sqrt{X_1X_2}} = k,$$

and this condition demands close-tuning of both primary and secondary for efficiency, which introduces a complication absent in the simple tuned anode arrangement. If, on the other hand, these principles are not to be observed, then there will seldom be any object in the adoption of the more complicated arrangement—which can, in fact, be shown to be such, notwithstanding the elimination of one or two variable capacities therein, since the leak in the one case and potentiometer (or leak and condenser) in the other cancel out, leaving on the one hand a simple fixed condenser, and on the other an inductance, the design and construction of which demand considerable care, to serve the same purpose.

(3) The use of grid rectification in the second valve being precisely the condition obtaining in the receiver under discussion, and this having been amongst the considerations weighing in favour of tuned anode coupling in this case, the point of this comment is not clear.

With regard to distortion in leaky grid-condenser rectification, whilst this is admissible in certain degree, the particular receiver concerned being intended primarily for the reception not of broadcast but of comparatively attenuated amateur signals, one of the main considerations before the writer in designing it was necessarily high sensitivity to *weak* signals, which provides sufficient reason for the adoption of this system of rectification. In practice the receiver in question is particularly free from distortion even with strong loud-speaker signals when intelligently constructed and operated, which may in this case be pre-supposed.

(4) (*a*) Here the writer expressly says *material* step-up, and thinks it will be conceded, without recourse to technicalities, that any gain possible in this direction will not in practice be such as in itself to warrant preference for either form of coupling as against the other.

(*b*) This is a *mis*quotation, as reference to the paragraph in question will show the author to be comparing similar principles in dissimilar applications, *i.e.*, H.F. auto-transformers with L.F. auto-transformers, and not with transformers at all. Moreover, it is incorrect to say that transformers and chokes operate on the same principle of simple self-induction as "Veritas" appears to suggest.

(5) This is in effect precisely what the article points out, and the remarks in question are intended to show, and is advanced as a consideration in favour of the simpler tuned anode arrangement. Actual superiority of the latter in the matter of selectivity is nowhere suggested.

(6) No condemnation of any system is intended or made—merely a comparison between two systems applicable to a given purpose. This purpose is specified in the article and the respective systems discussed relatively to it, quite fairly it is believed, and here the writer would refer "Veritas" to the summing-up on p. 35, l. 33, which reads: "It will therefore be clear that transformer coupling has *for our purposes* no real *advantage* to offer over the tuned anode method . . . etc.," and scarcely constitutes a condemnation of transformer coupling as such.

It should be borne in mind that transformers, compared with tuned anode coils, require very careful design and construction to be fully successful, and the question is merely raised as to whether —on the Irish principle that "the better of two equally good things will be the simpler"—the former have really much to claim over the latter in the majority of applications.

This surely does not quite justify the horrid impeachment of being "led astray" and of being wedded to one system to the blind persecution of another; and it may surprise "Veritas" to learn that the author has himself—faithless traitor!—found a certain amount of use for transformers in the course of his seventeen years' addition to ether-shaking, and is actually still quite partial to them —in their right place.

He is sorry if "Veritas" finds him unconvincing —*of course* he does if he has the true experimental spirit—but, perhaps, this is only because we are, after all, still at a stage in Radio where an open mind is better than—a closed circuit, for example!

CAPT. ST. CLAIR-FINLAY.

Neon Lamps.

To the Editor, EXPERIMENTAL WIRELESS.

SIR,—I have read with interest Mr. E. H. Robinson's article on neon lamps. As I have been experimenting with neon lamps for some time, perhaps I may be allowed to make the following suggestions:—

Firstly, I do not think that the characteristic curve which he shows gives the reader a clear conception of what occurs, as it leaves out a most important point. This is, that the lamp will not flash on until a voltage is reached which is considerably higher than the extinction voltage. Also it gives the reader the impression that the line is curved, when, however, if sufficient time is given for the temperature of the gas in the bulb, and consequently the gas pressure, to attain a steady value, it will almost universally take the form shown in Fig. 1. This shows that a high voltage A has to be applied to start the glow. After this, the voltage and current both follow a linear law for both increasing and decreasing values of voltage until the voltage B is reached. At this point the lamp will usually go out, but the current may often be brought down to zero if it is done sufficiently gradually.

Secondly, with regard to the production of oscillations. The condenser is shown connected across the lamp, but it may be connected with equal success across the resistance. Also the wave

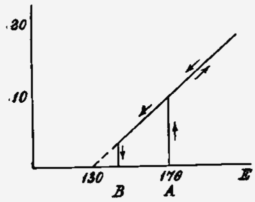

Fig. 1.

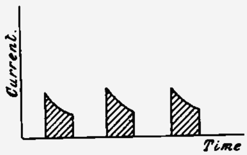

Fig. 2.

shape has evidently been deduced from the curved characteristic. If the straight line characteristic is taken a wave shape as shown in Fig. 2 will be obtained. This can be verified experimentally by means of an oscillograph.

Thirdly, with regard to the Anson relay, he states that the plate current rises on the arrival of a signal. Such, however, is not the case, as the current is at a maximum when there is no signal, and falls on the arrival of an impulse.—Yours truly,

H. Anson.

Sir,—Dealing with Mr. Anson's first point, I should like to draw attention to the fact that in nearly all cases where a neon lamp is applied to radio purposes we are concerned, not with the static characteristic of the lamp, but with the dynamic characteristic, that is, the characteristic showing the relations between the potential across the lamp and the current through it when conditions are varying rapidly. Fig. 2 in my article is not a static characteristic curve, but it was taken from a fairly rapid series of spot readings, and it therefore represents the usual dynamic working conditions more closely than does Mr. Anson's linear characteristic. A curve obtained by waiting for long intervals between successive readings is useless for high-frequency or even low-frequency work. As to the difference between ignition and extinction voltages I have drawn attention to this in the text of my article. The curve in Fig. 2, as clearly stated, only represents the extinction path.

With regard to the wave-form of pulsations produced by a neon lamp, let me say at once that I have not had the opportunity of making oscillograms. Much, however, may be learnt by the use of a simple rotating mirror, and this has indicated that the wave-form is by no means the same for all frequencies, the dark intervals being relatively shorter in comparison with the ignition periods for higher frequencies. I do not doubt for a moment that Mr. Anson has obtained oscillograms of the form he indicates, but he gives us no clue as to the circuits he used in obtaining them nor of the frequency. The chief object of Fig. 5 in my article was to illustrate the fact that a neon lamp does not produce a sine wave. I should also like to point out that in nearly all practical applications of the pulsating neon lamp there is some inductive circuit in series with the lamp. Take, for instance, Fig. 6 in my article, each discharge of the condenser C1 has to pass through the inductance L1. If the pulsation frequency is at all higher or the inductance L1 of appreciable size it will be a physical impossibility for the discharges to take place exactly in the form indicated by Mr. Anson's oscillogram, but the vertical sides will have to slope somewhat and the top corners will become rounded off. Under these circumstances the pulses will tend to assume the form indicated by myself.

I am interested to hear about the alternative position for the condenser, namely, across the supply resistance. For producing oscillations of any amplitude, however, it would be a distinct disadvantage to have a resistance shunted across one's condenser as the resistance would produce unnecessary damping effects.

Although an Anson relay may be made to work with the relay valve functioning either at the upper or lower bend of its characteristic curve, I was unaware at the time of writing my article that the practical form of the instrument is made to work on the upper part. It will be remembered that a demonstration was recently made before the Radio Society of Great Britain, in which the lamp operated at the lower bend.

E. H. Robinson.

Efficient Transmission.

To the Editor of Experimental Wireless.

Sir,—As a result of my article on "Efficient Transmission" I have received considerable correspondence, and it appears that I did not make one point clear. The whole of my remarks were confined to one particular wave and aerial arrangement. The aerial is supposed constant throughout, except for the addition of a counterpoise. Adding a counterpoise will bring down the fundamental slightly, and also the effective height will be reduced slightly, but these are more than counterbalanced by the enormous decrease in the "loss" resistances. Otherwise it might be thought I advocated an aerial 10 ft. high so as to get a huge aerial current!—Yours faithfully,

Frederic L. Hogg (2SH).

Unnecessary Radiation.—At a recent meeting of the Radio Transmitters' Society the subject of jamming on amateur wave-lengths was discussed. Much can surely be done by the elimination of harmonics and the use of selective receiving apparatus, but the old adage, "Prevention is better than cure," seems to be a better solution of the problem. Authority to transmit is only granted on the condition that the tests should be made for experimental purposes, and it is extremely doubtful if some of the transmissions now taking place represent experiments of any real value. We refer particularly to "test records" and such remarks as "My radiation is ·5; how are you getting me?" It is very hard to believe (as a result of following consecutive communications between two stations) that many of the experiments could not have been better carried out on an artificial aerial. It would be a step in the right direction if transmitters would give a little more thought to the use of non-radiating aerials.

Experimental Notes and News.

Wireless experimenters will have heard with very great regret of the death of Mr. J. H. Gregory, of Highgate, through a fall from a tree while engaged in fixing an aerial. Mr. Gregory was very well known in North London wireless circles, and was a student in medicine at Cambridge. Many experimenters have taken great personal risks when fixing aerials, but we believe that this is the first fatal mishap to be recorded.

* * *

The experimental side of wireless work is strongly represented in an excellent syllabus of forthcoming lectures which has just been issued by the Leeds Radio Society. The Society has over one hundred and fifty members, and holds comprehensive permits from the Postmaster-General for experimental work both in transmission and reception. We are interested to note that EXPERIMENTAL WIRELESS is already officially scheduled as being available for reference at the Society meetings.

* * *

The Manchester Wireless Society is another live society with a strong list of popular and advanced lectures. We notice in their list a paper to be read on February 27 by Mr. J. McKernan on "Selenium Cells," which is to be illustrated by experiments. This should be of particular interest to those experimenting on the wireless transmission of images.

* * *

We are informed by the Honorary Secretary of the Radio Society of Great Britain that the British Broadcasting Company have agreed to allow a society transmission to take place once a week from their London broadcast station, which will be simultaneously transmitted to each of the provincial broadcast stations. It will thus be possible for notice of meetings, future policy, and matters of general interest to members and those associated with this Society to be broadcasted regularly. The time arranged is each Thursday evening at 7.25. The first transmission took place on October 11, when Dr. W. H. Eccles, F.R.S., president of the Radio Society, spoke. As this broadcast will be made from all stations in the British Isles, there should be no difficulty in all members picking it up.

* * *

The Radio Research Society has been formed expressly for serious experimenters and research workers in wireless and kindred sciences. Meetings are held at the British Red Cross (Camberwell Division), 44, Talfourd Road, Peckham Road, S.E., every Wednesday, at 7.30 p.m. The Hon. Secretary is Mr. A. H. Bird, 35, Bellwood Road, Waverley Park, Nunhead, S.E.15.

* * *

A broadcasting company is to be established in the Irish Free State with a capital of not less than £30,000. A station is to be erected in Dublin, with, possibly, relay stations at Cork and Limerick.

* * *

The licence problem has arisen in Ceylon. A Bill has just passed the Legislative Council which provides for the use by private individuals of wireless telegraphy, a privilege which has hitherto been restricted to the Government and the Admiralty. We understand that, so far, telegraphy only is being used; telephony and broadcasting developments may be looked for in the near future.

* * *

The invention of crystal "tablets" is attributed to Mr. George T. Gurr, of Fulham. Under this scheme crystals are broken down and then compressed into tablet form. Mr. Gurr claims that the tablets are simpler to mount, give complete contact, and can be replaced in exactly the same size. Incidentally, they are saidto be cheaper to produce

Business Brevities.

Two new books issued by the Wireless Press, Ltd., are "Time and Weather by Wireless," by W. G. W. Mitchell, B.Sc., F.R.A.S., price 3s. 6d. net, and "Wireless Telephony," by R. D. Bangay, price 2s. 6d. net. The former explains the system of time signals in official use, and how they are sent, and also how weather forecasts and reports are prepared and distributed by wireless. The latter is an excellent introduction to the electrical and physical phenomena occurring in wireless transmission and reception, followed by simple explanations of the working principles of apparatus in general use. We have also received from the same publishers "The Wireless Experimenter's Diary," price 2s. 6d., and "The Wireless Amateur's Diary," price 1s., both containing appropriate wireless matter in addition to the usual diary information and spaces.

* * *

Numerous reductions in prices are announced by the Grafton Electric Co., 54, Grafton Street, W.1. A sheet of nearly 100 price changes, and additions to their list No. 2 has reached us, many of the reductions ranging from 20 per cent. to 50 per cent.

* * *

Members of the National Association of Radio Manufacturers announce that they are prepared to credit their trade customers with the difference between the old B.B.C. tariff and the scale now in force in respect of sets in stock on October 1, 1923, to which the B.B.C. tariff applies. Trade buyers desiring to claim such credit must lodge the claim with the respective suppliers of the sets on or before November 10, 1923, and should apply to their suppliers for the necessary forms of claim.

* * *

Ebonite accessories and materials for wireless are dealt with in a 4 pp. list received from the High-tensite and Ebonite Manufacturing Co., Ltd., Normandy Works, Customs House, E.16. A useful list for experimenters.

* * *

The "Morris" Valve Template is a simple device for enabling the holes for valve sockets or legs to be marked out quickly and accurately in one operation. It is supplied by Messrs. J. O. Nichol and Co., 46, Lancaster Avenue, Fennel Street, Manchester.

* * *

Readers who are experimenting with "Neon" lamps on the lines described by Mr. E. H. Robinson in our last issue will be glad to know that the General Electric Co., Ltd., can supply "Osglim" lamps fitted with standard caps but without resistances. These lamps can be obtained through the usual trade channels.

* * *

Messrs. George Philip & Son, Ltd., of 32, Fleet Street, London, E.C.4, send us a sample of an interesting instructional model in cardboard, illustrating and explaining the working of a two-valve receiving set. A rotating disc, behind a diagram of a 10-valve set brings into view supplementary portions of the diagram which show exactly what is happening in the circuit at various moments. The price of the model is 2s. 3d. They also send us a copy of Philips' Wireless Map of Great Britain, which shows at a glance the location of the principal wireless transmitting stations in the country and their call letters. An excellent adjunct to the amateur station.

* * *

A 48 pp. list of wireless apparatus components and materials has just been issued by the Scientific Supply Stores, 126, Newington Causeway, London, S.E.1. The list covers everything "from a loud speaker to an 8 B.A. screw."

* * *

No doubt all readers are familiar with the "Extraudion" valve which has been placed on the market by the "Economic Electric, Ltd.," of London. It will be remembered that the peculiarity is a curious shaped grid and anode. We understand that the valve has recently been re-designed, and we find that on test it behaves very well, a useful property being the low filament consumption.

* * *

"Cymosite" is the trade name of another crystal which has been sent to us for test, and we understand that supplies are now available. An interesting feature is that the crystal and special cats-whisker are enclosed in a dust-proof envelope, thereby guarding against damage by dust and grease.

The Trend of Invention.

We summarise below the more important wireless inventions which have been disclosed during the month, special reference being made to those of immediate interest to the experimenter.

Elimination of Interference.

A number of patents have been taken out from time to time covering arrangements for the purpose of separating received signals from atmospherics and strong jamming signals which depend on receiving the jammed signals on two circuits, the outputs of which are combined in such a way that all but the required signals are balanced out. Most of these arrangements appear to be sound at first sight, but in actual practice one would be liable to get one's desired signal in both circuits so that the desired, as well as the undesired, signals will be balanced out in the receiver. A method of preventing this happening is the subject of a voluminous specification of a patent recently granted to J. B. Bolitho (Brit. Pat. 202,700). Briefly, Bolitho's arrangement consists in coupling two H.F. amplifiers to one aerial, one amplifier being tuned and adjusted to respond to the weak signal which it is required to receive, the other amplifier being adjusted to respond only to the loud jamming signals. The latter condition can be attained by adjusting the grid-potentials on the second amplifier to a negative value sufficient to bring the operating points of the valves in this amplifier low enough on their characteristic curves to make the amplifier un-

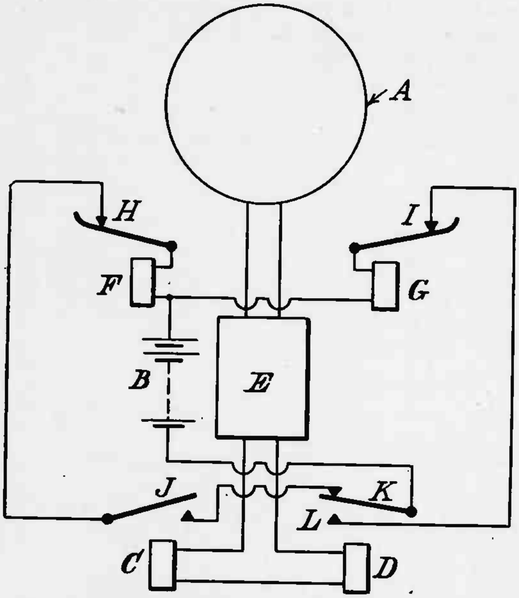

Fig. 1.—Scheme for self-aligning D.F. aerial described in British Patent Specification 202,733.

responsive to signals below a pre-determined amplitude. Thus, from the two amplifiers are obtained two sets of signals, one containing required signals plus jamming signals, and the other containing jamming signals only; by suitably superimposing these two sets of signals so as to oppose each other in some indicating device everything but the desired signal may be materially reduced. The specification describes various modifications of this system, and also arrangements for controlling the relative phases and waveforms of the different sets of signal currents before their combination is effected. The whole scheme is rather reminiscent of Round's balanced crystals, although elaborations and refinements are introduced which are scarcely anticipated by Round's patent.

Self-Orientating Loop Aerial.

Patent 202,733 (J. Robinson, H. L. Crowther and H. Derriman) describes a combination of relays and electro-mechanical devices with a rotatable loop aerial which, when the loop is tuned to a given signal will automatically cause the loop to rotate until the received current in the loop is a minimum, when the bearing reading may be taken. The adjustment is, therefore, not dependent upon the operator's estimate of audibility. Fig. 1 is a diagrammatic representation of one form of the invention. A is a loop aerial capable of revolution about a vertical axis. Received currents, after suitable amplification at E, energise the relays C and D, which in turn control the two magnetically-operated pawls H and I, which engage with ratchet wheels fixed to the axis of the loop aerial. Actual details of operation are given in the specification, along with modifications for automatically adjusting other types of D.F. aerial, including the one employing two loops fixed at right angles to each other.

Economical Production of Telephone Magnets.

The usual practice in making telephone earpieces has hitherto been to make the permanent magnet a separate stamping and to clamp on separate pole-pieces. The novelty in the stamping shown in Fig. 2 lies in the staggered shape, which permits the magnet and pole-ends to be stamped out of the same piece of metal. The patent covering this form of construction also covers other forms of stamping attaining the same object. (S. G. Brown, Brit. Pat. 203,121.)

Insulation of Water-cooled Anodes.

In valves having metallic water-cooled anodes (such as the type described in Brit. Pat. 190,184) provision must be made that

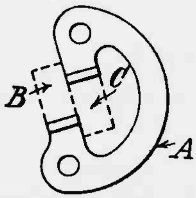

Fig. 2.—By stamping out telephone magnets as shown, and bending up the dotted portions, the construction of separate pole-pieces is avoided.

the water supply does not short-circuit the high-tension anode supply to earth. Such a provision is the subject of British Patent 185,753 (British Thomas-Houston Co., Ltd.), which covers the use of sufficiently long supply pipes to ensure that the column of water in them will have enough resistance to prevent the by-passing of the H.T. to any appreciable extent. In one particular arrangement described in the specification the supply and exhaust water tubes are made of non-conducting material and wound side by side as a spiral on a large insulating cylinder placed outside and concentric with the anode. The upper ends of the two tubes forming this double spiral are in connection with the water jacket surrounding the anode.

Loud Speaker Construction.

Loud speakers with large conical diaphragms and no trumpets seem to have been attracting the attention of several inventors

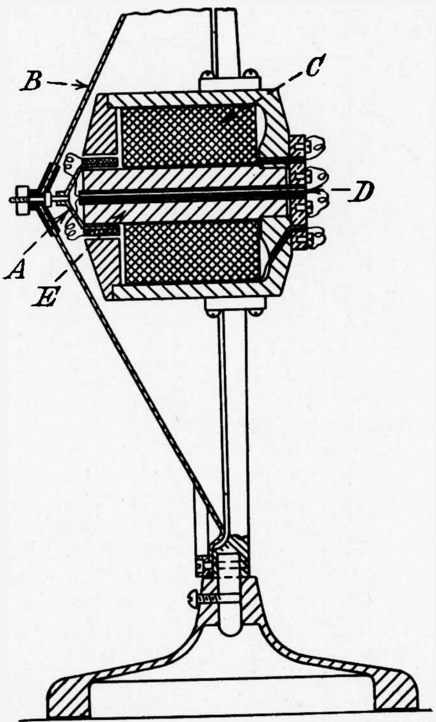

Fig. 3.—A loud speaker in which a large conical diaphragm is used, and the conventional horn dispensed with.

lately. Fig. 3 illustrates the mechanism of one such loud speaker (British Patent 178,862, C. L. Farrand and W. H. Davis). The polarising windings C are contained in an iron case, which also forms a completion for the magnetic circuit. Attached to the apex of the conical diaphragm B is a light coil A, which embraces, but does not touch, the central pole-piece E. The signal currents that are to actuate the loud speaker are passed into this coil A *viâ* wires brought out to terminals at D. It will be seen that the movement depends upon the solenoid principle. The diaphragm A is supported at its periphery. One of the specific features of the invention is that the electro-magnetic system is housed in the concavity of the diaphragm.

Valve Construction.

Fig. 4 illustrates a patent covering the grid used in the well-known C.V.C. valve (British Patent 203,097, W. R. Bullimore). The construction will be familiar to most readers, one of its objects being to make the grid mechanically rigid with respect to the filament and thus to avoid microphonic noises. The specification describes one or two slight modifications of the construction illustrated here.

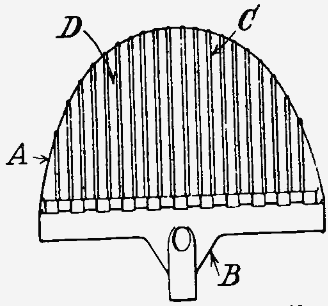

Fig. 4.—Illustrating the Cossor grid.
Keying a Magnetron Oscillator.

Keying a Magnetron Oscillator.

British Patent 199,038 (British Thomson-Houston Co., Ltd.) covers a method of controlling the output of a magnetron oscillator (such as is claimed in British Patent 169,889). Fig. 5 shows a magnetron circuit, the magnetron tubes V1 and V2 each containing only a filament and an anode, the reaction control being effected magnetically by the external coils D and E. An independent set of coils F, fed by battery B, contains the key. The strength of this independent magnetic field may be such as to reduce the anode current in the magnetrons to zero. G is the H.T. generator and T the filament lighting transformers.

Modified Beverage Aerial.

The Beverage aerial in its simplest form consists of a long single wire with a tuned receiver at one end, the remote end being earthed through a system of ohmic, inductive and capacitative impedances so adjusted as to avoid reflection of incident waves at the remote end. In practice it is rather awkward to have to make adjustments at both ends, and an ingenious scheme has been

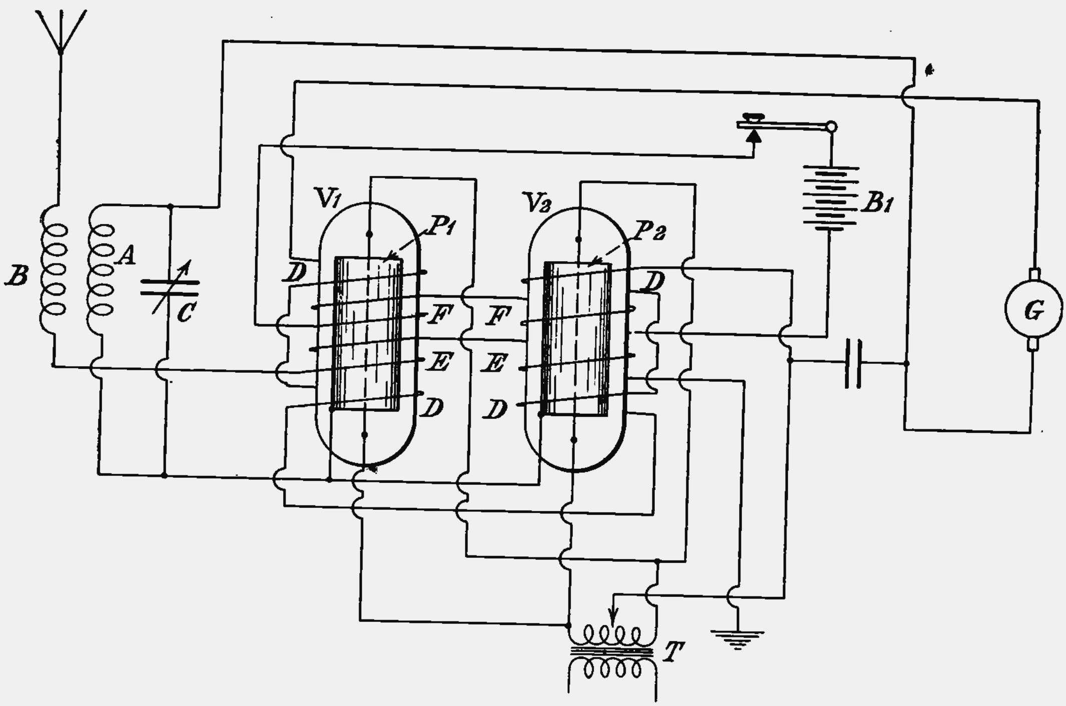

Fig. 5.—Keying a magnetron by means of an auxiliary field excited by D.C.

devised whereby all circuits requiring adjustment are brought to one end. The basic principle, covered by British Patent 192,346 (British Thomson-Houston Co., Ltd.), lies in the employment of two parallel wires instead of one combined with special transformer arrangements at each end, which allow the two wires to act in parallel as far

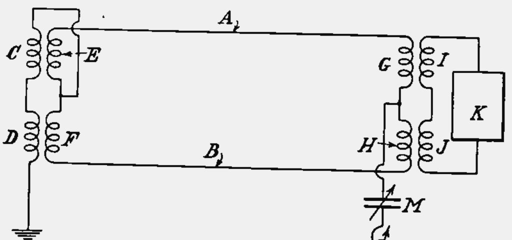

Fig. 6.—Modified Beverage aerial in which all adjustable members are brought to one point by the use of the "phantom circuit" principle.

as the incident ether waves are concerned, but to act in series as a "land-line" as far as the signal currents are concerned. British Patent 203,446, which is illustrated in Fig. 6, covers modifications allowing the receiver to be introduced at either end or any intermediate point in the aerial. The windings E and F are mutually non-inductive, but are inductively coupled to the windings C and D; hence, a wave travelling in the same direction with respect to A and B induces current by virtue of the transformers C, E and D, F, which circulate round the path E, F, G, H. The windings G, I, H and J act in a similar manner. The receiver K thus is affected by currents set up in the remote windings C and D. M, L and N are normally adjusted to have an impedance equivalent to the surge impedance of the aerial A, B in order to prevent wave reflection at the end G, H. It is stated, however, that a certain amount of reflection is sometimes desirable. The specification describes arrangements by means of which the receiver K may be introduced at a point intermediate between the extremities of the aerial.

Rapidly Adjustable Crystal Detector.

A tube E (Fig. 7) is supported between two pillars A, and in it the two crystals D are held in contact by plungers on the end of rods B and C. One plunger has a screw adjustment, while the other maintains a resilient pressure between the crystals by means of a spring. External connections are made to the plungers. (British Patent 203,517, H. P. P. Rees.)

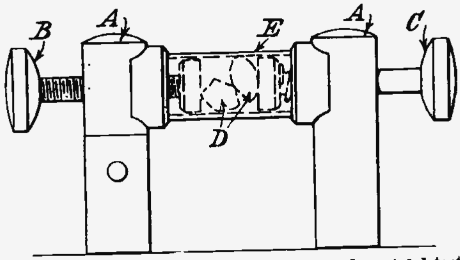

Fig. 7.—Construction of an adjustable enclosed crystal detector.

Recent Wireless Publications.

Figures after the title of each publication indicate Volume and Number of Publication containing the article. Where only one number is given, this indicates the serial number of the publication.

Abbreviations of Titles of Journals Used in the Bibliography.

Amer. Acad.—American Academy of Arts and Sciences.
Am.I.E.E. J.—Journal of American Institute of Electrical Engineers.
Ann. d. Physik—Annalen der Physik.
Boll. Radiotel.—Bolletino Radiotelegraphico.
Elec. J.—Electric Journal.
El. Rev.—Electrical Review.
El. Times—Electrical Times.
El. World—Electrical World.
Electn.—Electrician.
Frank. Inst. J.—Journal of the Franklin Institute.
Gen. El. Rev.—General Electric Review.
Inst. El. Eng. J.—Journal of the Institute of Electrical Engineers.
Inst. Rad. Eng. Proc.—Proceedings of the Institute of Radio Engineers.
Jahrb. d. drahtl. Tel.—Jahrbuch der drahtlosen Teleg, etc.
Mod. W.—Modern Wireless.
Nature—Nature.
Onde El.—L'Onde Electrique.
Phil. Mag.—Philosophical Magazine.
Phil. Trans.—Philosophical Transactions.
Phys. Rev.—Physical Review.
Phys. Soc. J.—Journal of Physical Society of London.
Q.S.T.—Q.S.T.
R. Elec.—Radio Electricité.
Roy. Soc. Proc.—Proceedings of the Royal Society.
Sci. Abs.—Science Abstracts.
T.S.F.—Telegraphie sans fils, Revue Mensuelle.
Teleg. without Wires, Russia—Telegraphy without Wires, Nijni Novgorod.
W. Age—Wireless Age.
W. Trader—Wireless Trader.
W. World—Wireless World and Radio Review.

I.—TRANSMISSION.

La Station Radiophonique de la Ville de Lausanne.—G. Lepot, Ingénieur E.S.E. (*R. Elec.*, 4, 12).

Ein Telefunkensender für den Unterhaltungs Rundspruch.—(*Telefunken Zeitung,*).

Transoceanic Radio Telegraphy.—E. F. W. Alexanderson (*W. Age*, 10, 12).

Efficient Transmission.—F. L. Hogg (*Exp. W.*, 1, 1).

Japanese-American Radio Circuit.—C. W. Latimer (*Am.I.E.E.*, 42, 10).

II.—RECEPTION.

Short Wave-length High-frequency Amplification.—W. James (*W. World*, 214).

Distortion in Low-frequency Amplifiers.—S. O. Pearson, B.Sc. (*W. World*, 216).

A Portable Armstrong "Super."—W. Winkler (*W. World*, 216).

Distortionless Telephony Reception.—F. H. Haynes (*W. World*, 217).

Distortion in Low-frequency Amplifiers (*concluded*).—S. O. Pearson, B.Sc. (*W. World*, 217).

Building a Three-valve Resistance Coupled Amplifier.—F. H. Haynes (*W. World*, 218).

A Simplified Method of Neutralising Valve Capacity in Radio-frequency Amplifiers.—(*W. World*, 218).

The Valve for the Man in the Country.—R. W. Hallows, M.A. (*Mod. W.*, 2, 1).

An Ultra Selective Circuit.—F. L. Hogg (*Exp W.*, 1, 1).

Some Notes on Distortionless Amplification.—Paul D. Tyers (*Exp. W.*, 1, 1).

Some Useful Long-wave Circuits.—G. P. Kendall, B.Sc. (*Mod. W.*, 2, 1).

A Demonstration of a Novel Instrument for Record Wireless Signals.—N. W. McLachlan, D.Sc., M.I.E.E. (*Phys. Soc. Proc.*, 35, 5).

The Freeman Counter E.M.F. Receiver.—Dr. A. E. Banks (*W. Age*, 10, 12).

The How and Why of Crystal Detectors.—J. Snyder (*W. Age*, 10, 12).

Physical Measurements of Audition and Their Bearing on the Theory of Hearing.—Harvey Fletcher (*Frank. Inst. J.*, 196, 3).

The Effect of Valve Capacity in H.F. Coupling.—P. K. Turner (*W. Trader*, 1, 8).

Das Gleichzeitige Auftreten Atmosphärischer Störungen.—M. Bäumler (*Jahrb. d. drahtl. Tel.*, 22, 1).

Uber die Störungsfreiheit der Empfänger der drahtlose Telegraphie.—A. Kœrts (*Thesis, Utrecht, Holland*, 1922).

Un Apparechio di Registrazione Automatica dei Segnali Radiotelegrafici, Regia Accademia Navale-Livorno.—Guiseppe Pession (*Publicazione dell' Istitute Elettrotecnico e Radiotelegrafico Della R. Marina*, No. 19, 1922).

The Fading of Signals.—O. F. Brown, M.A., B.Sc. (*Exp. W.*, 1, 1).

The Design and Operation of Tuned Anode Receivers.—Capt. St. Clair-Finlay, B.Sc.E. (Laus.) (*Exp. W.*, 1, 1).

Crystals and Crystal Testing.—A. V. Ballhatchet, M.J.I.E. (*Exp. W.*, 1, 1).

An Armstrong Super-Heterodyne Receiver.—E. J. Simmonds (*Exp. W.*, 1, 1).

Radio-frequency Amplification.—Louis Frank (*Radio News*, 5, 4).

The Galena' Loud Talker.—Clyde J. Fitch (*Radio News*, 5, 4).

III.—MEASUREMENT AND CALIBRATION.

A Simple Method of Coil Calibration.—Gerald R. Garratt (*W. World*, 217).

The Rapid Measurement of High Resistances with the Neon Lamp.—A. D. Cowper, M.Sc. (*Mod. W.*. 2, 1).

The Calculation and Measurement of Inductance.—(*W. Age*, 10, 12).

La Constuction d'un Ondamètre Portatif pour Petites Longueurs d'Ondes.—(*Onde El.*, No. 14, 1923).

Antenna Constants.—H. Andrewes, B.Sc., A.C.G.I., D.I.C. (*Exp. W.*, 1, 1).

IV.—THEORY AND CALCULATIONS.

La Vibration des Antennes.—(*R. Elec.*, 4. 12).

Pertes dans les Antennes aux Faibles Longueurs d'Onde.—W. Sanders (*R. Elec.*,4, 13).

Forced Oscillations in Self-maintained Oscillating Circuits.—(*Phil. Mag.*, 274).

Uber labile Röhrenschwingungen und Schwebungen in gekoppelten Kreisen.—K. Heegner (*Jahrb. d. drahtl. Tel.*, 22, 2).

V.—GENERAL.

Investigations on Some Valve Circuits with the Cathode-Ray Oscillograph.—N. V. Kipping (*W. World*, 214).

An Easy Method of Winding Honeycomb Coils.—R. O. Challis (*W. World*. 215).

A New System of Duplex Telephony.—H. N. Ryan (*W. World*, 215).

Testing High-frequency Transformers.—Maurice Child (*W. World*, 216).

The Amateur's Part in Wireless Development.—W. H. Eccles, F.R.S., D.Sc. (*W. World*, 217).

The Broadcasting Report (*W. World*, 217).

Home-made Inductance Coils of Low Distributed Capacity.—Victor Gabel (*W. World*, 218).

Variometers.—W. James (*W. World*, 218).

Un Gigantesque Laboratoire d'Etudes de la Propagation des Ondes.—(*R. Elec.*, 4, 12).

A Propos de l'Invention de la T.S.F.—J. Bethnod (*R. Elec.*, 4, 12).

Une Nouvelle Telegraphie sans Fil sous-marine.—Michel Adam, Ingénieur E.S.E. (*R. Elec.*, 4, 12).

Les Origines de la T.S.F.—Daniel Berthelot (*R. Elec.*, 4, 13).

Le T.S.F. en Amerique de Sud.—M. R. Belmere (*R. Elec.*, 4, 13).

Une Nouvelle Exploration Hertzienne.—E. Pepinster, Ingénieur E.C.P. (*R. Elec.*, 4, 13).

Les Radiotelegrammes Sismologiques.—(*R. Elec.*, 4, 13).

Single and Duplex Basket Coils.—E. R. Gilbert (*Mod. W.*, 2, 1).

Drahtlose Telephonie Amerika-Europa.—(*Telefunken Zeitung*).

Die Entwicklung der Radiotelephonie durch Telefunken.—(*Telefunken Zeitung*).

Recent Developments in the Application of Wireless Telegraphy to Shipping.—Capt. J. A. Slee (*El. Rev.*, 2,391-2,392).

Duplex Radio Telephony.—(*El. Rev.*, 2,393).

Recent Developments in the Application of Wireless Telegraphy to Shipping.—Capt. J. A. Slee (*Electn.*, 2,369).

Radio Extensions of the Telephone System to Ships at Sea.—H. W. Nichols and Lloyd Espenschied (*Electn.*, 2,369).

Transatlantic Radiotelephony.—H. D. Arnold and Lloyd Espenschied (*Electn.*, 2,370).

On Ionic Oscillations in the Striated Glow-Discharge.—R. Whiddington (*Phil. Mag.*, 274).

Wireless Direction Finding in Steel Ships.—C. E. Horton (*Inst. El. Eng. J.*, 61,322).

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Sekundäre Electronenemission Glühcathodenröhren.—A. Goetz (*Physikal Zeitschr.*, 24, 2).

Uber die Herstellung kleiner Wechselspannungen von bekannter Amplitude.—H. G. Möller and E. Schrader (*Jahrb. d. drahtl. Tel.*, 22, 2).

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Pioneer Work in Ether Waves.—Sir Oliver Lodge, D.Sc., LL.D., F.R.S. (*Radio News*, 5, 4).

Construction of Push-Pull Transformers.—(*Radio News*, 5, 4).

Neon Lamps and Their Use for Wireless Purposes.—E. A. Robinson (*Exp. W.*, 1, 1).