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# THE WIRELESS WORLD AND RADIO REVIEW

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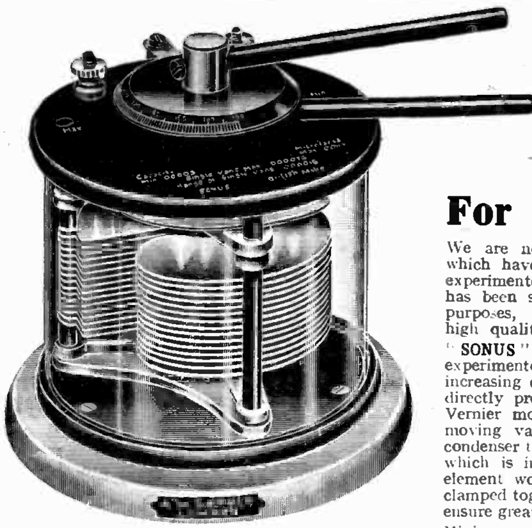

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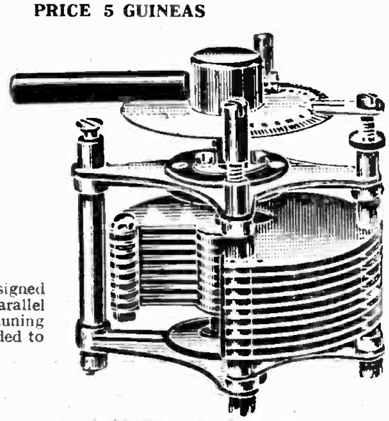

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# THE WIRELESS WORLD

## AND RADIO REVIEW

THE OFFICIAL ORGAN OF THE WIRELESS SOCIETY OF LONDON
A MAGAZINE DEVOTED TO WIRELESS TELEGRAPHY AND TELEPHONY

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# THE WIRELESS WORLD AND RADIO REVIEW

THE OFFICIAL ORGAN OF THE WIRELESS SOCIETY OF LONDON

Vol. X. No. 1. APRIL 1st, 1922 Weekly


## A Sensitive Direct Reading Voltmeter and Ammeter for High Frequencies*

By E. B. Moullin, M.A.

Even when dealing with the low frequencies of ordinary commercial power supply it is difficult to obtain a satisfactory voltmeter which can be used to measure alternating E.M.F's. as low as two or three volts, for if the instrument is either of the hot-wire or dynamometer type, the power it consumes is considerable. Hence in many cases its insertion in a circuit must appreciably disturb the conditions obtaining therein; again, should the instrument be an electrostatic one, its sensitivity is quite inadequate. But when one passes to frequencies of the order of a million periods per second, all these instruments are quite unusable: the impedance of the necessary windings of the dynamometer becomes prohibitive and the capacity of the electrostatic will be comparable with the capacities forming part of the high-frequency circuit. Hitherto, probably the only method of measuring high-frequency potential differences is by means of the "slide back" method of using a thermionic valve. This system possesses the great advantage that it uses no power, but, as will be shown below, it is as a rule incapable of measuring an E.M.F. as low as 2 V, and, moreover, except perhaps with very carefully chosen valves, it may lead to very incorrect results.

A thermionic valve, owing to its asymmetric characteristics, possesses the property of rectification: that is to say, if an alternating E.M.F. whose mean value is zero is applied to the valve, it will cause a current to flow whose mean value is not zero. The rectified current so produced may obviously be used to measure the applied E.M.F., and consequently any rectifying device can be calibrated as a voltmeter. If, then, it is possible to construct a rectifier in which the calibration is very little affected by small changes in the various conditions obtaining at the time of calibration, we have a ready means of making an instrument in which the applied alternating E.M.F. can be measured from the readings of an ordinary moving coil galvanometer.


*Received February 21st, 1922.


### Choice of Rectifier for Use as a Voltmeter.

In a thermionic triode rectification can be produced by means of the curvature of the grid voltage-anode current curve, or by the curvature of the grid current-grid voltage curve, and it is the latter method which proves most satisfactory, at any rate with an "R" triode, for the purposes of constructing a voltmeter. Even when there is no E.M.F. applied to the rectifier there will be some permanent anode current flowing, and probably also some grid current; so that in whichever circuit the indicating instrument is placed, it is necessary that the rectified current for a given applied voltage should not only be large enough to be indicated on galvanometers of reasonable sensitivity, but also it must be comparable with the current that is normally passing through the indicator. If a balance method is used this latter requirement is obviated, but for the purposes of making a convenient voltmeter with a permanent calibration it is advantageous to avoid balance adjustments.

By utilising the anode curvature of an "R" triode it is possible to obtain a rectified current of the order of 40 $\mu$A from an applied E.M.F. of 2 V, but to obtain this sensitivity as a rectifier steady grid and anode potentials must be employed such that the permanent anode current associated with them is about 1000 $\mu$A: evidently a maximum change of only 4% in the anode current cannot be accurately read without some method of balancing out the permanent deflection. But by utilising the curvature of the grid current characteristic and by causing the rectified grid current to pass through a "grid leak resistance," we can produce a reduction of mean anode current by an E.M.F. applied to the grid: this is a method of rectification familiar to those accustomed to wireless circuits, and the method of connection is shown in Fig. 1. With an "R" triode it happens that this method of rectification is much more propitious for the construction of a voltmeter, for it is possible to make an applied E.M.F. of about 3 V (R.M.S.) produce a change in anode current of as much as 40 or 50%.

**Method of Calibrating a "Rectifier Voltmeter."**

One of the most convenient methods of calibrating is to apply the terminals of the rectifier to a potential divider of resistance form, through which an alternating current is flowing. The method of connection is shown in Fig. 1. An ordinary slide wire makes a

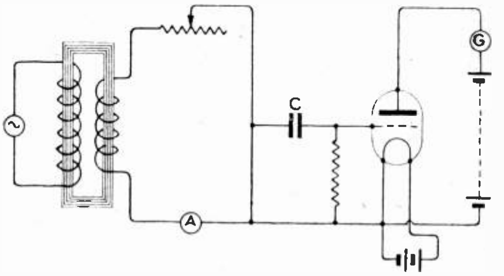


*Fig. 1.*

convenient form of potential divider, and by adjusting the current passing through it (as read by the hot-wire ammeter A) to suit the resistance of the wire, the readings of the slide can be read directly in volts (R.M.S.). The source of alternating current may conveniently be an ordinary low-frequency commercial supply, or, if it is desired to calibrate at a high frequency, a triode generator may be used. However, there is no need to doubt a calibration at low frequency, for the only part of the apparatus effected by frequency is the condenser C. If this has a capacity of about 5000 $\mu\mu$F the calibration will hold good for all frequencies: further reference to this capacity will be made later. The calibration consists in plotting the observed change in the readings of the galvanometer G, against the value of the applied E.M.F., as indicated by the slide wire.

Examples of two calibration curves (using an R triode) taken with different potentials on the anode, are shown in Fig. 2*. It is seen that if the voltage to be measured does not exceed 2·5 V (R.M.S.) the calibration curve is a straight line. These lines do not go quite through the origin, but cut the horizontal axis at about 0·1 V (R.M.S.). This is because the rectifier characteristic is a parabola if the applied voltage does not exceed about 0·2 V, and the line is really tangent to this curve at this point. The extent of the straight portions of these curves increases as the voltage applied to the anode is raised, but its steepness comes to a limiting value when the anode potential is about 100 V but the maximum percentage change in the anode current occurs when the anode potential is about 70 V. The permanent anode current associated with this potential will be about 1 mA, and consequently a galvanometer (such as a Weston student's galvo, altered so as to have a side zero) having a full scale deflection for a current of about 1 mA, will be very suitable for the indicator.

* See also paper entitled, "The Thermionic Triode as Rectifier," by E. B. Moullin and L. B. Turner, read before the Institution of Electrical Engineers, March, 1922.

Small changes of anode potential affect the calibration less and less as the anode voltage is raised; in fact, if the anode potential is about 80 V a change of ± 4% in its value has no effect whatever on the calibration. Reference to Fig. 2 will show that even a 25% reduction only makes a 12% change in the linear part of the curve. This is a peculiarly fortunate thing, for it means that if the instrument is calibrated with, say, 80 V on the anode, there is no necessity when using it to be particular about the voltage of the anode battery differing from its nominal value by two or three volts up or down.

Experiment also shows that with this anode potential, the filament voltage can be altered between 3·6 V and 4·2 V and only alter the calibration by at most 2%. So that here again a nominal "four volt accumulator" can be used to light the valve, and what is still more important it allows us to insert a resistance in the filament so as to reduce the potential difference on the latter to 3·7 V making the life of the valve almost infinite. Even changing the resistance of the grid leak from 1·8 MΩ to 4 MΩ only alters the calibration about 4%, so that any instability in its resistance will be of no consequence. So by a set of apparently fortuitous circumstances it is possible to calibrate an instrument permanently, and make it up in a form as portable and easy of use as the ordinary moving coil voltmeter of the direct current engineer.

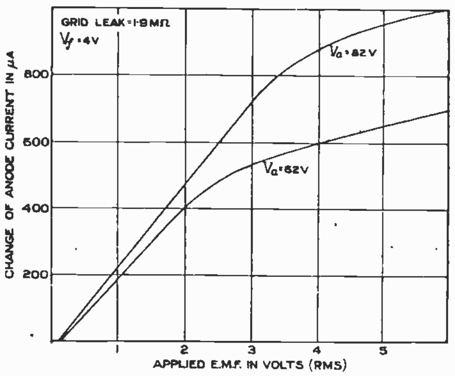


*Fig. 2. Calibration Curve of Rectifier Voltmeter.*

**Description of Completed Instrument.***

Figs. 3 and 4 show photographs of a completed instrument. In Fig. 3 the scale can be clearly seen, and it will be noticed that the zero of the scale of course coincides with the full galvanometer deflection. If the anode battery is slightly above or below its proper value it will, of course, cause the galvo needle to slightly under- or over-shoot the zero; but this can be adjusted by the ordinary zero adjuster of the galvanometer, for since it is the change of anode current that we are concerned with, this adjustment will not alter the calibration.

* The tests were carried out and the instrument made at the Engineering Laboratory, Cambridge University.

Fig. 4 shows the underside of the instrument, with the valve in position; the grid condenser appears to the left of the valve, and the 1·9 MΩ grid leak passing diagonally under the valve cap. The inch rule in Fig. 3 shows the scale of the instrument.

Should the valve be accidentally burnt out it is easily replaced and the instrument recalibrated; however, experiments with several R triodes by the same maker (Osram) show that the calibration depends extremely little on the particular triode. In any case the calibration is invariably linear up to 2 V (R.M.S.), and as a frequent use of such an instrument is to indicate when the voltage on part of a circuit has dropped to some assigned fraction of its original value owing to the introduction of a resistance, the absolute value of the deflection is not always important. (A small allowance for the line not going through the origin could easily be made.)

**Comparison of the Sensitivity of the Instrument with Instruments in Common Use.**

The power consumed by this instrument is only a few microwatts even for an applied voltage of 6 or 7 V (R.M.S.), (the measurement of its effective resistance is considered later) and consequently it is best compared to an electrostatic voltmeter. It can be seen from Fig. 2 that 1 V (R.M.S.) can be read with considerable accuracy; it is probably fair to say that with most electrostatic instruments 40 V (R.M.S.) is the smallest voltage that could be read to the same degree of accuracy, so giving a superiority to this instrument of forty times, even on circuits of such a frequency as to make the use of an electrostatic instrument possible.

By measuring the potential developed across an inductance or capacity of known value, the current passing can be found, if the frequency is known. In this way the instrument can be used to measure high frequency currents. With the frequencies and inductances in common use in wireless this method allows us to measure extremely small currents. For example, suppose we have an inductance of 10.000 $\mu$H and a frequency of $f = 10^5$, the current passing through it to produce 1 V across its terminals is about 160 $\mu$A (R.M.S.). With a vacuum-junction set of equal portability it is generally difficult to read a smaller current than about 2,000 $\mu$A, so that under these conditions this instrument has a superiority as an ammeter of about twelve times. Moreover, this instrument cannot be harmed if the voltage applied to it is excessive, whereas a sensitive thermo junction is burnt out if the current only slightly exceeds its proper value.

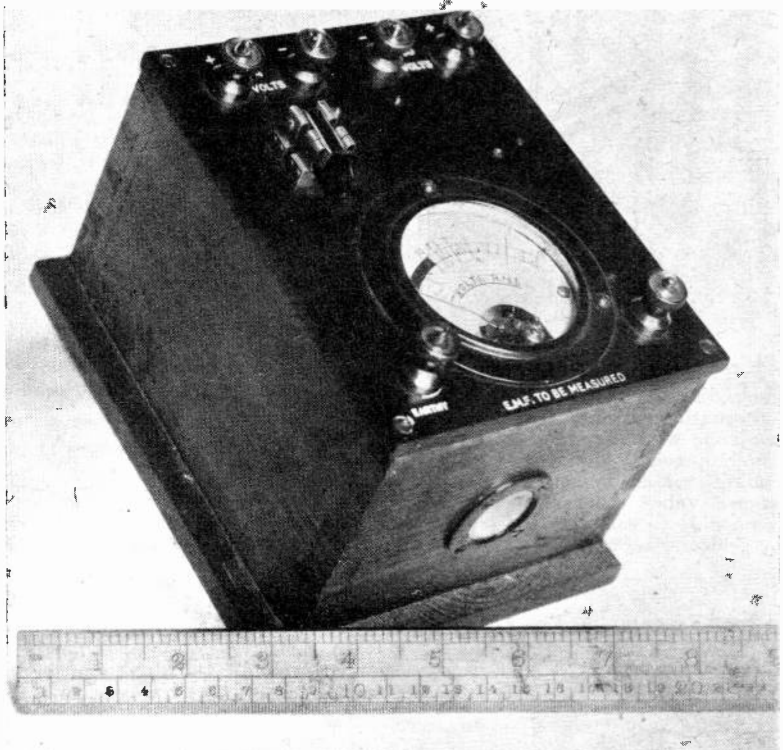


*Fig. 3. Photograph of the Complete Instrument.*

**Measurement of the Effective Resistance of the Voltmeter.**

If the voltmeter is connected across an inductance it must introduce a small decrement into the circuit, for reference to Fig. 1 shows that current can flow through the grid leak, and to a smaller extent through the grid. The slope conductance of the grid is about 1 $\mu$A/V but the decrease of anode current observed with a signal of, say, 2 V (R.M.S.) indicates that the mean potential of the grid is so negative that grid current can only flow for a portion of the positive half-cycle of E.M.F.; consequently, if the grid leak is 2 M$\Omega$, the effective resistance of the grid and leak in parallel can scarcely be less than 1 M$\Omega$. The function of the grid condenser is to connect the grid to the alternating circuit by a path which, though impassable

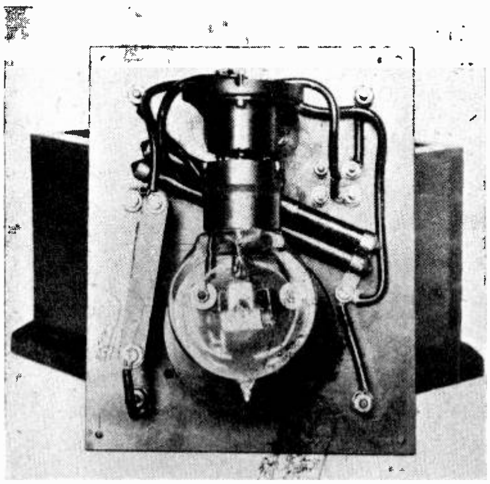

*Fig. 4. Photograph of interior of Instrument.*

to steady currents, shall present negligible impedance to the alternating current. By taking two calibration curves, one with a condenser so large as to present no appreciable impedance at the frequency of calibration, and one with a small condenser of known value, whose impedance is important, it is possible to calculate the effective resistance of the grid and leak.

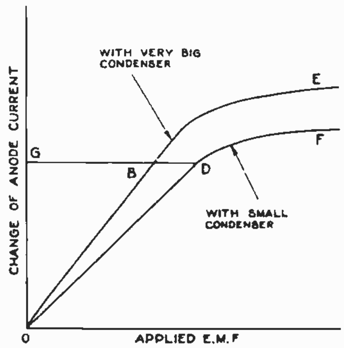


*Fig. 5. Two Calibration Curves to determine Effective Resistance of Voltmeter.*

Let the curve OBE in Fig. 5 be the calibration with a very large condenser, and the curve ODF be the calibration with a small known one. Then evidently the potential drop in the condenser is represented by BD, the potential actually applied to the grid by GB and the current through the grid condenser $=\text{BD}\times\omega C$, so that the effective resistance of the instrument must be given by $\frac{\text{GB}}{\text{BD}}\times\frac{1}{\omega C}$, where $C$ is the capacity of the grid condenser in the second case. Measurements at $f=90$; $R=1{\cdot}9$ M$\Omega$ and $C=0{\cdot}01\,\mu$F show that up to 4 V (R.M.S.) applied to the grid GB$=$10 BD. Hence the resistance of the grid and leak is 1·75 M$\Omega$, or nearly that of the leak alone; the power consumed with 4 V (R.M.S.) applied to the instrument is consequently about 10 microwatts.

Assuming that the voltmeter is across an inductance of 2,000 $\mu$H with a frequency of $f=10^5$ and that the resistance of the voltmeter is 1·75 M$\Omega$ then the decrement introduced by it would be 0·002. The decrement introduced by a vacuo junction with a 10 $\Omega$ heater, would under similar conditions be 0·025, some ten times the amount.

### The "Slide-back" Method of Measuring Voltage.

This method of measurement is well known and was described in the *Radio Review* for June, 1921; but a short description of it will make it easier to understand the tests about to be described.

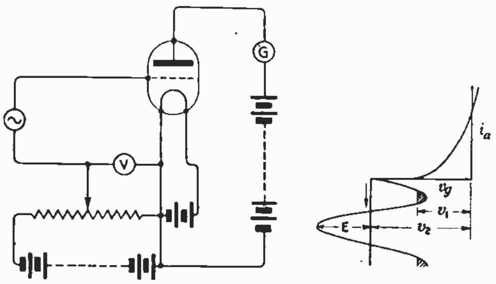


*Fig. 6.*

Let a triode be connected up as shown in Fig. 6 with an anode battery of from 20 to 40 V, and a grid potentiometer with a battery of about 30 V. When no alternating E.M.F. is being applied between the grid and the filament the grid is made more and more negative until the galvanometer in the anode circuit is just brought to zero. If an E.M.F. $e=E\sin pt$ is now introduced into the grid circuit the galvanometer will show that anode current is flowing; this is because the current produced by the positive half-cycle of E.M.F. so greatly exceeds that produced by the negative half-cycle that the result is a mean anode current of appreciable value. The current so produced can only be reduced by making the grid potential still more negative, so that anode current can flow for a portion only, instead of the whole of the positive half-cycle of E.M.F. The condition of affairs then obtaining is depicted in Fig. 6, where the mean grid potential has been reduced by an amount $(v_2-v_1)$. Anode current is now caused to flow by that portion only of the E.M.F. wave which is shown shaded.

If the grid potential is made still more negative, a condition of affairs will be reached at which anode current just ceases to flow, and when this state has been reached, it is evident that the amount by which the grid potential has been reduced, or the "slide back," as it is called, is exactly equal to the maximum of the applied E.M.F.

Now in the practical application of this measurement the anode current should not reach zero; for in order to be sure that the "slide back" has not *exceeded* its proper value we must still just be able to perceive an indication on the galvanometer, and the more sensitive this is, the less will be the error in taking the "slide back" as equal to the maximum of the E.M.F. At the point where the anode current becomes zero, the slope conductance of an R triode is about 6 $\mu$A/V. Let us suppose that with the galvanometer used the smallest current that can be detected is $x\mu$A. Let the area of the shaded portion of the half-cycles in Fig. 6 be $a$ volt-seconds, so that if the frequency is $n$ periods per second we must have $a \times n \times 6 = x$, or $a = x/6n$. The area $A$ of a half-wave of E.M.F. is $E/2\pi\ n$ volt-seconds, and hence $\frac{a}{A} = \frac{2\pi x}{6E} \doteqdot \frac{x}{E}$; consequently, the percentage error in taking the "slide back" voltage as equal to $E$, diminishes as $E$ increases.

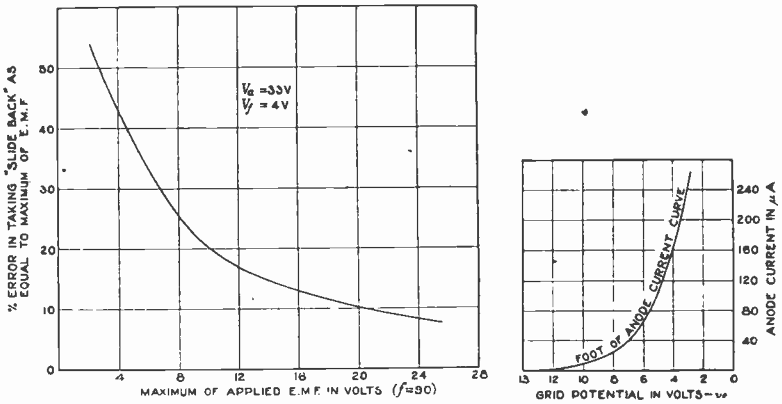


*Fig. 7. Curves for R Triode No. 34817.*

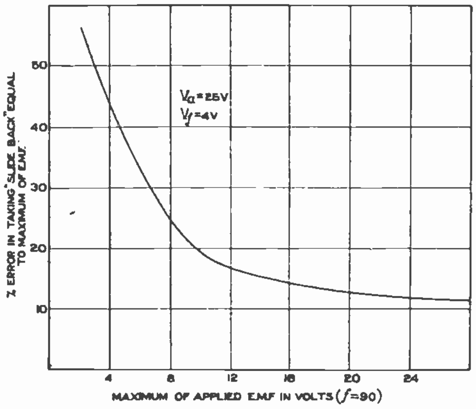


*Fig. 8. Curve for R Triode No. 34817.*

Figs. 7 and 8 show results obtained from tests of the "slide back" method, using applied E.M.F's. at $f = 90$, and inset is the foot of the anode current curves. The triode was an R pattern (Osram), and the galvanometer a 350 $\mu$A Paul unipivot: it is seen that even when $E$ is 20 V the error is still about 10%. In this particular R triode the grid extended slightly beyond the anode and completely screened the filament. Fig. 9 shows a similar curve obtained with a different specimen of R triode and using a galvanometer which would easily indicate a current of 0·02 $\mu$A. In this case an

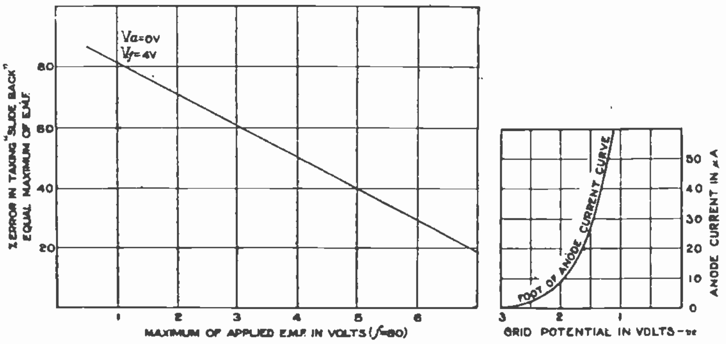


*Fig. 9. Curves for R Triode . . . 93.*

E.M.F. of 7 V maximum is sufficient to reduce the error to 10%.

By using very specially-chosen triodes the "slide back" method is perhaps capable of attaining to much greater accuracy; but if ordinary valves are used, it may evidently lead to very erroneous measurements, unless the E.M.F's. to be measured are quite large.

The "rectifier voltmeter" appears to have an advantage over the "slide back" method, in that it is very much more sensitive; also, as it is calibrated experimentally, it is free from the error produced by assuming that the "slide back" voltage is equal to the maximum of the E.M.F. to be measured. It is true that the "slide back" method could also be calibrated, but it would still be open to uncertainty, owing to the personal factor in deciding when the appropriate "slide back" has been reached. The decrement introduced by the "rectifier voltmeter" is no real disadvantage, since as has been seen, it is very small and its amount can easily be measured.

In comparison with a vacuum-thermo-junction, the instrument has equal accuracy, and an advantage on the score of sensitivity; also the instrument is equally portable and easier to make direct reading. But whereas the thermo-junctions are very fragile and easily burnt out, the "rectifier voltmeter" cannot be damaged, and consequently its use must entail a great saving in the cost of upkeep of high frequency experimental apparatus.

Engineering Laboratory,
Cambridge University.

*February 18th*, 1922.

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# "The Wireless World and Radio Review"

## MESSAGES FROM MEN OF MARK IN THE RADIO WORLD

**From Senatore G. Marconi, G.C.V.O., D.Sc., LL.D., etc.**

No better proof of the growing interest of the general public in matters relating to wireless and its continuous development could be afforded than the increasing popularity of *The Wireless World.* Ten years ago this periodical started upon its career as a monthly publication, appealing only to a very limited number of students and technicians. Two years ago it began to appear fortnightly, and with the present number it joins the ranks of the widely read weeklies. Having been invited by the editor to contribute a message to the first number of the new volume, I feel I cannot do better than to congratulate him as well as the editorial staff on the great success of *The Wireless World.* At the same time it gives me great pleasure to send a personal greeting and a word of encouragement to all those who devote themselves to the study of wireless.

I hope that they will continue to find the subject as absorbing and fascinating as it still is to me.

**From Admiral of the Fleet Sir Henry B. Jackson, G.C.B., K.C.V.O., F.R.S., D.Sc., LL.D., M.I.E.E., President of the Wireless Society of London; Chairman of the Radio Research Board.**

I feel sure that all those really interested in the development of radiotelegraphy and telephony will wish the publishers and staff of this new venture every success in the bold step they have taken in arranging to produce a weekly journal devoted to this important and fascinating science.

The incorporation of *The Radio Review* with *The Wireless World* indicates what a large field this magazine will have to cover, as they have, between them, included everything, from the highest mathematical physics, as applied to radiotelegraphy, to the elementary teaching of electricity to the youthful amateur and, also, the mechanical construction of the latest details of amplifiers and their adjuncts, and the latest wireless news and doings of the many clubs and societies interested in wireless, and, not least, the practical advice given to correspondents as to remedying the faults in the arrangements of their apparatus.

The popularity of the two publications is a proof that their work was efficiently done, and the retention of the editorial staff in the new venture assures that this will remain so.

The more frequent publication than formerly will also improve its facilities for the distribution of news and intelligence, and I have no doubt that the secretaries of the wireless societies and clubs will take every advantage of this to assist the editors in the preparation of their "news" sheet, which, I venture to hope, will include forthcoming as well as past events, such as wireless lectures, probable times of transmission by those holding licences, changes in times of transmission of well-known stations; in fact, a small "Stop Press" paragraph might be greatly appreciated.

I feel sure that I am voicing the opinion of the Wireless Society of London in wishing their *Official Organ* every success in its new form, and an even greater circulation in the future.

**From Dr. W. H. Eccles, A.R.C.S., M.I.E.E.**

In these modern days every group of persons possessed of a common interest or passion require an organ that shall serve as a bond of union to advance and protect mutual interests, as a means of communication, and as a platform from which the skilled may address and instruct the learners. And sooner or later, in circumstances like these, there arises an enterprising publisher who tries his luck in promoting a journal. Sometimes he receives encouraging support, sometimes his subscribers are too few, and he loses his venture. If success is indeed achieved, we may safely deduce that there is a large and keenly interested body of men studying the subject concerned and that the subject is a live and progessive one.

It is therefore with feelings of pleasure that one hears of the continually increasing success of *The Wireless World*, and that one learns that the bold venture made two years ago in converting the monthly to the fortnightly issue is now being followed up by the inauguration of a weekly issue. Evidently the lovers of wireless are already numerous and are increasing yearly. Doubtless many of them, perhaps most of them, are amateurs. Provided that the augmentation of their number does not interfere with the rights of the rest of the community in respect of wireless communications, the increase in number is a matter for national congratulation. How many hundreds of wireless students of to-day have learned nearly all they know of electricity as a consequence of the pursuit of wireless as a hobby? And since, as I believe, the future civilisation is to be predominantly electrical, is to be an epoch in which the industrial prestige and commercial standing of whole peoples will be largely determined by the wisdom with which they employ electrical methods and machinery, I feel that the perpetual dissemination of a knowledge of electricity by means of the study of wireless is a thing that all serious observers of affairs must applaud. This wholesome spreading of wireless knowledge is immensely assisted by your valuable journal, and therefore I send my best wishes for your continued useful and successful career.

### From Major J. Erskine-Murray, D.Sc., Past President of the Wireless Society of London.

I am greatly interested to hear of the amalgamation of the *Radio Review* and *Wireless World*. The inclusion of the more technical papers of the former in the weekly publication will give your readers an opportunity of learning for themselves more of the fundamental researches on which their art is based, and at the same time will spread the scientific knowledge of the subject throughout a larger circle. I wish you every success in your venture.

### From Professor J. A. Fleming, M.A., D.Sc., F.R.S.

I am very pleased to hear that *The Wireless World* and *The Radio Review* are to be amalgamated together into a single weekly magazine, promoting the interests of wireless telegraphy and telephony. I am sure there is a great future for such a magazine, and I wish it every prosperity and success.

### From Mr. F. Hope Jones, M.I.E.E., Chairman of the Wireless Society of London.

The appearance of *The Wireless World* as a weekly marks an important stage in its progress, and even of radiotelegraphy in general. The tenth milestone invites Rest, Retrospect and Resolve. The Rest you are not likely to get; the Retrospect I leave to abler pens than mine, and as for your Good Resolutions, let me tell your readers that it has been my privilege to know the editors and their colleagues; that they have high ideals: that their policy is to run the paper for the good of the science, the industry and the hobby; that they will not grind individual axes nor will be influenced by commercial interests.

It is obvious that this change will greatly benefit the Wireless Society of London, and here it should be put on record that the Society is entirely satisfied with the publication of its Proceedings and the conduct of its official Journal. We have experienced invariable courtesy and material assistance.

*The Wireless World* has recently been open to the criticism that too large a proportion of its pages has been devoted to mere records of meetings of wireless societies. As one who is always reported in full, it would ill become me to complain of this; but I have often sympathised with your readers, and I am glad to think that the incorporation of *The Radio Review* will now redress the balance.

There is one gap which you will now be able to fill properly. There is a real need for prompt intimation of changes and additions to the programmes of regular transmission services. As an instance of this, I may mention that many beginners are still fumbling for time signals among the sidereal rhythmics at 10 a.m., in spite of the recent republication of your big list. It is your duty and privilege to publish the only Wireless Time Table. Keep it up to date, preferably by a weekly Bulletin, always to be found on the same page.

Thanks to the improved conditions which we are fighting for and are confident of obtaining, the present number of licences will, in my opinion, be doubled in quite a short time. *The Wireless World* should be indispensable to all licencees and your future prosperity is assured.

### From Sir Oliver Lodge, F.R.S., D.Sc., etc.

Everything which tends to reduce the number of periodicals and increase their scope, is to the good. Amateur enterprise in this country is deserving of encouragement, as is already done in America. Combined effort will advance the subject, and amateurs with no professional duties which forbid experiment have every chance of introducing improvements.

### From Captain F. G. Loring, R.N., M.I.E.E., Inspector of Wireless Telegraphy, General Post Office.

In reply to your request for a personal message to your readers on the occasion of the first appearance of *The Wireless World* as a weekly publication, and at the same time of the incorporation of *The Radio Review* with it.

It gives me great pleasure to testify to the interest and usefulness of those two periodicals, and as a reader of both I welcome their combination as a matter of convenience and economy. The particular interest of *The Wireless World* for me lies perhaps in the fact that it is the official organ of The Wireless Society of London and its affiliated Provincial Societies. As a result *The Wireless World* becomes the mouthpiece of the British experimental and amateur wireless movement. No one may deny the important part played by the so-called "amateur" in the development of science and art and every *bona fide* wireless experimenter should receive all the encouragement it is possible to give him, provided that in return he will but master the rules and observe the regulations which admit him to the Freemasonry of the ether.

I have been greatly interested in the recent experiments with American amateurs, and take leave to congratulate both British and American amateurs on the results obtained. The important point to my mind is the fact that they were accomplished as part of a programme. Unexpected freak ranges at night of hundreds and even thousands of miles on short waves with small power have always been common knowledge.

I have a distinct recollection that as far back as 1901 or 1902 the Marconi Company reported that one of their ships, using a 10-inch induction coil on " Tune A " (360 feet wave), sent out signals which were received by another ship over 1,000 miles away on a filings coherer and were recorded on a tape machine. No doubt in those days such a wonderful result had its influence on the policy of the Company in regard to the erection of stations for Transatlantic communication. Good signals at 1,000 miles on ¼ kilowatt under special conditions was not, however, the precursor of good signals at 2,000 miles on 100 kilowatts at all times. Since those days the study of very short waves on low power has been rather neglected until quite recently, when their marvellous range under certain conditions has been rediscovered and communication established during a predetermined period over a distance of 3,000 miles and more. Whether there has been any real advance towards the use of such waves for regular long-distance communication, is not yet evident. I suggest that the investigation of very short wave wireless transmission and reception is a field of investigation peculiarly suitable to the members of wireless societies who must always be under considerable restrictions in regard to the power which they are permitted to employ in their experiments. I shall hope to read in due course that it has become possible for British and American amateurs to exchange signals on 180 metres, not accidentally nor even during a predetermined period, but at a predetermined moment of the year. I wish I felt as confident of the accomplishment of this result as I am that if and when it is accomplished the Postmaster-General will take steps to see that there shall be no infringement of his monopoly !

Wishing *The Wireless World* and *The Radio Review* the best of circulations in their combined form.

**From Lt.-General Sir Robert Baden-Powell, Kt., K.C.V.O., K.C.B.**

I am delighted to see that the demand for *The Wireless World* has rendered necessary its issue as a weekly journal.

This step " wirelesses " to the world the inspiring fact, which I have also realised for myself among the Boy Scouts, that the students and users of the science are growing greatly in numbers and keenness.

Thus there lies before us the promise of wonderful developments and inventions in the near future, where so many pioneers are devoting not only brain and resourcefulness but heart as well to the fascinating subject.

**From Mr. A. A. Campbell Swinton, F.R.S., etc., Past President of the Wireless Society of London.**

I am sure that all readers of *The Wireless World* and, indeed, all those interested in wireless telegraphy, will be very much pleased to hear the announcement that *The Wireless World* is in future to be published weekly instead of fortnightly, and is to include a section comprising the class of matter that has hitherto been published monthly in *The Radio Review*.

I know of no new pursuit of a scientific character which in recent years has aroused so much general interest as has Wireless Telegraphy. Indeed, there has been nothing like it since the early days of motoring, and, before then, since the days of the invention of the telephone and microphone. As such interest is likely to increase rather than diminish, I foretell an increased circulation for *The Wireless World* in its new form. I am sure the Wireless Society of London did a very good stroke of business when they arranged for *The Wireless World* to become their official organ and to publish all their papers.

Wishing *The Wireless World* all success.

**From General G. Ferrié, C.M.G., LL.D., Inspector - General of French Military Telegraphs.**

La télégraphie sans fil constitue à l'heure actuelle le plus parfait moyen de diffusion rapide de la pensée humaine. Son développement ne peut donc que contribuer à accroître la concorde dans le monde, car les peuples se connaitront mieux grâce à elle. De plus, ses applications scientifiques dans divers domaines prennent une importance sans cesse croissante.

Il est donc très utile d'accroître de plus en plus le nombre de personnes qui sont au courant des progrés et des applications de la T.S.F., et de leur donner les indications necessaires pour qu'elles puissent utiliser ces progrés pour leur usage personnel.

L'extension de votre intéressant publication contribuera à atteindre ce but. Je suis donc convaincu qu'elle est appelée à un grand succés.

(TRANSLATION).

*Wireless telegraphy constitutes at the present time the most perfect medium for the diffusion of human thought. Its development, therefore, cannot but contribute to the establishment of goodwill in the world, for, thanks to it, the nations are able to know each other better. Moreover, the scientific applications of wireless telegraphy in its various aspects are of ever-growing importance.*

*It is therefore useful to increase more and more the number of persons conversant with the progress and applications of wireless telegraphy and to give them the advice necessary to enable them to utilise this progress for their personal needs.*

*The expansion of your interesting publication will assist in the attainment of this end. I am therefore confident that a great success awaits it.*

**From Dr. Pierre Corret, Editor of La T.S.F. Moderne, Vice-President of La Société Française d'Etude de Télégraphie et de Téléphonie sans fil. From the French Amateurs to the British Amateurs.**

At the moment when your excellent gazette, *The Wireless World*, attains the status of a weekly, and thus bears witness to the brilliant state of wireless amateurism in Britain, we, French amateurs, wish to greet and congratulate you, our unknown friends, across the Channel.

In advance of us, and guided by leaders more expert, you set out on the path of wireless experiment. Amateurs well grounded in theory and skilful in practice are more numerous with you than with us. You have a larger number of societies and the subjects with which they deal are more scientific. We look forward eagerly to the day when we shall have, in our societies, meetings as interesting as in yours, particularly in your Wireless Society of London. Also your valued organ, *The Wireless World*, we keenly envy, not only for its frequent and punctual appearance, the number of its pages and the diversity of its subjects, but principally for its highly interesting character and for the skilful manner in which it is conducted by its clever editors.

As is shown by the present state of our *Société Française d'Etude de Télégraphie et de Téléphonie sans Fil*, of our not yet very numerous provincial societies, and of our modest organ, *La T.S.F. Moderne*, we are at the present time as it were your younger brethren, who are very desirous of following your example and that of your still older cousins of the United States. With joy we applauded your brilliant success in the Transatlantic Tests, having here only one amateur who received only partially the American signals; and now we shall, doubtless, be able soon to set to work with you.

As you, of course, know we recently received from our somewhat dilatory postal administration a transmitting licence, which we had not even applied for; we had experienced such difficulties with the administration with regard to reception merely that we had not ventured even to think of the possibility of transmission.

This licence was not intended in principle for us amateurs, but in a general way for experimental and testing stations. However, we were, of course, very glad to seize the opportunity promptly and to receive legal permission for our tests and experiments also.

Owing to its not specially amateur character, our present transmitting licence is of a somewhat peculiar nature. Theoretically, there is no limit to usable power, nor to wavelength. Permission is obtainable even for a station with 100-kilowatt power and any wavelength whatever, but will be granted by the postal administration on condition only that the motives given for the establishment of the station seem sufficiently justified. However, if the power does not exceed 100 watts, nor the wavelength 200 metres, it is not necessary to state motives in the application for a licence. Hence we may say, though this is not absolutely precise, that for amateurs the limits are 100 watts and 200 metres.

It had not been laid down, whether the 100 watts is *input* or *output* power. In order to obtain a definition, *La T.S.F. Moderne* applied for permission, without statement of motives, for a station with a maximum of 100 watts in the aerial and a maximum wavelength of 200 metres—and received it.

The annual charge is 100 francs for each kilowatt or part thereof, hence for amateurs 100 francs. Only scientific research and tests of apparatus are allowed, but not correspondence on personal and contemporary affairs. If private and contemporary correspondence with any other station be desired a special licence must be obtained and an additional charge of 45 francs for each kilometre between the two stations is levied. If more than two stations wish to correspond there must be a further payment of 45 francs for each corresponding station beyond the first two.

In conformity with these arrangements *La T.S.F. Moderne* has applied for a licence for private and contemporary correspondence with one receiving station, whose owner wishes to receive promptly information of all kinds on radio telegraphy, hours of transmission from large stations, etc.

Such is a summary of the conditions under which we French amateurs can now receive a transmitting licence. We hope that ere long we shall be able to carry out tests and experiments with you, our British friends. Still, some considerable time must certainly pass before that can be achieved, for hitherto we in France have had very little experience and practice in short waves, and we have need of learning something in this branch, which is not of the easiest.

Still another difficulty we foresee, namely, the barrier of language. What language shall be used by British and French amateurs, who do not know each other's national tongue? What will be the use of words reaching us from across the Channel, if we do not understand them? This difficulty has already been made clearly evident to you in the announcement, in French, of the names of items in the Telephonic Concerts from the Eiffel Tower. Happily a simple solution exists: we shall be able to use the very easily acquired international language, Esperanto.*

Possibly you wonder that I, a Frenchman, write so well in English; yet I do not know your language at all. I can to some extent guess at its meaning when reading it, but I am quite unable to write it. This friendly message I have written to you in Esperanto without difficulty, and its text has been translated into English by a British Esperantist. I am absolutely certain that he has transmitted my thoughts to you far more accurately than could have been done by a Frenchman with a "good knowledge" of English, or by an Englishman with a "good knowledge" of French.

As a preliminary test in this direction, *La T.S.F. Moderne* will use Esperanto for items of general information transmitted to its private correspondent.

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The Editor wishes to thank all those who have written to express appreciation of the introduction of the weekly publication of *The Wireless World* and the incorporation of *The Radio Review*.

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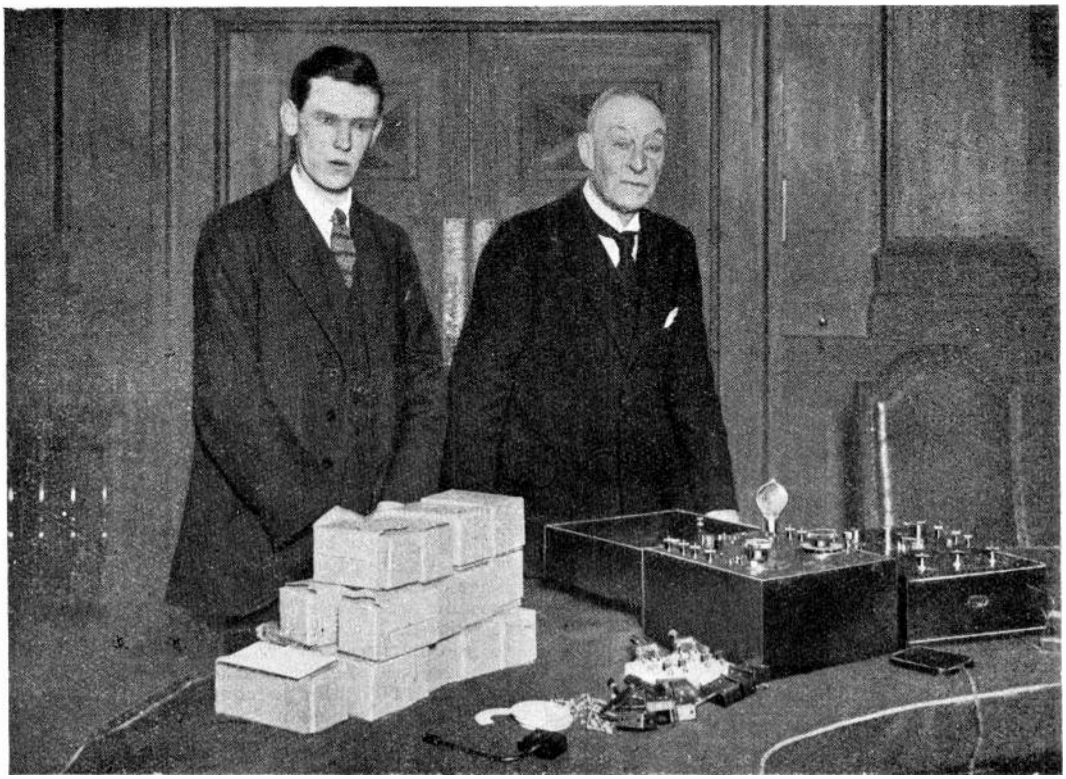
* All information on the subject may be obtained from the British Esperanto Association, 17, Hart Street, London, W.C.1.

# Presentation of Prizes to the First Prize Winner in the Transatlantic Amateur Tests.

AT the meeting of the Wireless Society of London, held at the Institution of Electrical Engineers, Victoria Embankment, on Tuesday, February 28th, a presentation of prizes gained by Mr. W. R. Burne, first prize winner in the Trans-Atlantic Amateur Tests, was made.

Mr. W. R. Burne had been invited to London from Manchester for the occasion by the Wireless Society of London, and in receiving the prizes at the hands of the President he represented also those other successful competitors in the Tests who had gained Second and Third Prizes. Addressing the meeting, the PRESIDENT said :—

The next business is a very pleasant one indeed, and that is to present the prizes to the successful competitors in the Transatlantic Radiotelegraphic Communication Tests in December. Mr. Coursey is going to give a brief description of the work done by the successful receiver, so that I will not take up the time of the meeting, except to say that I feel we ought to be very grateful to the firms who have encouraged this work by their very generous offers of these prizes, some of which are on the table here. Only one successful member is present to-night, and I think that all the apparatus on the table and something that I have in my pocket, presented by Messrs. G. Z. Auckland & Son, has been won by him. But we are really congratulating all the successful competitors, eight in all, and their prizes either have been or will be sent to them in due course. I will ask Mr. Coursey to give a short description of the Tests. (*Applause.*)



*The Presentation to Mr. W. R. Burne.* [*Photopress.*

MR. P. R. COURSEY.

I have been asked to say two or three words this evening on the subject of these American short wave tests, which were carried out in December last. Probably many of the audience here this evening remember Mr. Godley's visit to this country and his attendance at one of the meetings of this Society, when he told us about the American Radio Relay League, which is one of the largest amateur organisations in the United States.

The first organised Transatlantic Test was made in February, 1921. It lasted three days only with one blank day in between the Tests. Nothing definite, however, was received on this side, and a considerable amount of disappointment was in consequence felt both in this country and in America. These negative results were due not so much to any failure on the part of either the transmitting stations in America, or of the receiving stations on this side, but to the fact that the tests lasted for too short a period for definite communication to be established in view of the very variable atmospheric conditions.

The second test took place between the 7th and 17th of December last, and lasted for ten successive days or, rather, nights. There was, therefore, much more chance of signals being heard, and we can now say that American amateurs certainly got into communication with amateurs in this country using comparatively small apparatus, as compared with the high-power transatlantic stations. The chief point of interest in the Tests lies in the short wavelengths employed, most of them being round about 200 metres, but some going up to 360 or 375 metres. The bulk of the stations worked on round about 200 metres.

Before the tests were carried out opinion in America was very divided as to whether spark or C.W. stations would come out best. I think in this country we had very little hesitation in saying which we thought would be the best. But very good results had been obtained in America with spark sets having an input of 1kW, and these led them to expect that quite good results might be obtained from their spark transmitters. This in a sense proved to be the case, as signals from spark stations were heard by Mr. Godley at Ardrossan, Scotland, but no definite signals from spark stations were heard by the British listeners. Mr. Godley's reception results showed that although he heard some spark signals, he heard far more C.W. stations. I think this conclusively proved, if such proof were needed, that C.W. transmission is undoubtedly more effective than spark over long distances for the same power.

The scientific interest of the tests lies in the accomplishment of radio communication, including the reception of at least one complete message over such a long distance with such short wavelengths and such small power. Some somewhat misleading statements have been made as to the possibility of the value of such signals: but it is quite obvious that to secure commercial transmission over such a range requires much larger power in order to secure regular communication, not only every night, but every day as well. These Tests showed that the signals came over very much better on about two nights than they did for the remainder of the period. The transmission qualities over the Atlantic during the period rose to a maximum after about three or four days, and then fell off to zero, and practically nothing more was heard

I think it would be of interest to point out here that the British entrants made greater use of high-frequency magnification than did the Americans. The first four of the most successful of our amateurs on this side all used high-frequency magnification on the short wavelengths. Mr. Godley brought apparatus with him which was typical of the best American practice that they had evolved for long distance short wave reception, and he did not have any high-frequency magnification in front of his first detector valve. He used the Armstrong super-heterodyne principle, in which the incoming signals are heterodyned before the first detector valve. That scheme has been used in this country, and one listener at least, I know, obtained very good results with it; but in broad outline the successful receivers followed the same general scheme—one, two or three, or even four or five, high-frequency stages with tuned anode coupling between the valves, followed by a detector valve and possibly one or two stages of low-frequency amplification. The best reception as regards the number of stations heard was made by Mr. W. R. Burne, of Sale, Cheshire, who intercepted signals from seven American stations. Three for certain of these were received correctly, with the code words which were allotted to these stations, as a means of definitely verifying the reception. Others were not doing individual test transmission work, and had therefore no definite code signals, but were heard during a "free for all" period, and the remaining one was a special C.W. station put up by a group of American amateurs using practically the full licensed power of 1 kW input. The signals from that station were certainly very much more powerful than heard from any other United States station, and it has subsequently transpired that the other C.W. stations that were heard were using much less power than 1 kW.

The next best reception was made by Mr. Whitfield, of Birmingham. He received three stations—**1BCG**, the above-mentioned special station, and two others with complete code words. For the next best reception two have been put together. They are Mr. Corsham, of Willesden, and Mr. Spence, of Huntly, Aberdeenshire. Each of these received one station with the correct code group. Others who received signals were Mr. A. E. Greenslade and Mr. E. McT. Reece, of Clapham, who made a very prolonged reception of **1BCG**; Mr. T. Cutler, of Southampton, Mr. J. R. Forshaw, of Liverpool, and another one in the South of England, who does not wish his name to be divulged.

The American set used by Mr. Godley contained in all ten valves—two oscillators and the remaining ones detecting and amplifying. As a comparison to this there was one British amateur who heard signals from **1BCG**, and used two valves and a crystal detector. It is, I think, extremely creditable that signals should have been heard on such simple apparatus. Others used up to four or five stages of high-frequency amplification.

Another interesting point might be mentioned with regard to the comparison between the times at which signals were heard by Mr. Godley and by the British workers. On the morning of the 8th Mr. Godley reported hearing a station **1AAW.** That has not been verified, as it has been proved since that that station was not sending, so it seems that somebody was using a false call. On the morning of the 9th he reported no signals. On the morning of the 10th he heard **1BCG**, the special transmitting station. On the morning of the 11th he heard the greatest number of signals; he reported fifteen stations that morning, that is on the first Sunday morning during the Tests. As against Godley's first definite reception, reported on the morning of the 10th, we have that of Burne, who heard four stations on the morning of the 8th December

As regards the methods of valve amplification on this side, we were probably in advance of Mr. Godley in that respect. We do not come up to him with regard to the number of stations heard, but when taking into consideration the fact that at the beginning of the Tests he used an aerial 1,350 ft. long, and afterwards cut that down to 850 ft., whereas all the British people had not more than the Post Office aerial of 140 ft., it does not seem surprising that he should hear more signals. In fact, I think it is all the more creditable to the British workers that they heard any at all, and, taking into account the difference in the aerial sizes, our results show not at all badly as compared with Mr. Godley's. He also heard signals on the morning of the 12th; but on the 13th, 14th, 15th and 16th he reported no signals. As against that we certainly have several signals on the 8th; we have one on the 10th, we have several on the 11th, and we have one on the 14th, so that again in two cases we may say we were hearing signals when he did not do so. A receiving station in the South of France also heard signals towards the end of the Test when Mr. Godley reported nothing.

It is also interesting to note that the United States station **2ZL** owned by Mr. J. O. Smith, of Long Island, was heard by the first three British prize-winners, but was not heard at all by Mr. Godley at Ardrossan.

I will only detain you a little longer to mention the fact that a number of prizes, as already stated by our President, were offered by wireless firms in this country to those who made the best reception, and two or three prizes were offered in some cases. Some of the prizes carried conditions attached to them to the effect that they would not be awarded unless the successful amateur used apparatus supplied by these firms, and that has cut out the award of a few prizes. But the remainder, as already announced in *The Wireless World*, have been allocated. Several of the instruments are here on the table, but one or two remain to be chosen by Mr. Burne, who has been offered the choice of apparatus to the value of the prize. Well, I do not think I need detain you any longer in discussing this matter. The Tests have been successful, and it is hoped that before long further definite communications may be established and possibly also in the course of time regular working between the amateurs of the two countries. (*Applause*).

The President.

Mr. Burne is present in person as a guest of the Wireless Society this evening, and I think we will ask him to represent all the other successful competitors; and I should like to ask him to come to the table to hand him a cheque which, as has been stated, I have in my pocket, and let that represent my presentation to him and to the other successful competitors. I should like to tender to them my personal congratulations on the successful completion of the Test. (*Applause*). I think we must also thank Mr. Coursey for his very lucid description of what happened; I think we ought to thank those in America who sent the messages through for this most interesting and instructive competition. I hope that we will repeat it again next year with even better results.

Mr. W. R. Burne.

May I just say a few words, as I have come up to London from Manchester, and am expected to represent all the successful people. I would like to thank you very, very much indeed for the splendid way in which you have dealt with me in inviting me up to London to receive these prizes. I assure you it is a great thing for me, as I have not been in London before. What is more, I was hoping it would be wet. People who come to Manchester from London say Manchester is always wet, and those who come from Manchester to London say in London it is always raining. I was hoping it would be wet, so that I could say the same. However, I am very glad it did not rain, because of it being Princess Mary's wedding day: it would not have been at all nice.

With regard to further tests across the Atlantic, I have got into communication with Mr. J. O. Smith (**2ZL**), Mr. Estey (**1AFV**) and others, who very kindly sent again to a few of us who listened. Mr. Corsham, Mr. Whitfield and myself listened until about 2.30 a.m. from the beginning of this month, and I cannot say that the tests have been altogether successful; but I think that one station was heard one night by Mr. Whitfield and myself. On another morning at 2.15 a.m. a station was undoubtedly heard by myself. I do not know whether the others heard it. To-day I had a letter from Mr. J. O. Smith, of Long Island, saying he was very keen on further tests, and saying that he would be sending every night at 8 o'clock, New York time (*i.e.*, at 1 o'clock a.m. G.M.T.) calling **2KW**, and if anybody else would like to listen for him I shall be pleased to hear from you.

I think it is a great thing, this Transatlantic signalling, and I am only sorry that I did not do better. Having had an accident I was not able to rig up my apparatus until the morning of the Tests. Everything was so hurried that I could not possibly do better really, but I am very, very pleased that other Britishers besides myself have been successful, and I hope it will not be the first or second time, or anything like that, but that we will be able to get into communication with the American people, and not only receive their signals, but send to them as well, if only the Post Office could be persuaded to grant us licences for short wave work. (*Applause.*)

## French Amateur Transmitting Stations.

The French amateurs are taking full advantage of their recently granted facilities for experimental wireless transmissions. We learn that some ten stations have already been licensed and we are able to publish the calls of the first of these, which are as follows:—**8AB**, **8AD**, **8AE** and **TSFM** (the station of *La T.S.F. Moderne*), and **8AH**.

The station **8AB** belongs to Mr. Léon Deloy, of Nice. We understand that this station which has already begun to transmit has been heard in London. We shall be glad to receive reports of the reception of any of these stations or any other stations bearing the distinguishing figure eight, which it appears is to be allotted to the French experimental stations.

# A Tuner and Three-Valve Amplifier for all Wavelengths*

By Percy W. Harris.

A FEW months ago the writer of this article was faced with the problem of how best to design and erect a receiving station of high efficiency and low cost, to comply with the following conditions :—

(1) The installation to be suitable for the reception of all wavelengths from 300 metres to 23,450 metres (Bordeaux).

(2) To be sufficiently sensitive to give good readable signals from the chief American high-power stations on a standard amateur aerial.

(3) The constructional work to be performed without a workshop or lathe and with a few ordinary tools, from well-made component parts, readily procurable from the dealers.

(4) The total cost, including aerial, mast, insulators, tuner, amplifier, valves, batteries and telephones, not to exceed about twenty-five pounds.

In due course the problem was solved, and it is thought that a complete description of the installation and the manner in which it was made will be of some interest to those amateurs who lack workshop facilities and experience in making wireless gear. As will be seen, the installation is such that any intelligent amateur can construct most of it by the fireside.

* This apparatus was demonstrated and briefly described at the Meeting of the Wireless Society of London, on December 28th last. See *The Wireless World* for January 21st, page 643.

### Aerial and Earth.

Having obtained the necessary permit from the Post Office, the construction of the aerial was first undertaken. The writer is no believer in high aerials for reception, for this reason it was decided to make the aerial from 50 to 60 feet in length and 20 feet in height, with twin wires six feet apart, a twenty-foot down-lead at one end being taken to the house. Actually it is slightly under 60 feet in length, owing to the fact that, with the twin down-lead, the permitted 140 feet of wire is not exceeded.

For the mast, a 20-foot aeroplane spar was purchased (from one of the dealers advertising in this paper, at a cost of 16s., delivered). This was secured to the back of a shed at the end of the garden (see Fig. 1). Owing to the fact that the spar is fairly rigid and supported against the shed for eight feet or so from the ground, no guy ropes were required. To the top of the mast a small pulley block (1s. 6d.) was tied, and a rope, 30 feet long (ordinary clothes-line), run through it and the two ends tied together. This double rope thus hung down within easy reach for hauling purposes. A six-foot ash spreader (3s. 6d.) was then purchased from the dealers, together with five of the well-known green porcelain "shell" insulators at 1s. 8d. each, and a 150-foot roll of 7/22 phosphor bronze aerial wire (13s. 6d.). The spreader was laid on the ground, a short length of rope secured to each end to form a bridle, and this rope fastened at its middle point to the 30-foot rope already mentioned. Two of the "shell" insulators

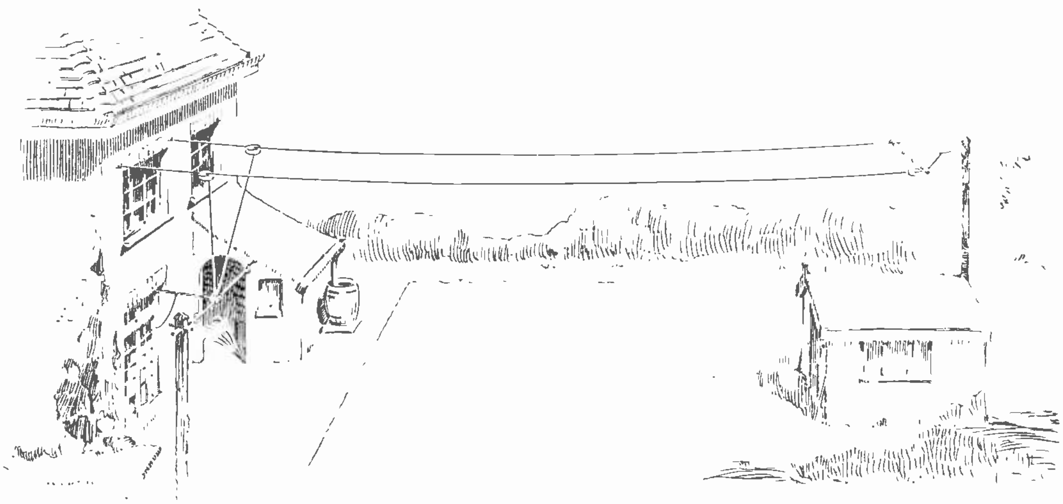


*Fig. 1.—It is a mistake to think that high aerials are necessary for long distance reception. The aerial described in this article is only 20 feet high and, as shown in the sketch, is of modest proportions. The total length of wire is 140 feet. The free end is due south.*

were then tied to the spreader with strong cord (one at each end), and the aerial wire unrolled down the garden and cut into two equal lengths. Two

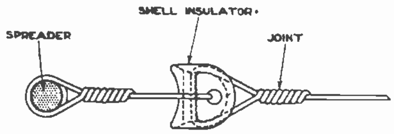



*Fig. 2. Method of attaching Aerial Wire to Insulator, and Insulator, to Spreader.*

of the ends of wire were then passed through the insulators, the strands separated and twisted round the wire to form a secure joint (see Figs. 2 and 3). At the house end, two large hooks were screwed into the frame above the upstairs windows, 20 feet from the ground and six feet apart. To these hooks short lengths of rope were fastened and at their ends two more shell insulators, through which the two aerial wires were passed. The down-leads were then brought down and together passed through a further shell insulator, which had previously been threaded on a transverse rope, supported between a short pole and a hook on an outhouse. The dining-room window frame was drilled to take the wire, which was then passed through the hole and finished with a terminal inside the window-frame. To prevent water entering, the hole was filled with Chatterton's Compound. The general arrangement will be seen from Fig. 1. An important point, and one which contributes to the efficiency of the aerial, is that the down-lead is held well away from the house. No leading in insulator is used—the wood of the window-frame sufficing. (Fig. 4.)

Fortunately, the rising pipe from the water-main is situated in the kitchen immediately adjoining, so that a very short lead, taken through a hole in the wall inside a cupboard, (a hole luckily made previously by workmen to take a gaspipe), formed the earth connection. One end of the earth-lead finishes in a terminal in the woodwork of the cupboard and the other in a strip of tinned copper, clamped to the pipe in the kitchen (see Fig. 4).

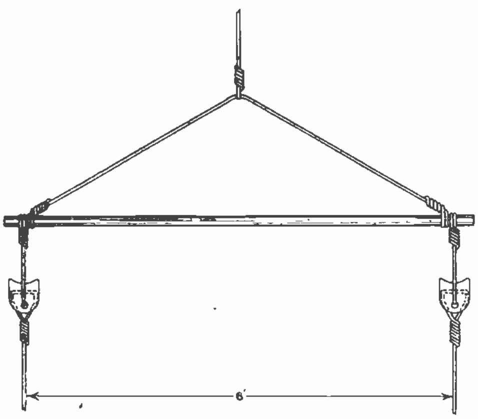



*Fig. 3. Method of attaching Spreader to Rope.*

### The Tuner.

Having purchased a Mark III* tuner and a pair of 4,000 ohm Brown's telephones, the internal connections were altered slightly, as described by Mr. Philip R. Coursey in this magazine (5th and 19th March, 1921), so that additional inductances could be inserted in the primary and secondary circuits, and the aerial condenser placed in parallel, as well as in series, with the A.T.I. For preliminary experiments, an inductance was wound on a cardboard former, 8 inches in diameter and about the same length, tappings being taken off every few turns, and very thorough tests undertaken with the aerial and tuner. Using the perikon detector, it was possible to read North Foreland, Niton, Cherbourg, Havre, Ostend, Cullercoats, Land's End, Norddeich, Poldhu, Paris and many others, including on a few

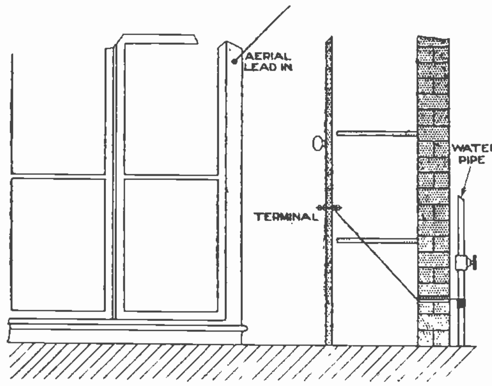



*Fig. 4.—The aerial is led in through a hole drilled in the window frame. No leading in insulator is used. On the right is shown the terminal for the earth lead. It is fixed in the woodwork of a cupboard.*

occasions even St. Maries de la Mer and Cadiz, while ships, of course, were always audible.

After these preliminary experiments were over, the complete station was designed. It was to consist of a three-valve amplifier, with reaction, one valve to be for high-frequency amplification, one for detecting and one for note magnification. As no workshop facilities and very few tools were available, it was necessary that everything should be put together from purchased components, easily obtainable from the dealers.

### Circuit.

The circuit decided upon is shown in its simplest conventional form in Fig. 5. The portion marked A, is comprised within the Mark III tuner, on to the back of which was mounted a three-coil holder to take the well-known Duolateral, Honeycomb or Burndept coils, one coil being for aerial circuit, one for secondary and one for reaction. The portion B is all contained within a second Mark III tuner case, from which all of the original parts had been removed. These empty cases can be obtained for

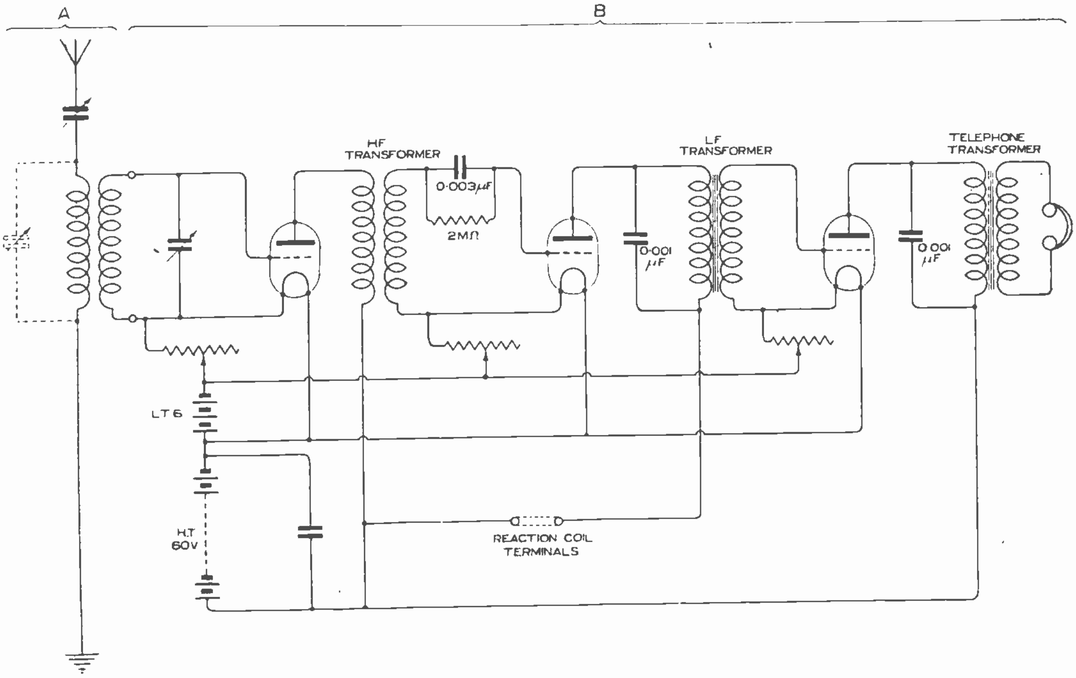



*Fig. 5.—Simplified diagram of connections. It will be noticed that the H.T. battery is joined to the + terminal of the L.T. battery, in which way the 6 volts of the L.T. are added to the H.T. No grid potentiometers are used.*

a few shillings, and being very strongly made of solid mahogany, are particularly suitable for assembling wireless apparatus. In addition, the lid is of great value in keeping the instrument free from dust.

There are many occasions when three valves give far too strong signals, and when one is ample for the purpose. Further, it is useful to be able to compare one, two and three valves on certain signals, and to try the relative merits of a high-frequency valve with detector, against a detector with a note magnifier. It was, therefore, decided to add switches to the set to allow of a rapid change over to various combinations. After much consideration, the circuit was elaborated so that with the aid of four switches, any arrangement of valves could be obtained, and on the last valve high or low resistance 'phones used, according to whether a telephone transformer be switched in or out. Figs. 6 to 9 show how the switches are used.

It will be seen from Fig. 5 that the valves are transformer-coupled for both high and low frequency. Transformer coupling was chosen so as to obtain the highest efficiency, although resistance-capacity coupling would have been cheaper to buy. It must be remembered, however, that resistance-capacity coupling in high-frequency amplification is not suitable for shorter wavelengths. For high-frequency amplification, the new Sullivan H.F. transformer was purchased (this has a four-point switch for 200-400, 400-1,000, 1,000-3,000 and over 3,000 metres), and for low-frequency the "Federal" transformer. Both have answered all expectations, and indeed, exceeded them. The grid leak and condenser are of the combined pattern, the values being ·0003 microfarads and two megohms.

The change-over switches are of the well-known American battery type, demounted from the porcelain bases. The telephone transformer is of the well-known Army type (valve to 'phone).

The method of assembly was quite simple. First of all, the wooden partition of the empty Mark III case was removed and the ledge on which the ebonite top rests continued right round the edge. From one of the dealers a sheet of new ebonite, 5/16ths thick, was obtained and fitted by the dealer to the exact size of the top. When cut it weighed exactly two pounds, and cost about 15s. or 16s. cut, fitted and smoothed off.

The next step was to cut a sheet of paper the exact size of this top, and lay out the various components upon it, until a good arrangement was found. The position of all terminals, holes, etc., was then marked with pencil and transferred to the ebonite, and the necessary holes drilled with an American hand twist drill. The largest hole is ¼ in. in diameter, so large twist drills are not required. For the drilling the ebonite was laid in place on its ledge and the drill rotated until it passed right through into the box. This saved the table and the "mess" was kept within reasonable bounds.

The switches were not mounted in the original way as purchased, but by screws (4 B.A. will do) passed through the ebonite and locked with nuts

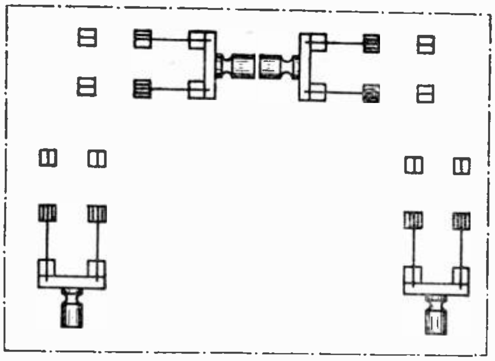


*Fig. 6. Switches set for use of detector valve alone.*

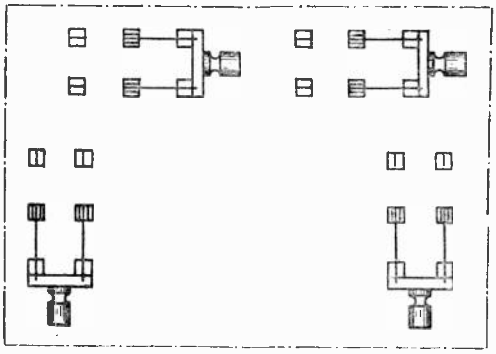


*Fig. 7.—Detector valve and note magnifying valve.*

on top. The connections were then soldered underneath the ebonite to these screws. This makes a neater job than passing the wire through the ebonite and connecting it outside, as with the porcelain arrangement.

The terminals are all standard Mark III terminals, easily obtainable from any dealer for 3d. to 3½d. each. The rotary filament resistances require ¼ inch holes. It will be noticed that separate filament resistances are used for each valve—an arrangement highly recommended if different types of valves are to be tried. It also has the advantage that valves not in use can be switched off. The valve sockets require five holes each—one for each

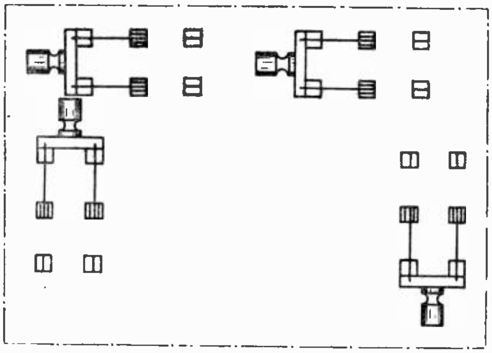


*Fig. 8.—High-frequency amplifier followed by detector.*

pin and one for the central holding screw. The small two-way switch above the centre socket serves to short-circuit the reaction coil. It should be noted that when changing from detector valve alone or with note magnifier to H.F. and detector with or without note magnifier, the connections of the reaction coil must be reversed. A reversing switch would be an improvement here.

When all the holes are drilled (you will be surprised how many there are !) the various components can be screwed into place without difficulty. The most difficult job is the demounting and mounting again of the Sullivan switch for the transformer, as the tiny studs must be carefully set. It would probably be better to buy the transformer without switch and use a larger one than that fitted to the complete transformer. Those who have them could use the separate transformers mounted on valve plugs in this instrument, thus saving expense.

Small mica and copper condensers (·001 microfarad) are shunted across H.T. terminals, telephone transformer primary, and L.F. transformer primary.

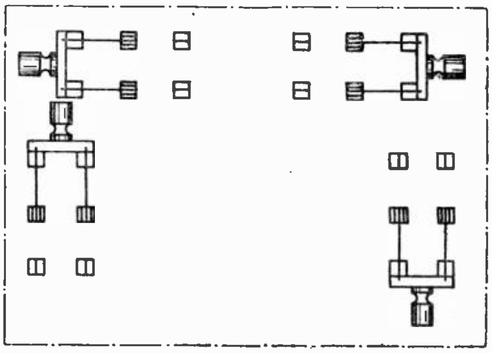


*Fig. 9.—H.F., detector and note magnifier used together. Note: The switch in the right-hand corner connects the final valve either to H.T. telephones (upper position) or transformer and L.T. telephones (lower position, as shown).*

(In a further instalment of this article the wiring will be described and details given of the amplifier panel, together with photographs of the completed station.)

## THE DUTCH CONCERTS.

The following is an extract from a letter received from Mr. H. H. Idzerda, of the Nederlandsche Radio-Industrie, acknowledging the sum subscribed by readers of *The Wireless World* :—

"We have received your letter of February 17th, with enclosed cheque for £62 6s. 6d.

"Whilst we thank you for your remittance, we want especially to express our appreciation to all subscribers and your good selves for the support given and interest shown in our concerts."

# Experimental Wireless Stations.

## DIRECTORY OF CALLS.

Delete the particulars previously published in *The Wireless World* of the following stations, **2FB, 2KO, 2NR.**

The following additions or corrections should be inserted :—

| Call Letters. | Power in Watts. | Wave-lengths in Metres. | Hours of Working. | System. | Name and Address. |
|---|---|---|---|---|---|
| **2 FB** | 10 | 180<br>1,000 | Various. | Spark, C.W. and Telephony. | W. Ison, 80, Harnham Road, Salisbury. |
| **2 KO** | 10 | 500<br>1,000 | 2000–2200 Weekdays, 1100–1300 Sundays. | C.W. and Telephony. | C. S. Baynton, 48, Russell Road, Moseley, Birmingham. |
| **2 NR** | — | — | 1900–2100 | — | J. Knowles Hassall, Mount Pleasant Works, Wooden Box, near Burton-on-Trent. |
| **2 PA** | — | 180<br>1,000 | 1900–2100 | Spark, C.W. and Telephony | G. Z. Auckland & Son, 395, St. John Street, E.C.1. |
| **2 PX** | 10 | 1,000 | — | C.W. and Telephony. | H. H. Lassman, 4, Avenue Parade, Barking Road, East Ham. |
| **2 QO** | — | — | — | Telephony. | P. Pritchard, Blenheim House, Broad Street, Hereford. |
| **2 RK** | — | 180 | — | Spark. | A. E. Blackall, 7, Maple Road, Surbiton. |
| **2 RB** | 10 | 180<br>1,000 | — | Spark, C.W., and Telephony. | H. B. Grylls, Trenay Fawton, Carew Road, Eastbourne. |
| **2 SD** | — | — | — | — | J. Mayall, Burfield, St. Paul's Rd., Gloucester. Portable Set. |
| **2 SI** | — | Up to 180 & 1,000 | —<br>— | Spark, C.W., T.T., and Telephony. | L. C. Holton, 112, Conway Road, London, N.14. |
| **2 TG** | 10 | 1,000 | — | C.W. and Telephony. | Sheffield University, Dept. of Applied Science, St. George's Square, Sheffield. |
| **2 TH** | 10 | 1,000 | — | C.W. | Sheffield University. Portable Set. |
| **2 TO** | 10 | 180<br>1,000 | 1900–2100 | C.W. and Telephony. | F. Townsend, 46, Grove Lane, Ipswich. |
| **2 UM** | 10 | 180<br>1,000 | 1600–1700<br>1900–2000 | Spark, C.W. and Telephony. | H. Lloyd, 3, Ventnor Place, Sheffield. |
| **1 VP** | — | — | — | — | L. J. Hughes. The Wireless Station, Mombasa, British E. Africa. |

The following French Amateur Stations have now been licensed.

| | | | | | |
|---|---|---|---|---|---|
| **8 AB** | 100<br>200 | 200<br>525<br>1,000 | 2100–2115 and at intervals till 2230. | C.W. | Léon Deloy, Villa des Hautes-Roches, 55, Boulevard Mont-Boron, Nice. |
| **8 AD** | — | About 200 | Sundays 1500–1600 | Spark | J. Roussel, 12, Rue Hoche, Juvisy-sur-Orge, France. |
| **8 AE & TSFM** | — | 200 | — | C.W. | La T.S.F. Moderne. 11, Avenue de Saxe, Paris. |
| **8 AH** | — | 200 | Daily, various | C.W. and Telephony. | Marcel Coze, 7, Rue Lalo, Paris, 16e. |

# Resistance Capacity Amplification*

By B. L. Stephenson.

THERE are roughly speaking three methods of amplification which can be easily adopted for amateur purposes, these being "Note Magnification," "High Frequency" amplification by means of intervalve transformers, and "H.F." amplification using resistance capacity intervalve couplings.

The first method seems to be the one which has been most generally adopted by amateurs, but as has been frequently explained, it cannot receive stations which would not be, at least, audible using a single valve, under the same working conditions. In other words, as the term "Note Magnification" implies, it merely makes signals which can be received on one valve louder. In addition to this it has the attendant disadvantages of being noisy, owing to the magnetic effects of the iron of the transformers, and costly, for these transformers can hardly be made by the average amateur.

The second method, employing intervalve air-cored transformers, for amplification at radio-frequency (*i.e.*, of the signals before rectification) is undoubtedly the most efficient method of amplification. It amplifies very weak impulses in the aerial-circuit and causes them to become strong enough to operate the rectifying valve, thus causing fluctuations of current through the 'phones. These weak impulses might not be strong enough to cause a single valve to rectify, where no previous amplification was used. This method, however, has a great disadvantage in cost and trouble of operating. The amateur, in most cases, requires an installation which will work with reasonable efficiency on all wavelengths, say, from 400 metres to 20,000 metres. In order to do this he would need about 9 separate intervalve transformers, as well as an extra variable condenser for shunting across their primaries. All this has, I think, been fully gone into, lately, before this Society.

The third method, using intervalve couplings consisting of a high resistance and a capacity is, I think, the simplest of the three, and it has all the advantages of the last two methods, with none of their disadvantages. That is to say, it is both cheap, highly efficient and easy to operate.

First of all we will take a circuit of the usual type, embodying the principles of Resistance-Capacity Amplification.

There are two distinct components of current flowing round the anode circuits. The first is the normal D.C., due to the H.T. battery and limited by the anode resistance, and the resistance of the stream of electrons flowing from the filament to the plate of the valves. This, of course, cannot operate the telephones in any way. The other is the A.C., at radio frequency, which is superimposed on the D.C., when signal oscillations are applied to the grid.

Now it is necessary to maintain the plate of a common "R" type valve at a potential of about 25 volts positive, to ensure efficient working and the normal steady current flowing will be about 0·7 milliamps. From this fact we can easily calculate the necessary H.T. voltage, with any given value of anode resistances. These are given in the following table :—

| *H.T. Volts.* | *Anode Resistance.* | *Amplification.* |
|---|---|---|
| 40 | 20 thousand ohms. | 2 |
| 50 | 38 ,, ,, | 3 |
| 60 | 50 ,, ,, | 4 |
| 70 | 65 ,, ,, | 5 |
| 80 | 80 ,, ,, | 6 |
| 90 | 90 ,, ,, | 7 |
| 100 | 100 ,, ,, | 8 |

If the anode of the first valve is connected direct to the grid of the next valve, this grid will have a potential of about 25 volts positive relative to the filament. This will, of course, render the valve inoperative.

If, however, we put a condenser between these two points we shall effectively stop the D.C., while the high frequency oscillations will be readily able to pass. By this means the proper controlling of the valve is obtained.

These intervalve grid condensers should be made such that they are large enough to pass the H.F. impulses caused by low wavelengths, and their capacity seems generally to be given, in text-books, as between 0·0002 mfd. and 0·0008 mfd. Consequently the value usually given is 0·0005 mfd.

In actual practice, however, very much larger ones seem to work better, particularly between the first two valves. A table can be given as follows :—

| | | |
|---|---|---|
| Between first 2 valves | .. | 0·003 mfd. |
| ,, second 2 ,, | .. | 0·002 mfd. |
| ,, third 2 ,, | .. | 0·0008 mfd. |

and not until the fifth valve do we come down to the 0·0005 mfd. condenser.

Much has been said regarding the loss of efficiency of Resistance-Capacity amplifiers when receiving wavelengths below about 1,000 metres. This may be largely due to the fact that the grid condensers used are too small, and will not pass the H.F. impulses due to short waves. The loss of efficiency is there in any case, but it can usually be made less noticeable by increasing the capacity of the condensers.

The reason for the inefficiency of these amplifiers on short wavelengths is that the valves have an inter-electrode capacity of appreciable value. This has an effect equivalent to shunting the filament anode path with a condenser, which is the same as shunting the anode resistance, and thus providing a path for the H.F. currents. This will lower the resultant impedance of the anode resistance to A.C. and the voltage drop across it will therefore be reduced. This will, of course, lower the amplification factor.

Now the impedance of a condenser to A.C. varies indirectly as the square of the frequency, so that high frequency impulses, caused by low wavelengths will pass the condenser very easily, and thus lower the amplification much more than in the case of longer waves. This will be more readily understood when we study the actual frequencies caused

* A Paper read before the Manchester Wireless Society on December 1st, 1921.

by certain waves. The frequency of 300 metre waves is 1,000,000, while that of 1,000 metres is 300,000. Now the detrimental effects of the inter electrode capacities vary as the square of these numbers (*i.e.*, as 100 is to 9). So that this effect on a wavelength of 300 metres is roughly 11 times as much as it is on 1,000 metres.

Another centre of discussion seems to be the grid-leaks. If these are of too high a resistance the set seems to "howl" very readily with a low humming sort of note, and C.W. signals are flat. On the other hand, resistances of too low a value certainly stop the "howling," but at a great cost to signal strength, and in some cases the set may stop oscillating, particularly on low wavelengths.

This question of "howling" is extremely vital when using Resistance-Capacity amplifiers, and a great deal of their variableness can, I think, be put down to an unsuitable choice of grid-leaks. Personally I used a standard 3-megohm leak for some time, with a two-valve amplifier, and the set could not be induced to "howl" under any circumstances. Later I took the leak away all together, and the set then "howled" on the least provocation. Signals were stronger than with the 3-megohm leak, but C.W. signals were flat and had a "poppy" sort of note. At present I am using a strip of dry oak 2" long, as a grid-leak, with just a terminal through it at each end for connections. This is very effective and has greatly improved signal strength, at the same time causing continuous wave stations to come in more on their real shrill note. This, of course, enables them to be heard at a greater distance from the telephones. The set "howls" when the reaction coupling is too tight, and best signal strength is found when the set is just off the "howling" point. This is, however, usually the case with any receiver.

*(To be concluded.*

# Notes

### The Telephony Transmissions from Eiffel Tower.

The following notes on the apparatus used in the transmissions of telephony from the Eiffel Tower in the afternoons may be of interest.

The transmissions are made on a wavelength of 2,600 metres, a valve transmitter being employed with four valves in parallel. A plate voltage of 2,300 volts is used to feed the valves and about 800 watts energy is put into the aerial.

A fifth valve of the same type is used to modulate the aerial current, the plate circuit being coupled to the grid circuit of the transmitting valves. The grid of the modulating valve is controlled by a microphone through the medium of an amplifier.

### The Public Subscription for Professor E. Branly.

The public subscription recently opened for Professor Edward Branly has, it is understood, now been closed. The total sum received is 218,253 francs, and though the money is a personal gift to Professor Branly, he intends to devote it to the furtherance of his wireless researches.

### Time Signals from Wellington, New Zealand.

We are advised by the Hector Observatory, Wellington, New Zealand, that in future on Mondays, Wednesdays and Fridays at 10.30 a.m. local time, time signals will be sent out by Wellington Radio. These will be in addition to the programme at present in force for sending out at 8.30 p.m., and the procedure adopted will be exactly the same.

### Magnetic Detectors for Colleges.

We are advised that Messrs. The Wilkinson Motor & Engineering Company, of Lonsdale Road, Kilburn, N.W.6, are prepared to present to any public school having a wireless laboratory or to any wireless society affiliated to the Wireless Society of London, a Marconi magnetic detector in case. A limited number only is available. The only stipulation made is that the instrument remains the property of the school or club in question, and that carriage on the instrument will be paid.

### International Scientific Congress to be held in Belgium.

The Association des Ingénieurs sortis de l'Ecole de Liège are organising an International Scientific Congress to celebrate their 75th anniversary. The congress will be held in Belgium from June 11th to 16th, and an invitation to be present is extended to qualified engineers of Belgium and allied countries. Wireless telegraphy is included under the section devoted to Electricity.

Full particulars are to be obtained on application to Mr. O. Lepersonne, Secrétaire-Général, 16, Quai des Etats-Unis, Liège, Belgium.

### Wireless Navigational Warnings to Airmen.

Information of a specially urgent nature concerning aerial navigation, *e.g.*, warning regarding the discontinuation of navigational aids or obstruction of landing areas at aerodromes, will in future be broadcasted by wireless telegraphy from Air Ministry Wireless Telegraph Station, in addition to being promulgated in the usual manner.

Such notices issued by wireless will be added at the end of the Air Ministry synoptic weather reports transmitted on a wavelength of 1,400 metres C.W. at any of the following times (G.M.T.): 0600, 0800, 1400 and 1900.

### Amateur Wireless Discussed in the House of Commons.

In the House of Commons on March 7th Mr. Hurd (Member for Frome) asked the Postmaster-General if his attention had been called to the development of wireless telegraphy under private enterprise in the United States: whether he was aware that the number of wireless telephone receiving sets had increased in one year from 50,000 to 600,000 and the entire country had been plotted into circuits with a central station so that every rural and urban home might obtain, at a cost below that of an ordinary gramophone, weather forecasts and business information as to prices and market conditions as well as records of sermons, lectures and entertainments; and whether he would endeavour to provide comparable facilities under the Post Office monopoly in this country.

In reply, Mr. Kellaway said: I am aware that there has been a considerable increase in the number of private wireless installations in the United States, but I have no definite information as to the number of such installations, or as regards the arrangements for providing the facilities described by the Hon. Member. I understand, however, that in consequence of the danger of interference with Government and commercial communications, the United States Government are considering the restriction of the use of the wireless telephone for other purposes.

Permission to use wireless receiving apparatus for experimental purposes is granted with comparative freedom in this country, the number of installations being at present 7,000. The provision of facilities for broadcasting messages by wireless is under consideration.

Sir Harry Brittain (Member for Acton): How can you interfere with the Government wireless by means of a receiving set ?

Mr. Kellaway: I can give one instance which occurred recently in the United States where the Australian and New Zealand Governments both complained that their communications were interfered with by an amateur in California who was trying to wireless a local concert.

Sir Henry Brittain: An amateur receiving station is a different thing.

### The U.R.S.I. Signals.

Amongst the decisions arrived at by the International Conference on Radio Communications held in Paris during June, July and August, 1921, was the necessity for the transmission by a number of transmitting stations, of scientific signals for the purpose of observations relating to the *law of the propagation of energy.*

The *law of the propagation of energy* has not yet been established on a completely and rigorously scientific basis. The study of this question covers the choice of the most convenient analytical formula, the determination of its constants, the examination of the continuous variations that the phenomenon of propagation undergoes and of the causes which produce them, the definition of the methods suitable for the measurement of the very feeble reception currents and of the electromagnetic fields produced, the establishment of the direction along which the propagation of energy takes place, etc. In order to commence the attack upon the problems it has been proposed by the Paris Conference that a certain number of transmitting stations should execute at suitable hours some particular transmissions of which the wavelength (or frequency) and the intensity of the current in the antenna should be accurately measured. A certain number of observers, distributed in the receiving stations of different countries, should record the intensity of these signals, or better, that of the corresponding electromagnetic field and possibly also the direction of propagation.

The signals, to be transmitted under the direction of the Union Radioscientifique Internationale (U.R.S.I.), should last three full minutes; the first minute serving for the regulation of the receiving apparatus and consisting of the repeated emission of a signal composed as follows :—

"URSI of (name of the station)—(wavelength in metres of the emission made the day before)—(intensity of current in amperes during that same emission)" as, for example, "URSI of XY—18,500—230." The succeeding two minutes should be occupied in the emission of a long dash. There should then be sent to the Central Bureau (at Brussels) the schedules of each transmitting station containing the largest possible amount of technical data upon the emissions carried out, on the antenna, on the apparatus, on the meteorological conditions, etc. Analogous data should be despatched also by the stations that send out signals at regular times because they also are able to serve for measurements of intensity of reception. All this data should be rapidly co-ordinated by the central bureau, and should be printed and distributed widely to those interested. Similarly, receiving stations should record all relative data for the purpose of co-ordination of results.

The study of atmospheric disturbances and research in the direction of their elimination is probably one of the most important subjects in connection with wireless telegraphy in the present day.

France has already inaugurated the transmission of U.R.S.I. signals from Eiffel Tower **(FL)**, Nantes **(UA)** and La Fayette **(LY)**, these having commenced on February 1st.

The transmissions are made daily at the times indicated below :—

#### Eiffel Tower (FL).

(Spark Transmission. Wavelength 2,600metres.)

G.M.T.

1035 URSI de FL URSI de FL . . . . . .
(exact W/L and energy in aerial of the previous day's transmission).

1036 Two minutes dash.

1038 Preparatory signals preceding the ordinary semi-automatic time signals of 1045.

#### Nantes (UA).

(Arc Transmission. Wavelength 9,000 metres.)

1415 URSI de UA URSI de UA . . . . . .
(exact W/L and energy in aerial of the previous day's transmission).

1416 Two minutes dash

#### La Fayette (LY).

(Arc Transmission. Wavelength 23,450 metres.)

1955 URSI de LY URSI de LY . . . . . .
(exact W/L and energy in aerial of the previous day's transmission).

1956 Two minutes dash.

1958 Preparatory signals preceding the scientific time signals of 2000.

*Note.*—In the absence of accurate information as to the exact W/L and energy in aerial of the transmissions of the previous day a series of the letter X will be transmitted in place of these figures.

### A Wireless Reunion Dinner.

A Wireless Reunion, inaugurating what it is hoped will become an annual event, was held at the Trocadero Restaurant on Saturday evening, the 11th instant, when Admiral of the Fleet, Sir Henry Jackson, G.C.B., K.C.V.O., F.R.S., took the chair at a Wireless Dinner. The company, numbering about 150, was composed entirely of those who had served during the great war as wireless officers of one of the fighting services or in an equivalent capacity, and included a large number of senior officers of the Services, the General Post Office, and the leading scientfiic and commercial interests.

After honouring the toast of the King, the Chairman proposed the health of Senator Marconi in an interesting and reminiscent speech, outlining the growth of the youngest of the practical sciences from its very small beginnings to its establishment as the greatest medium for a system of world communications. He tendered his hearty congratulations to Senator Marconi on his almost unique experience of having seen the results of his genius and application grow to fruition in the course of little over a quarter of a century.

Senator Marconi in reply referred in moving terms to his early association with Admiral of the Fleet Sir Henry Jackson (or Captain Jackson as he then was), who had passed from the role of Inspecting Officer to that of active collaborator, and to whose enthusiastic support the early adoption of wireless by the British Admiralty was largely due. He also paid a glowing tribute, based on personal inspection over various war fronts, to the efficiency of the British Wireless organisation during the great war, and to the skill and devotion displayed both by land and sea.

The Chairman in complimenting the Organising Committee responsible for the arrangements proposed the health of its Chairman, Colonel L. F. Blandy, D.S.O., R.E.

Colonel Blandy in reply explained the origin of the idea of holding a Reunion and proposed that a Wireless Dinner Club should be formed, and an Annual Dinner arranged on the lines of the present dinner. He proposed, that in the first instance, qualification for membership should be the same as that which guided the Committee in arranging the dinner this year, *i.e.*, that membership of the Club should be confined to those who had done wireless work during the great war as officers or in an equivalent capacity.

The proposal was welcomed and everyone present at the Dinner joined the newly inaugurated Wireless Dinner Club, Admiral of the Fleet Sir Henry Jackson kindly consenting to be the first President.

# Calendar of Current Events

April 5th.—Cambridge and District Radio Society.

April 5th.—Cowes and District Radio Society. Open Night.

April 6th.—Luton Wireless Society. "Resistance Amplifiers," by Mr. F. Halstead, 8 p.m.

April 7th.—Wireless Society of Highgate. "Valve Characteristics and Practical Measurements of Valve Constants," by Mr. L. Grinstead.

April 7th.—Sheffield and District Wireless Society. "Syntony and Resonance," by Mr. F. G. Gilberthorpe. 7.30 p.m.

April 12th.—Cowes and District Radio Society. "Semi-Aperiodic Amplifiers and the Reaction Principle."

April 12th.—Radio Scientific Society, Manchester, 61, High Street, Manchester. Open evening.

April 13th.—Liverpool Amateur Wireless Society, Colquitt Street, Liverpool. "Accumulators: How Made, Used and Abused," by Mr. S. K. Wilkie.

April 13th.—Ilford and District Radio Society. Social Evening.

April 14th.—Leeds and District Amateur Wireless Society, University of Leeds, College Road, Leeds. "Samuel Morse," by Mr. W. R. Plowers. "High Frequency Intervalve Transformers," by Mr. G. F. Kendall, B.Sc. 8 p.m.

## SHARE MARKET REPORT.

Prices as we go to press, are :—

| | £ | s. | d. |
|---|---|---|---|
| Marconi Ordinary | £2 | 0 | 6 |
| „ Preference | 2 | 0 | 0 |
| „ Inter. Marine | 1 | 6 | 7½ |
| „ Canadian | | 6 | 6 |
| Radio Corporation of America :— | | | |
| Ordinary | | 14 | 9 |
| Preference | | 14 | 0 |

# Correspondence

*To the Editor of* The Wireless World.

Sir,—We take the liberty to inform you that a wireless society, the "Norsk Radio-Amateurklub," has recently been formed in Norway and has already acquired many members. We see from various letters from you to Mr. K. E. Weedon, Kristiania, who is one of our members, that you will kindly publish reports from our Society occasionally, and therefore enclose a short paragraph, which we should like to see published in your paper, which, by the way, is very much appreciated by our members as a most valuable and interesting source of both information and entertainment for the "Wireless" man.

From the enclosed notice you will realise that we shall have to meet with many difficulties in our work to liberate the amateurs in this country. However, we have decided upon a method of progress which will certainly lead to a result, whichever this may be, and we hope that our Government will understand, that the absolute prohibition of wireless work is, in the long run, an impossibility, and that the Government had better grant some freedom voluntarily.

Thus we hope within a not too long time to have reached a position approaching that of the English amateur.

Taking into consideration your kind interest in our position formerly, we trust that you will find this information of interest.

G. H. Petersen,
*Hon. Secretary.*
*Norsk Radio Amateur Club.*

*To the Editor of* The Wireless World.

Sir,—On the 2nd March, from 1800 to 1830, I heard 2LQ transmitting music, and afterwards speaking, to 2LM and 2CW on just over 1,000 metres.

As none of these call letters appear in your lists I should be obliged if you can advise me who 2LQ is, or, failing this, if you would be good enough to publish my letter in order that I may get into touch with him.

He may be interested to hear how I received him.

W. Harwood Moon,
*Captain.*

*To the Editor of* The Wireless World.

Sir,—I notice among the correspondence in *The Wireless World* for February 18th a letter on "freak" aerials, from Mr. Williams, in which he asks if any other amateurs have done anything in this line.

I have made several experiments with different "aerials," and have also noticed that static is greatly reduced with certain types.

One thing I tried was using the earth only, but connecting it to the aerial terminal of the receiver, all the European high-powered stations come in readably and NSS, WII, etc., can just be heard, using one rectifying and one note magnifying valve; by adding another stage of note magnification, the American stations are quite readable.

Has Mr. Williams tried disconnecting aerial and earth, but leaving a tuning circuit across A and E? (I used a 0·001 condenser in parallel with a honeycomb coil 4 inches outside diameter). Then, by standing the coil upright on its edge, directional reception is possible; but, of course, greater amplification is necessary in this case. I found that with the above, and using two H.F. valves, one rectifying and one note magnifying, IDO, POZ, Stavanger, etc., are quite easily read.

Referring to the end of Mr. William's letter, some time ago, while receiving NSS on one valve, I removed the grid leak and substituted my fingers without any change in strength of signals.

Hoping to hear of more "stunts."

S.E. 25. C. H. P. Nutter.

*February 16th, 1922.*

*To the Editor of* The Wireless World.

Sir,—The explanation given by Mr. Clinker to "Experimenter" on page 610 of your issue for December 24th, appears undoubtedly to be the correct one. It does not seem possible to me to obtain a "Lower Harmonic," *i.e.*, one having a longer wavelength than the fundamental for the following reason.

Given a wire stretched at a constant tension between two fixed points, the wire, if struck, will vibrate at a certain frequency $N$ having a wavelength $L$. This will be the natural or Fundamental $N$ and $L$ of the wire. By touching it lightly half-way up and striking it the frequency alters to double the Fundamental, *i.e.*, to $2N$ and the wavelength correspondingly decreases to $\frac{L}{2}$. This is known as the first harmonic in music, but apparently as the second harmonic in wireless. I use the latter nomenclature. By touching the wire $\frac{1}{3}$rd or $\frac{1}{4}$th of the way up, the 3rd and 4th harmonics can be produced, having rising frequencies of $3N$ and $4N$, and shorter wavelengths of $\frac{L}{3}$ and $\frac{L}{4}$ and so on.

Now for a "Lower Harmonic" one must somehow obtain a frequency of $\frac{N}{2}$ with a wavelength of $2L$. I cannot conceive how this can be done without altering the given conditions.

In experimenting with a banjo it was found when the top D was struck the lower D also vibrated. This would appear contradictory to what has just been written. The explanation is I think the bottom D vibrates not because the top D radiates a lower harmonic but by virtue of the bottom D being inherently able to respond through a higher harmonic and so resonate with the higher frequency of the top D.

These harmonics are a nuisance generally, but are sometimes very useful. With a heterodyne wavemeter, range 1,000-2,500 metres, by means of harmonics, I am able to measure all wavelengths between 300 and 25,000 metres with a very fair degree of accuracy. The wavemeter harmonics are utilised for wavelengths below 1,000 and the Receiver Harmonics for those above 2,500 metres.

Regarding "Experimenter's" letter. If **GSW's** transmitting fundamental wavelength be taken as 5,000 metres, then to get what he calls a "Lower Harmonic" his receiving set must have been tuned to something in the vicinity of 10,000 metres, the second harmonic from it would then beat with **GSW**. The same thing would happen if his receiver were tuned to 15,000, 20,000, 25,000 or 30,000 metres provided the harmonics given out by his receiver were powerful enough. These harmonic effects would be due entirely to his receiver and not to **GSW**. As the Inductance has been increased, naturally it is necessary to increase the Reactance to get an optimum value and signals would therefore gain in strength as the coupling is made closer.

On the other hand; with what he calls the higher harmonics, this effect is due entirely to **GSW**, and I take it "Experimenter" is fairly close to this station. With **GSW** transmitting on 5,000 metres he will be radiating harmonics with wavelengths of 2,500, 1,666, 1,250, 1,000 and so on, and "Experimenter's" set if tuned to near these wavelengths would pick them up. Naturally again a weaker coupling giving less reactance will be necessary with the smaller value of Inductance.

It may interest D.H. (Sutton) and Ohm Sweet Ohm (Hampstead), who ask questions on the subject, to know that **BYC** is easily read at Bushire on one valve and Annapolis fairly well on two valves. With three valves **POZ, IDO, YN** and **OUI** come in fairly loud on a plain "Burndept" type of coil without any aerial or earth. The ordinary resistance capacity coupling set is used. Distances are roughly 3,000 and 9,000 miles to **BYC** and **NSS**.

Gordon Barnes.

Bushire W.O.,
Persian Gulf.
*February 1st, 1922.*

# Wireless Club Reports

*NOTE.—Under this heading the Editor will be pleased to give publication to reports of the meetings of Wireless Clubs and Societies. Such reports should be submitted without covering letter in the exact form in which they are to appear and as concise as possible, the Editor reserving the right to edit and curtail the reports if necessary.* **The Editor will be pleased to consider for publication papers of unusual or special interest read before Societies. An Asterisk denotes affiliation with the Wireless Society of London.**

## The Wireless Society of London.

The forty-fifth Ordinary General Meeting was held on Tuesday, February 28th, at the Institution of Electrical Engineers at 6 p.m.

The **President**, opening the meeting, said:

Ballot papers have been circulated and will be collected at the end of the meeting for the election of new members to the Society.

The following Societies have been affiliated:—The Radio Society of South Africa, Kensington Wireless Society and the Highgate Wireless Society.

Mr. Henry Mitchell has been made a full Member—formerly he was an Associate Member.

*A Presentation of Prizes gained in the Transatlantic Tests was then made to the first prize winner, Mr. W. R. Burne, who also acted as the representative of other prize winners not present.* (*See page 10 of this issue.*)

After the presentation the **President** said:—

I will now call upon Mr. Phillips to open the Discussion on High Frequency Application.

At the conclusion of the Discussion (for which see next issue) the President announced the election of the following to be Members of the Society: Rev. C. H. Townson, G. A. Exeter, H. J. Talbot, J. Gillett, R. A. Palmer. W. H. Lloyd, A. W. Fithian, H. G. Treadwell, H. Taylor, O. J. Carpenter; and Associate Members, M. Burchill, Felix M. Loufté, K. P. Strohmenger.

The meeting adjourned at 8 p.m.

## Liverpool Wireless Association.*

The Fourth Meeting of the Liverpool Amateur Wireless Society was held at the Royal Institution, Colquitt Street, Liverpool, on February 23rd last. Dr. Marchant, who was in the chair, in introducing Mr. W. R. Burne (Transatlantic Test winner), said that they were indeed very fortunate to have Mr. Burne to lecture to them. It was a noteworthy achievement that an amateur had bridged the Atlantic with only one kilowatt. Marconi, in his experiments, when only coherers were available for receiving, used about 10 kilowatts. Knowing what we do now about Transatlantic transmission, it seems likely that Marconi made his first tests on a very favourable night.

Mr. Burne, at the outset of his address, congratulated Mr. Forshaw, of Liverpool, on his success. Mr. Burne then went on to say that he had heard one station over 3,700 miles away sending with a power of 1 kilowatt, and that it spoke very well for the American amateur stations. In the case of these big commercial stations Mr. Burne said the tendency was to turn loose a large power rather than to have efficiency at the receiving end. He went on to say that he believed that with a good receiving set it was, in his opinion, not unlikely that the amateurs would succeed in getting messages across the Atlantic with 100 watts; he was himself contemplating a set of this power with a view to doing this, and pointed out that he had succeeded in working regularly with an amateur in Surrey with an input of less than 1 watt. He said, in conclusion, that he hoped the British Post Office authorities would let all amateurs work on any wavelength under 250 and do away with the longer wave, adding that in his opinion the day would come when amateurs would be compelled to work on long waves, while the commercial stations would use the shorter waves, as these were far better for long-distance work.

Professor Marchant, in proposing a vote of thanks, pointed out that in the early days of wireless, short wavelengths were preferred. Hertz, in his original papers, showed that the rate of radiation of energy was inversely proportional to the square of the wavelength. It was only when very long distances had to be covered that longer wavelengths were used, because it was found that the absorption of the longer waves was less than with the shorter waves. There is, in fact, a best wavelength for any particular distance of transmission, and that for the Atlantic is in the neighbourhood of 7,000 or 8,000 metres. The transmission of Transatlantic signals, therefore, with a wavelength of only 200 metres, is a most interesting and important achievement.

Mr. Forshaw seconded the vote of thanks, which was carried with prolonged applause. About sixty members attended.

The Fifth Meeting of the Liverpool Wireless Society was held on March 9th last, when Mr. H. Clarke, of Liverpool University, delivered a paper on the Thermionic Valve.

Hon. Secretary, Mr. James K. Wilkie, "Avondale," Knowsley Road, Cressington Park, Liverpool.

## Kensington Wireless Society.*

A Meeting was held at 2, Penywern Road, Earl's Court, on Thursday, March 2nd, at 8.30 p.m. After the business of the evening had been transacted the President called upon Mr. Maurice Child to give his lecture on "Transmitters," with "Demonstrations of Adjustments to Transmitting Gear."

Mr. Child commenced by dealing with the early Hertz, Lodge and Marconi oscillators, and demonstrated by means of a large quantity of apparatus, the defects and advantages of condensers, rotary and fixed gaps, tight and loose coupling, etc., in spark transmitting circuits.

A very hearty vote of thanks was tendered to Mr. Child and, after some discussion, the meeting was adjourned.

Hon. Secretary, Mr. W. J. Henderson, 2, Hollywood Road, S.W.10.

### The Wireless Society of Highgate.*

Hon. Secretary, Mr. D. H. Eade, "Gatra," 13A, Sedgemere Avenue, East Finchley, N.2.

The membership of this Society is still increasing, and we have now nearly thirty members on the books. The Society has now been able to arrange to hold its meetings regularly at the Highgate Literary and Scientific Institution, South Grove, Highgate, N., and an aerial has been erected on the roof of that building. A G.P.O. licence, both for receiving and for transmission (artificial aerial only) has been obtained, and a sub-committee has been appointed to deal with the installation of the Society's receiving set. The Society's call letters are 2US.

The following lectures have been given since the last report: February 3rd, Mr. L. Grinstead, "Amplifiers"; February 17th, Mr. D. H. Eade, "The Electron Theory"; March 3rd, Captain W. R. H. Tingey, "Wireless Reception."

The lecture kindly given by Captain Tingey proved most interesting. Much interesting apparatus had been brought by the lecturer, and he illustrated his remarks throughout by experiments. Exceptionally loud signals were obtained, including some music from Captain Tingey's works at Hammersmith, the latter being reproduced on the loud speaker with remarkably little distortion.

The Hon. Secretary would welcome enquiries from anyone interested in wireless who is desirous of applying for membership of the Society.

### Cambridge and District Wireless Society.*

Hon. Secretary, Mr. J. J. Butterfield, 107, King Street, Cambridge.

A very successful meeting was held in the clubroom, Ram Yard, on Wednesday evening, March 8th, when Mr. Farren was in the chair and Mr. Barron, of the Cambridge and Paul Scientific Instrument Company, lectured on "Ray Track Working." Mr. Barron showed a series of lantern slides illustrating the tracks of alpha, beta and X-rays. These were actual photographs and were obtained by photographing the rays at the moment they were shot off from a particle of radium enclosed in a glass chamber containing air saturated with water vapour, and, on the air being suddenly expanded, the rays left a track of vapour behind them. The Ray Track apparatus for showing these tracks was then demonstrated, and thanks are due to the Cambridge and Paul Scientific Instrument Company for the loan of the apparatus. Mr. Barron's kindness for bringing along so much interesting apparatus was thoroughly appreciated.

### Cowes and District Radio Society.*

Hon. Secretary, Mr. A. Ball, "Pretoria," Castle Street, East Cowes, I.W.

The above Society is now in a very favourable position, and upwards of thirty members have now been enrolled. Thanks to our President (S. E. Saunders, Esq., O.B.E.), we have got headquarters, and some very interesting work is being done. Meetings are held every Wednesday evening at 7 p.m., and anyone interested will be cordially welcomed. The annual fee for membership is 7s. 6d.

### Stoke-on-Trent Wireless and Experimental Society.*

To close a very successful year we are holding an Exhibition of Wireless Apparatus in the Town Hall, Burslem, on March 30th, 31st and April 1st. By doing this we hope to encourage amateur wireless in our district. Demonstrations will be given during the time the exhibition is open with various methods of reception of telegraphy and telephony.

Soon we hope to be in possession of a transmitting licence, which will be much appreciated in our town, because at present there is no local transmission of telephony or telegraphy.

Any person interested should apply to the Hon. Secretary, Mr. F. T. Jones, 360, Cobridge Road, Hanley.

### North Middlesex Wireless Club.*

The 86th meeting of the Club was held on the 8th March and was very well attended. The occasion was an Auction Sale and Exhibition of Instruments. There were some excellent instruments on show, but the majority of those brought to the hall were for sale. The autioneers were Messrs. Dixon and Evans, and those who expected the proceedings to be lively were certainly not disappointed.

The President thanked the two gentlemen who had acted as auctioneers, and had materially contributed to the success of the evening.

Particulars of the Club may be had from the Hon. Secretary, Mr. E. M. Savage, "Nithsdale," Eversley Park Road, Winchmore Hill, N.21.

### Bradford Wireless Society.*

Hon. Secretary, Mr. J. Bever, 85, Emm Lane, Bradford.

A meeting was held in the clubroom at 7.45 p.m. on March 10th, with Mr. W. C. Ramshaw, in the chair. After the business of the meeting the Chairman called upon Mr. J. Bever to continue his lecture on the "Principles of Wireless Reception." At the conclusion of the paper a hearty vote of thanks was accorded. The attendance was very good.

### Sheffield and District Wireless Society.*

Hon. Secretary, Mr. L. H. Crowther, A.M.I.E.E., 156, Meadow Head, Norton Woodseats, Sheffield.

On the 24th February, at the Department of Applied Science, George Square, Mr. A. F. Carter exhibited a 7-valve receiving set fitted into a writing cabinet, and gave a practical demonstration. He pointed out the various difficulties which had to be overcome, also the best arrangement to get the maximum results. A critical and informative discussion followed.

On the 10th March Mr. A. Horton read a paper on "Mark III Conversion."

Several converted Mark III sets were exhibited and their advantages and disadvantages pointed out.

### Cardiff and South Wales Wireless Society.*

A general meeting was held at headquarters on Thursday, February 9th, Mr. N. M. Drysdale presiding.

Mr. H. C. Linck delivered a lecture on "Telephone Relays." Mr. Linck is to be congratulated upon the masterly way with which he treated this subject, and a hearty vote of thanks was tendered to him for his interesting lecture.

On Thursday, February 23rd, 1922, Mr. A. H. G. Field gave a lecture on the "Basic Principles of

X-rays." The lecturer dealt with the theory of light and sound, proving that both are produced by vibrations, and it was clear that we were able to get inaudible sound as well as invisible light.

A very hearty vote of thanks was accorded to Mr. Field.

Hon. Secretary, Mr. P. O'Sullivan, 16, Adamsdown Square, Cardiff.

### Burton-on-Trent Wireless Club.*

At a meeting of the Club, held on Friday, February 24th, Mr. A. J. Selby gave an interesting lecture on "Ether Waves and Ideas Obtained from the Spectrum." There was a large attendance, including several visitors. Mr. Selby explained the various groups of ether waves, the nature of light, the origin of colours, and electro-magneto waves. A spectroscope was exhibited and explained. A very interesting discussion followed, and a vote of thanks was accorded to Messrs Selby and Parkin, who kindly lent and demonstrated the spectroscope.

Hon. Secretary, Mr. A. J. Selby, 66, Edward Street, Burton-on-Trent.

### The Lowestoft and District Wireless Society.

Hon. Secretary, L. W. Burcham, "Gouzeaucourt," Chestnut Avenue, Oulton Broad.

The First General Annual Meeting was held on March 7th at the new Headquarters at St. Margaret's Institute, Lowestoft. The President (Mr. C. Chipperfield), in his opening address, reviewed the progress of wireless telegraphy, the useful work done by the society and its members in the past year since the society's inauguration. The number of stations operating in March, 1921, were 5 crystal, 1 valve reception and 1 spark transmitter; to-day there are 10 multi-valve, 3 single-valve, 3 crystal reception and 2 spark and 2 valve and telephony transmitter stations in operation.

The balance sheet presented by the Treasurer showed a modest balance in hand of 11s. 2d. on the year's financial transactions. There being no discussion, the balance sheet was adopted.

Ballot papers were then distributed for the election of officers, etc. In the Chairman's report on the work for the forthcoming year, details were given of the proposed exhibition, to be held in Lowestoft on the 3rd and 4th August of this year, also various schemes for field days and outdoor work. The Secretary's report on fees, etc., is as follows: Members' fees, 7s. 6d. per annum and 5s. after September 1st; Associates, 3s. per annum and 2s. after September 1st; also a levy of 6d. per month to be made to cover cost of clubroom.

The result of the election being to hand, the Chairman announced that the Officers and Committee had all been unanimously re-elected. The Committee is preparing new fees for provincial members. Will all those interested in the Society please communicate with the Secretary.

### The Leeds and District Amateur Wireless Society.*

A General Meeting was held at the Leeds University on February 24th. At 8 p.m. Mr. G. P. Kendall, B.Sc. (Vice-President), took the Chair and called upon Mr. C. P. Hall to deliver a paper on "The Theory of the Valve." This lecture had been specially arranged for the junior members, who turned up in large numbers and benefited greatly as a result of the lecturer's remarks. Apparatus, kindly loaned by our President (Professor R. Whiddington, M.A., D.Sc.), was exhibited by Mr. Hall, who at the close of his paper and discussion demonstrated the method of plotting valve curves. A hearty vote of thanks was accorded to Mr. Hall.

Mr. Kendall then vacated the Chair, Mr. A. M. Bage presiding. The Chairman called upon Mr. Kendall to deliver his paper on "High Frequency Intervalve Transformers." The lecturer briefly outlined the essential differences between H.F. and L.F. intervalve transformers, both from the electrical and mechanical points of view. At the close of the discussion a vote of thanks was proposed and carried amid loud applause.

Mr. A. M. Bage exhibited a "Bage" loud-speaking telephone at the meeting, the instrument having been constructed at home.

On Friday, March 10th, at the Leeds University the Morse class was under the direction of Mr. P. Cockroft. At 8 p.m. Mr. A. M. Bage (Vice-President) took the Chair.

Mr. R. E. Timms delivered his lecture on "High Speed Line Telegraphy." Amongst the very numerous apparatus on view were a Creed perforator, a Wheatstone transmitter and a printing receiver, all of which were described in some detail. A discussion followed, after which the apparatus was closely examined by a very enthusiastic audience. A hearty vote of thanks was accorded to Mr. Timms and delivered after the usual manner.

Hon. Secretary, Mr. D. E. Pettigrew, 37, Mexborough Avenue, Chapeltown Road, Leeds.

### Wireless and Experimental Association.*

At a meeting at the Central Hall, Peckham, on March 2nd, members turned their attention to the previous night's reception of the Princess Mary wedding music. All members agreed that the modulation was as nearly perfect as possible and the Secretary was instructed to write to the Marconi Scientific Instrument Company to express their thanks.

At the Central Hall, Peckham, on Wednesday, March 8th, the Committee considered the proposals of the London Wireless Society with regard to representations to the Postmaster-General for revising the regulations applying to wireless amateurs. After a prolonged discussion it was unanimously agreed that the London Wireless Society had handled the matter in a splendid manner, and pledged the Wireless and Experimental Association to support unreservedly the steps that had been and were being taken.

Hon. Secretary, Mr. Geo. Sutton, A.M.I.E.E., 18, Melford Road, S.E.22.

### Plymouth Wireless and Scientific Society.*

On Wednesday, February 8th, the members of the Society attended a lecture of the Junior Institution of Engineers, on the subject "Alternating Current Motors."

On February 15th the ordinary weekly meeting was held, at which a lecture on Radium and Radio-Activity was given by Mr. C. E. Harris. Dealing with the subject historically at first, the lecturer mentioned the work of Becquerel, the Curies, and Rutherford.

On Wednesday, February 22nd, an exhibition of apparatus was held at Plymouth Technical College. Several complete sets were on view and at work. Some very fine signals were obtained on a 5-valve set, with separate heterodyne. A show of various wireless components of Messrs. Auckland proved a centre of attraction.

On Wednesday, March 1st, a lecture was given by Mr. P. Arberry on "Heterodyne and Autodyne." The lecturer himself is an enthusiastic believer in separate heterodyne, but succeeded in giving us a perfectly unbiased account of the two methods.

There is still plenty of room in the Society for new members, and the Hon. Secretary, Mr. G. H. Lock, 9, Ryder Road, Stoke, Devonport, would be glad to hear from prospective members.

**The Wireless Society of Hull and District.***

At a recent meeting, Mr. J. Nicholson, A.M.I.M.E., gave some very useful advice on the upkeep and care of accumulators, which are so essential to all wireless experimenters in these days of valve reception. Mr. W. J. Featherstone occupied the chair, and at the close of the meeting moved a vote of thanks to the lecturer.

On Monday, February 27th, a meeting of the committee was held under the chairmanship of Mr. Henry Strong (Vice-President), when a number of matters were dealt with. The Hon. Secretary reported that the membership had now reached 34, and that the funds in hand amounted to £10 15s. 8d., which was considered very satisfactory.

Mr. G. H. Strong (President) occupied the chair at the ordinary meeting of members which followed, when there was a good attendance to hear a paper read by our Vice-President, Mr. Henry Strong. The lecturer treated those present to a clear explanation of elementary electricity and magnetism which led up to present day wireless.

Mr. Henry Strong was accorded a hearty vote of thanks on the proposition of Mr. J. Nicholson.

The fortnightly meeting of the Society was held on Monday, March 6th. Mr. G. H. Strong (President) presided over a good attendance of members.

After some routine business was dealt with, Mr. Henry Strong, A.M.I.N.A., M.I.Mech.E., gave a very comprehensive and instructive paper on "Valves." At the conclusion the lecturer was heartily thanked on the proposition of Mr. Jephcott, which was seconded by Mr. Snowdon.

Further intending members will be welcomed, and should apply for particulars to the Hon. Secretary, Mr. H. Nightscales, 16, Portobello Street, Hull.

**Southport Wireless Society.***

Hon. Secretary, Mr. W. E. Otter, 5, Tower Buildings, Leicester Street, Southport.

The usual weekly meeting was held in the Queen's Hotel, Promenade, Southport.

It was announced that the late Secretary, Mr. Eustace Field, had been re-elected Associate I.R.E.

Will all interested in wireless in Southport or Birkdale district, please communicate with the Hon. Secretary.

Since the purchase of a four-valve German low-frequency amplifier, signals are not so elusive, and the Club-room is to be repaired during the next few days, thanks to our Chairman and a few members.

**The Thanet Radio and Experimental Society.**

All communications to be sent to the Hon. Organising Secretary as below.

The above Club had a very successful show and demonstration of wireless apparatus at the Art and Industries Exhibition, held at the Margate Pavilion and Winter Gardens, January 25th to February 4th. (A description will be published later)

As members are coming in from the surrounding towns it has been decided to alter the name of the Club to The Thanet Radio and Experimental Society, and a long and useful life of this Society is confidently anticipated.

Hon. Secretary, J. H. Byes, 33, Richmond Avenue, Margate.

Hon. Organising Secretary, Mr. H. M. Wainman, 10, Norfolk Road, Margate.

**Edinburgh and District Radio Society.***

A General Meeting was held on March 1st. Business being concluded, the chairman expressed his appreciation in welcoming Mr. Forbes Boyd, of the Sheffield Society, who had so kindly come forward to give a paper on "Direction Finding."

Mr. Forbes Boyd dealt with his subject as very few others could have done, explaining where improvements were required and how, in spite of innumerable difficulties, they had been achieved.

After the usual discussion the meeting expressed their gratitude to Mr. Boyd, in passing a very hearty vote of thanks.

Hon. Secretary and Treasurer, Mr. W. Winkler, 9, Ettrick Road, Edinburgh.

**The City and Guilds Wireless Society.***

The above Society held a General Meeting on Wednesday, February 8th, with Mr. H. J. B. Chapple, B.Sc., in the chair. Business being concluded, the President (Professor E. Mallett, M.Sc.) delivered an address entitled "Wired Wireless."† The address was devoted to an outline of the subject upon which Professor Mallett has done much research work, and was presented to a good audience in a most interesting form. The subject is one which is still in its infancy, and not well understood, though its possibilities in long-distance telephony are very great.

At the close of the meeting a very hearty vote of thanks was accorded the President.

**Preston Scientific Society.***

A General Meeting was held in the Society's rooms, 119a, Fishergate, on December 19th, 1921, when the following Officers and Committee were co-opted to carry on until the Annual General Meeting to be held on Monday, March 27th, 1922. Chairman, Mr. W. J. Rolfe, A.M.I.E.E.; Vice-Chairman, Mr. W. Paddock; Hon. Secretary, Mr. A. Pickering; Committee, Messrs. J. H. Morris, J. N. C. Bradshaw, W. J. Bryce, W. Beattie, A.M.I.E.E., C. C. Breakall, T. Melling and W. Danson.

On January 18th a lecture on "Wireless Telegraphy and Telephony" was given by Mr. W. Paddock, before an audience numbering 80.

A lecture on "High Frequency Amplifying" was given on February 6th by Mr. J. N. C. Bradshaw.

Will members please note that meetings will be held every Monday evening until further notice. Any particulars of membership will be supplied on application to the Hon. Secretary, A. Pickering, 16, Bispham Street, Preston.

† This paper will be published in a subsequent issue

### Brighouse and District Wireless and Experimental Society.

The first meeting of the above Society was held in the lecture room at the Liberal Club on Monday, February 13th.

It is proposed to hold instructional and buzzer practice classes one night each week.

In the winter session a series of lectures will be held.

Mr. R. A. Blakeborough, Toothill Hall, Rastrick, was elected President.

Although new, the society has now about 26 members. Will anyone interested in the society please communicate with the Secretary, at Oak View, Rayner Road, Brighouse. The headquarters of the Society will be notified later.

### Redhill and District Y.M.C.A. Wireless Society.

On February 8th an exhibition of members' apparatus was held. A coil winding machine by Mr. J. S. B. Clarke, was one of the attractions.

On February 15th, Mr. R. L. Dawson gave a very interesting lecture on inductance, giving the various formulae used in its calculation, and explaining their derivation. He was accorded a hearty vote of thanks for his efforts, his lecture being greatly appreciated by those present.

An interesting demonstration of a two-valve receiver was given by Mr. J. S. B. Clarke on March 1st. He showed the connecting up, and members had an opportunity of trying the set for themselves, from which much amusement was derived.

The Society's licence having been obtained it was decided to erect the aerial as soon as possible.

### Dundee and District Amateur Wireless Association.

At a meeting of the above Association held at the Club Rooms, Morgan Academy, Dundee, on Tuesday, February 17th, Mr. R. L. D. Kennedy lectured on Set Construction.

As the Club valve set is built on the same lines as Mr. Kennedy's own set, members obtained the additional advantage of listening to a most interesting lecture, in which the Club set was included.

Hon. Secretary, Mr. R. H. B. Candow, 33, Cowgate, Dundee.

### Bolton Wireless Society.

Hon. Secretary, H. Chadwick, 9, Raimond Street, Bolton.

On Tuesday, February 14th, in the new headquarters, Bradford Buildings, Mawdsley Street, the Society had the pleasure of making the acquaintance of Mr. J. McKernan of the Manchester Wireless Society, and spent a very absorbing evening on the wonders of "High Frequency Currents."

The lecture was ably given by Mr. McKernan, and was repeatedly illustrated with practical experiments, the instruments forming a very imposing show when arranged on the table. Mr. McKernan was warmly thanked and applauded for his efforts.

A sale of members' spare gear was held in the headquarters on February 21st, and continued on the 24th. The Society benefited by a prearranged percentage on all sales.

On Tuesday, March 7th, we were honoured by a visit from Mr. W. R. Burne, who is now so well known as to need no introduction.

Mr. Parkinson, in the chair, called upon Mr. Burne to give a few words of advice regarding wireless telegraphy working.

Mr. Burne responded with a description of various types of high frequency amplifiers, about which most of us know so little. He described the resistance, reaction and transformer coupled circuits, the last named being dealt with in detail, as it is in this type that most of us are interested, Mr. Burne having used them in the Tests.

At the conclusion of the lecture Mr. Burne was kept busy answering questions, and some very knotty points on high frequency work were straightened out, after which Mr. Parkinson moved a vote of thanks; this was heartily accorded by all present.

Hon. Secretary, Mr. H. Chadwick, 9, Raimond Street, Hallwell, Bolton.

### Southampton and District Wireless Society.

Hon. Secretary, Mr. T. Cutler, 24, Floating Bridge Road, Southampton.

A very successful meeting of the newly formed Society was held in the Kingsland Assembly Rooms, Southampton, on Wednesday, March 8th. Arrangements were made for the buzzer practice, etc. The Club aerial will be erected in the course of a week. Application is being made for the use of receiving and C.W. transmitting gear, and it is hoped that concerts will be given weekly. Mr. Freeman was elected Chairman. The aims and objects were discussed and rules drawn up and confirmed.

New members will be welcomed, and enquiries from anyone in Southampton and district interested will be gladly answered by the Secretary.

### Hounslow and District Wireless Society.

The above Society have secured permanent headquarters at the Council House, Hounslow, where they hope to settle down to serious work. The Society is still handicapped for apparatus, but hope to get this as they go along. A junior section has now been formed, and in time should be a great success. Application has been made for affiliation to the London Wireless Society.

On February 16th a demonstration and lecture was given by Captain Tingey. The lecturer first dealt with the aerial earthing arrangements. He next proceeded to demonstrate his apparatus, showing both low frequency and high frequency amplification.

Mr. A. R. Pike thanked the lecturer and proposed a vote of thanks which was heartily carried.

Meetings are held at the Council House, Hounslow, each Thursday at 8 p.m.

Hon. Secretary, Mr. A. J. Rolfe, 20, Standard Road, Hounslow.

### Ilford and District Radio Society.

This Society has been fortunate in securing more central headquarters at St. Mary's Church School, Ilford.

A most enthusiastic gathering listened to a lecture given by Captain Tingey on January 18th, the subject being "Faults," which were dealt with in a very practical manner. The lecture was much appreciated by all present.

On February 8th, Mr. Rope, one of the Society's members, gave an instructive address on Accumulators, and many of us learned to appreciate more the value of this important piece of apparatus and will certainly give it more care and thought in the future.

On March 2nd, Mr. Welsh, the Senior Vice-President of the Society gave his long-promised lecture on "Alternating Currents." The lecturer at the close was asked many knotty questions which he ably answered.

Hon. Secretary, Mr. Lionel Vizard, 12, Seymour Gardens, The Drive, Ilford.

### The East London Radio Society.

Hon. Secretary, Mr. L. E. Lubbock, Hay-Currie School, Poplar, E.14.

The above Society has been very fortunate in having two rooms put at their disposal. One in the Lecture Hall, Woodstock Road, and the other in King George's Hall. Though recently formed, we are pleased to report that substantial progress has been made, and the membership now totals fifty. Meetings are held on Tuesday evenings at 7.30 when practical work and experiments are carried out, and on Saturday afternoons from 3 p.m. to 5 p.m. for lectures.

On February 11th a demonstration in Wireless Telegraphy and Telephony was given by Mr. F. O. Read, on apparatus kindly lent by Messrs. Burnham of Deptford. The meeting was well attended, and we are greatly indebted to Mr. Read for a very instructive and enjoyable evening.

A series of lectures has been given by Mr. Haines and Mr. Keens; the former on the construction and working of one and two-valve sets, and the latter on High Frequency Currents, and the Action of the Telephone.

Arrangements are being made for affiliation with The Wireless Society of London.

### Wolverhampton and District Wireless Society.

At an informal meeting held at 26, King Street, Wolverhampton, on March 1st, it was decided to form a Wireless Society for Wolverhampton and District. Twenty-four prospective members attended and were enrolled, and as many others who were unable to be at the meeting have expressed their desire to join, there is every prospect of a strong membership. The following officers were elected :—

Chairman, Mr. H. H. Speke; Hon. Secretary (*pro tem.*), Mr. G. W. Jones; Hon. Treasurer, Mr. F. G. Redhead; Committee, Messrs. H. Stevens, H. Taylor, H. L. Freakley, J. H. Devey, T. W. Higgs, Geo. W. Fairall.

The second General Meeting was held on Wednesday, March 15th, Mr. H. H. Speke in the chair. There was again a very good attendance and several new members were elected. Mr. G. W. Fairall was elected Vice-Chairman, and Mr. Douglas Baker was elected to take his place on the Committee.

During the evening one of the members Mr. H. Taylor, **2KQ**, was tuned in as he was turning out gramophone music. Mr. G. W. Jones, afterwards gave a few hints and tips on the best methods of receiving telephony, and all were interested. Proceedings terminated at 10.30 p.m. Everyone is looking forward with great interest to future meetings, which will be held every week, on Wednesday evenings at 7.30 p.m.

The Hon. Secretary, Mr. Geo. W. Jones, will welcome any applications for membership at 8, Roseberry Street, or at the Headquarters, 26, King Street, Wolverhampton.

### The Wallasey Wireless and Experimental Society.

Hon. Secretary, Mr. C. D. M. Hamilton, 24, Vaughan Road, New Brighton.

The Society held their seventh evening meeting on Thursday last, at 106, Albion Street, Mr. J. C. Mason in the chair.

The first half of the meeting was principally business, and an excellent syllabus for the coming session was arranged.

The remaining time was taken up by general discussions, many questions being asked and ably answered by the members. Affiliation with London is being arranged.

### Grimsby and District Radio Society.

An efficient and comfortable Club-room has now been secured by the above Society. On March 7th a meeting was held, there being 21 members present; Mr. Hewins (President) Mr. Rushton and Mr. Wood (Vice-Presidents) all demonstrated their apparatus, and an enjoyable evening was spent by all.

Meetings will be held each Tuesday evening from 7 p.m. to 10.30 p.m. in the Club-room at The Lincolnshire Motor and Electric Traction Co.'s Offices, Wellowgate.

Hon. Secretary, Mr. J. H. Perkins, 35, Hare Street, Grimsby.

### Richmond and Kew Wireless Society.

The above Society has now been formed, and meetings are held at 3, Lonsdale Mews, Sandycombe Road, near Kew Gardens Station.

During the last two meetings the following have been elected :—President, Mr. H. Lloyd; Vice-President, Mr. T. Golding; Secretary and Treasurer, Mr. A. J. Richardson; Assistant Secretary and Treasurer, Mr. P. Kendrick.

Already an aerial has been erected and a complete set of instruments installed.

Correspondence and applications for membership should be addressed to the Hon. Secretary, 14, Forest Road, Kew.

### Ipswich and District Wireless Club.

It is with the deepest regret we have to chronicle the death, on January 29th, of Mr. W. C. Firman, of our Committee, and one of the oldest pre-war amateurs in the district. A letter of condolence was sent and our Treasurer (Mr. Keeble) represented the Club at the funeral. A wreath was also sent by members of the Club.

Our local Member of Parliament (Sir F. J. C. Ganzoni) has kindly consented to become First President of the Society. The Club set is now working and buzzer practice is indulged in every Monday night for a short period.

### Ealing.

Mr. W. F. Clark, 52, Uxbridge Road, Ealing, W.5., will be pleased to hear from any gentlemen willing to help form a Wireless Society for Ealing.

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**Note.**—In bringing reports up to date, owing to the change from fortnightly to weekly issue, it is regretted that it has been necessary to considerably curtail many of the reports in order that future reports may receive prompt publication. [Ed.]

# Questions and Answers

*NOTE.—This section of the magazine is placed at the disposal of all readers who wish to receive advice and information on matters pertaining to both the technical and non-technical sides of wireless work. Readers should comply with the following rules.—(1) Each question should be numbered and written on a separate sheet on one side of the paper only. (2) Queries should be clear and concise. (3) Before sending in their questions readers are advised to search recent numbers to see whether the same queries have not been dealt with before.* **(4) The Editor cannot undertake to reply to queries by post.** *(5) All queries must be accompanied by the full name and address of the sender, which is for reference, not for publication. Queries will be answered under the initials and town of the correspondent, or, if so desired, under a "nom de plume."* **(6) Readers desirous of knowing the conditions of service, etc., for wireless operators will save time by writing direct to the various firms employing operators.** *(7) Four questions is the maximum which will be accepted at a time.*

**"NOVICE" (Edinburgh)** *asks questions about a single valve receiver.*

(1) Connections are all correct. There is no need to use No. 47 wire for external connections to H.T. and telephones. Use any convenient wire a good deal coarser than this. The condenser capacities are correct.

(2) If the reaction coupling is strong enough a parallel condenser of about 0·0008 mfds. may be used with the aerial condenser shown without a great loss of efficiency.

(3) The reaction coil should be placed against the A.T.I. coil. There will be no coupling in the way you propose.

(4) We are afraid you will not hear either of these stations owing to the great distance.

**F.N. (Oldham).**—(1) The circuit is correct, except that the blocking condenser should be connected across both H.T. and telephones: 0·006 mfds. is rather a large value.

(2) Yes.

(3) With an indoor aerial there is not much choice, except to have as much wire as possible without allowing one length to turn back on another so as to balance out any signal induced in it.

(4) A 2½″ former, 10″ long, full of No. 28, should be a suitable reaction coil.

**A.P.S. (Cape Town)** *asks for details of chokes for a set as described on page 533, November 26th issue.*

We are sorry that we have no information regarding this circuit beyond that given in the article in question. Chokes of this sort are best determined by experiment.

**R.K.C. (Liverpool)** *asks* (1) *The identity of the telephony station sending during the afternoon on about 2,000 ms.—apparently in French.* (2) *For the best 3-valve circuit for telephony.*

(1) This station may be FL (Paris) who sends daily on 2,600 ms. There is, however, a new station sending music on about 1,900 ms. who is at present unknown to us.

(2) The best circuit to use is a H.F. amplifier with either resistance or a transformer coupling between the valves.

**A.T.N. (Croydon)** *asks* (1) *If it matters if two wires of the aerial are not of the same gauge.* (2) *What wire to use for leading-in.* (3) *for a single valve diagram.* (4) *The range of his set.*

(1) It is immaterial.

(2) Use the same wire as for the aerial, without a break in it if possible.

(3) See page 584, Fig. 2, December 10th issue, omitting the condenser across the anode inductance.

(4) The maximum wavelength will be about 3,500 ms.

**G.F. (Walworth)** *asks* (1) *For criticism of a crystal set.* (2) *For dimensions for a frame aerial to use with it.* (3) *If the circuit is incorrect, for a better one.* (4) *If a telephone transformer is necessary with L.R. telephones.*

(1) The circuit shown is correct, and the dimensions of the parts are also right.

(2) A frame aerial is entirely useless with a crystal set.

(4) Yes, a telephone transformer is desirable with nearly all crystals.

**"NEMO" (Wilts)** *has a resistance amplifier which gives disappointing results, although each part of the circuit except the grid condensers and leaks appears to work well when used in other ways. He asks for suggestions.*

0·001 mfds. is large for a grid condenser, try about 0·0001 mfds. Your resistances may be faulty. Some of the grid leaks on the market are of very doubtful accuracy and permanence. Try removing the leaks. If this improves results, either the leaks are too low, or the condensers themselves are leaky. Possibly you are not using enough H.T. volts. A valve used in this way requires greater H.T. than when used in any other way.

**L.H.B. (Luton)** *asks for a diagram of the connections of a valve panel, containing filament res., grid condenser and leak.*

See diagram Fig. 1 for a panel for single-valve work.

**"GRID" (Brighton)** *asks for particulars of winding of a set of slab coils for a range of 300-30,000 ms.*

See reply to **W.H.D. (Leeds)** above. The amounts of wire required will be approximately the same for slab coils as for duo-laterals.

**"AEROLUS" (Whitefield)** *asks* (1) *Which is the better of two sets described.* (2) *Where he can obtain "watersheds" for aerial insulators.*

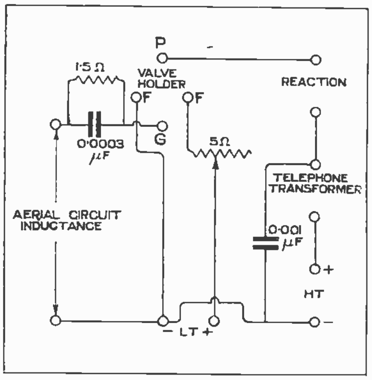


*Fig.* 1.

(1) You do not give sufficient particulars to make an accurate estimate.

(2) Inverted cone watersheds of the type you sketch should be obtainable from almost any dealer in wireless sundries. Amongst other firms, the Marconi Company make a good type.

**F.T. (Birmingham)** *asks* (1) *Whether certain stations will be audible on a single valve set.* (2) *Winding for an A.T.I., using No. 27 wire, to give 7,000 ms., with a parallel condenser of 0·0005 mfds.* (3) *If a crystal set sketched will be satisfactory.* (4) *The names of the following spark stations:* **CO** and **MO.**

(1) The stations referred to are Belgrade, Vienna, Sofia, and Moscow. It is possible to receive all of these stations on a very good single valve set, skilfully handled, but they are not at all easy to get with a set of this type.

(2) 10″ × 7″.

(3) No, put the telephones in series with the condenser.

(4) We have no information.

**"AMATEUR" (Newcastle)** *asks* (1) *Whether it would be better to use an aerial condenser of 0·001 or 0·0015 mfds., with honeycomb coils.* (2) *If it is possible to receive the Dutch concert with a 2-valve L.F. amplifier.* (3) *If a 0·0006 mfds. condenser will be of any use across a reaction coil.*

(1) This depends to a certain extent on the windings of the coils, about which you say nothing. In general, however, it will not make much difference.

(2) We do not think so.

(3) No.

**A.C. (Bexhill)** *asks* (1) *Who transmitted the tune "I want to go home," with various other tunes on Sunday (which Sunday is not specified) about 3.30 p.m.* (2) *What was the wavelength.* (3) *Will they do it again.*

(1), (2) and (3) We do not know. In general it is quite impossible to answer questions of this nature.

**G.H.M. (Anfield)** *sends a diagram of a 3-valve set, which will not give telephony on about 400 ms., gives fair results on longer wavelengths, but does not give* **PCGG.** *He asks for criticism and advice.*

Valves are arranged as detector followed by 2 L.F. This alone is sufficient to explain why you do not get **PCGG,** for which you would want at least one stage of H.F. For short waves do away with the parallel A.T.C. The probable reason for your not getting short wave signals is that your aerial is not tunable to the short wavelengths. We cannot say for certain as you give no particulars.

**S.C.P. (Derby)** *asks* (1) *Whether a Weston relay, sensitive to 50 microamps. could be used in conjunction with the Turner relay circuit.* (2) *Whether a 2-valve resistance amplifier could be used with the above to work a siphon recorder.* (3) *If not, for a suitable circuit for 2 valves.*

(1) Yes, but a somewhat coarser type of relay may be used instead if you wish. The Turner circuit gives enough current to work a P.O. type relay at reasonable speeds, and this type of relay is generally less liable to get out of order and give trouble.

(2) & (3) The suggested circuit will be as good as any for fairly long wavelengths, but we should prefer the tuned transformer type at short wavelengths.

**W.H.D. (Leeds)** *asks* (1) *For the amount of No. 26 D.C.C. necessary to make duolateral coils for a single valve receiver ranging up to 30,000 ms.* (2) *How to connect up the coils to a multiple switch so that they may be used alternatively.*

(1) With a parallel condenser of 0·002 mfds., you will require for the largest coil about 1½ lbs., which will give a coil of 4″ mean diameter and about 1,200 turns. The other coil should be intermediate between this and about 1 oz.

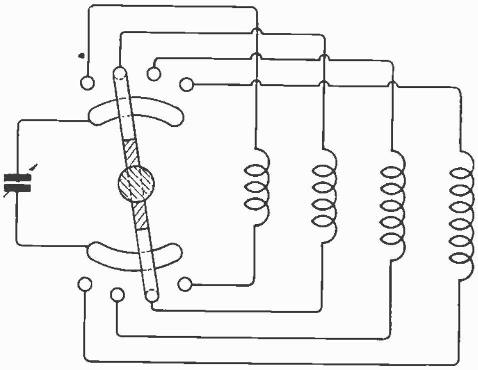

*Fig.* 2.

(2) A switch can be arranged as in the diagram Fig. 2, but we do not recommend it. It is better to connect each coil into the circuit as required. This can be done almost as easily as switching if suitable plug connections are used.

**H.S.W. (Leytonstone)** *asks various questions about a receiving set.*

(1) The general arrangements will be all right, but it will not be necessary to make such elaborate tuning arrangements for the reaction coil. A single coil with a few tappings without dead end switches will be all right for this, and do not use a condenser across it.

(2) About 2 lbs. of No. 26.

(3) It is quite impossible to predict the positions for the tappings for such a list of wavelengths. You would have to determine them by experiment, but it will be much better to tap the coil so that each tapping increases the inductance by about the same proportionate amount, and be satisfied with the results obtained.

(4) The capacity in each circuit should be about 0·001 mfds.

across the 500 turn coil, which discharges itself regularly when the potential across it rises above a certain value.

(2) One turn is best, but three or four may be used without appreciable ill effect.

(3) Almost immaterial, except that solenoids are rather more convenient at short wavelengths.

**E.H.G. (Glasgow)** *asks for criticism of a set, and for details of the size of parts.*

The sketch you send is unintelligible, as it appears

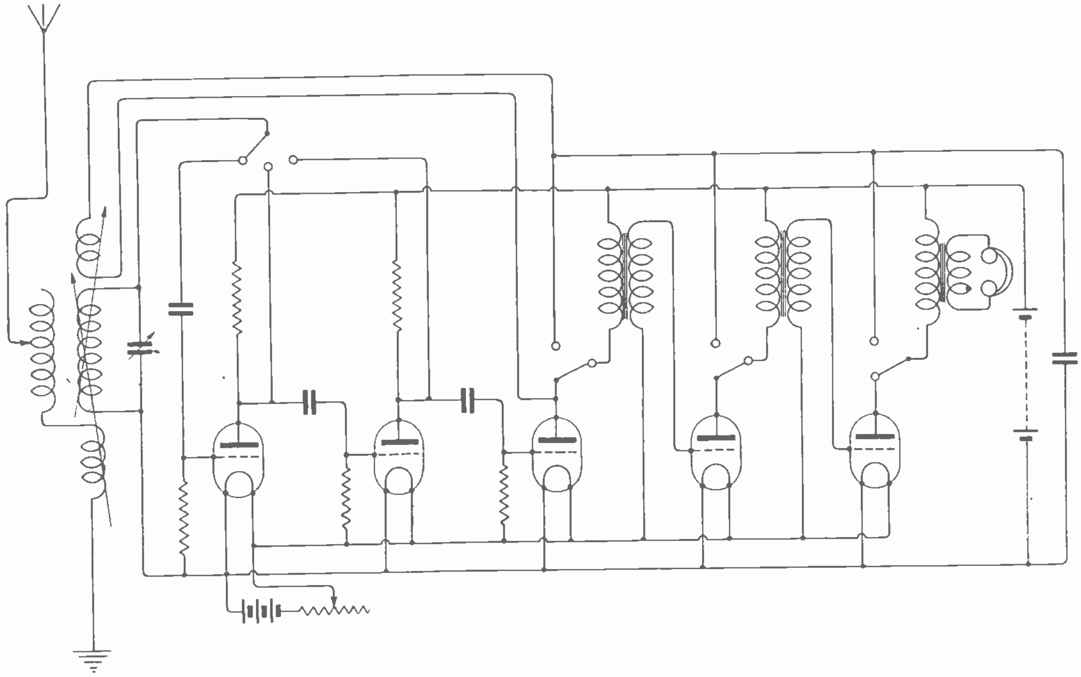

*Fig. 3.*

**H.W.K. (Greenwich)** *asks for a 5-valve circuit to comply with certain switching requirements for altering the arrangement of the valves.*

Simplifying the diagram by the omission of filament switches, the circuit shown (Fig. 3) should give you the desired switching facilities.

**J.D.M. (Oundle)** *asks for a criticism of a circuit, and how it may be improved.*

The circuit shown is correct as far as it goes. It would be improved by a potentiometer to the grid of the first valve, also by a telephone transformer and L.R. telephones. Separate resistances to the filaments of each valve are hardly necessary.

**F.H.C. (Huddersfield)** *asks* (1) *For advice on a set which is giving trouble and* (2) *If slab coils should be wound with only one turn of wire in the width, or whether three or four turns may be used.* (3) *If a loose coupler (presumably of solenoid form) is better than slab coils.*

(1) The presence of the click indicates that the set is osciIalting. The beat you hear makes us suspect that there is a partial short circuit

to show two L.F. transformers between each pair of valves, with reaction *ad lib.* The set might be of some use if the transformers near the plates were H.F., but if this is the case the final reaction is led back to the wrong transformer in the first plate circuit. We are afraid the set would be rather unmanageable. There will be nothing abnormal about the dimensions, and we think that if you are capable of making and handling a set of this type you will be able to collect the dimensions you require from the many sets illustrated recently.

**W.J.E. (Skipton)** *has a short wave set which will not give signals. He asks for advice.*

You do not need a 0·001 mfds. parallel condenser for short wave work. Cut it out entirely. Are you certain you are using enough H.T. volts? Put the telephones on the earth side of the H.T. battery, which should then be well insulated. Possibly the grid condenser, leak, or the valve is defective.

**A.C.H. (Smethwick)** *asks* (1) *For a circuit diagram to cover certain alterations to his set.* (2) *What is the station with call letters* P.J.

(1) See diagram Fig. 4.
(2) Not known.

**W.E.S. (Haslemere).**—We see no reason why the set should not oscillate below 2,000 metres, or even 1,000 ms., as it stands. Capacity reaction is at times uncertain at short wavelengths owing to stray capacity effects, but this should not give trouble at such comparatively long wavelengths. Magnetic reaction will certainly allow you to get below this. Possibly your reaction condenser is altogether too large. It should be of the order of 0·0005 mfds.

**RADIO (Cardiff)** *asks* (1) *If a 2-valve set connections are correct.* (2) *If a grid potentiometer will be of any advantage.* (3) *If he will hear* **PCGG.**

(1) Your connections are correct, with the exception that the grid leak should be connected to the negative side of the filament instead of the positive as shown. Connect a 0·001 mfds. condenser across the anode winding of the telephone transformer.

(2) You may find it useful if the grid leak resistance is not of the best value.

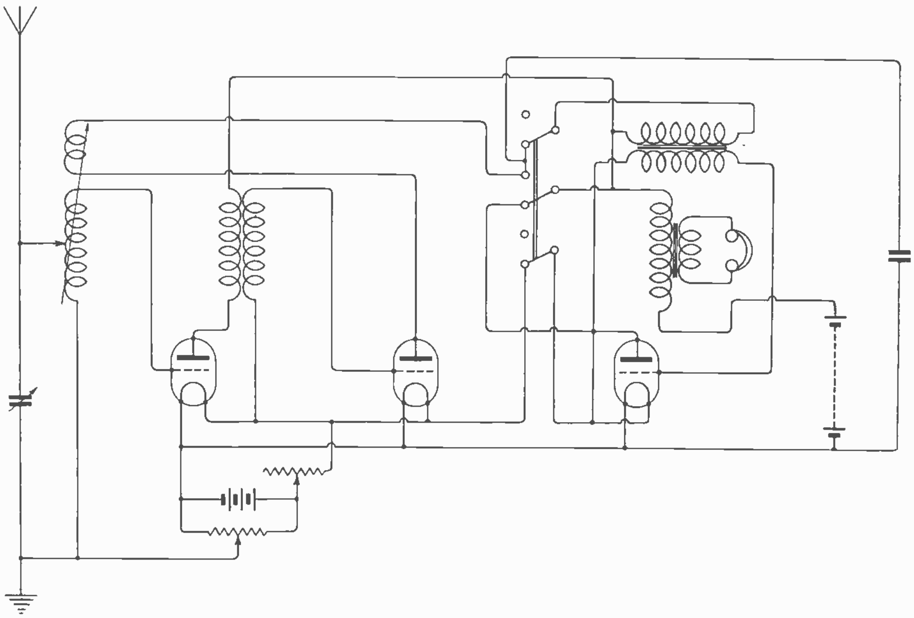

*Fig.* 4.

(3) If the set is carefully adjusted beforehand to the exact wavelength by means of a buzzing wavemeter you may just hear it, but it will be inaudible while searching in the ordinary way. For useful results another H.F. magnifying valve is necessary. For such short wavelengths the A.T.I. and A.T.C. should be in series.

**J.E.D. (Loughborough)** *asks for information about the construction of a multivalve frame aerial set.*

You will find the construction of such a set described in considerable detail in issues Nos. 16 to 21 inclusive of Vol. VIII, which you can obtain from the publishers.

**A.M.L. (Salford)** *asks* (1) *The wavelength of a certain coil.* (2) *For a single valve circuit.* (3) *If the aerial described is suitable for additional apparatus to increase efficiency.*

(1) The inductance is 2,600 mhys., which will tune a P.M.G. aerial (0·0002 mfd.) to approximately 1,400 ms.

(2) The circuit shown on page 584, Fig. 2, December 10th issue (either with or without reaction condenser) should be suitable.

(3) For best results the aerial should be above the two rows of houses if possible.

(4) A single valve set may be made quite efficient up to a certain point. To increase the efficiency additional valves will be required.

**R.T. (Northampton)** *asks* (1) *If a single valve diagram is correct.* (2) *If it is necessary to earth the aerial when not in use.* (3) *What capacity to use with slab coils for 300 to 2,500 ms.*

(1) Yes; connect a 0·001 condenser across the telephones.

(2) It is not essential, but it is quite easy to just join the A.T.I. terminals of the receiver when the set is not in use.

(3) This depends on the number of slabs. The fewer the number the larger the condenser in parallel with the inductance must be to cover the range. If you wish to purchase a condenser and wind the slabs, we suggest 0·001 mfds. as a good value.

# THE WIRELESS WORLD EXCHANGE AND MART

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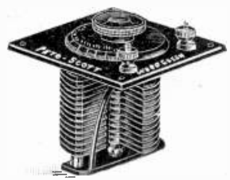


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THE OFFICIAL ORGAN OF THE WIRELESS SOCIETY OF LONDON
A MAGAZINE DEVOTED TO WIRELESS TELEGRAPHY AND TELEPHONY


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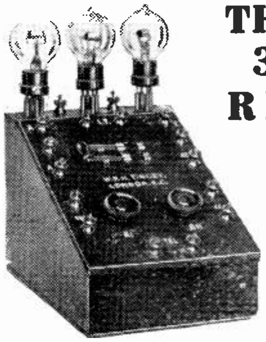

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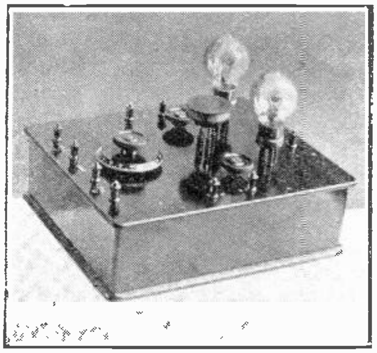

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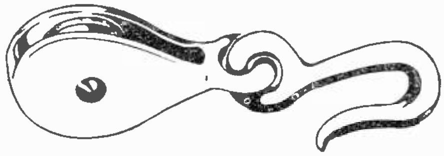

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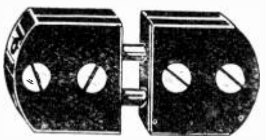

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# THE WIRELESS WORLD AND RADIO REVIEW

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VOL. X. No. 2. APRIL 8TH, 1922. WEEKLY

## The Beverage Antenna

By PHILIP R. COURSEY, B.Sc., F.Inst.P., A.M.I.E.E.

IN the recent short wave Transatlantic Tests during which the representative of the American Radio Relay League—Mr. Godley—listened in at Ardrossan, near Glasgow, he employed not an ordinary form of aerial, but what is usually termed a "Beverage Antenna."* From the description of his experiences, as published in *The Wireless World* for February 4th, 1921, it may be noted that this antenna consists of a long low horizontal wire stretched out on short poles in the direction of the incoming signals. In the actual arrangement used by Godley this wire was supported on poles 12 ft. high, and was at first 1,350 ft. long, but was afterwards reduced to about 850 ft. For the signals on 200 metres wavelength, however, it will be noted that this length is nearly 50 per cent. more than one complete wavelength, so that although the wire was connected to earth at both ends it was evidently not functioning in the manner of an ordinary loop aerial (even of exaggerated size) such as one might at first be led to expect. The fact that one of these earth connections was made through a resistance of several hundred ohms, also disposes of this idea, since the presence of such a large resistance in an oscillation circuit would be very detrimental to its proper functioning.

In what manner, then, does the arrangement work, and in what respects does it differ from an ordinary type of aerial?

To investigate this point it may be of interest to consider the arrangement more in detail. From its great length in comparison with the height of the wire above the ground, it resembles in many respects an ordinary form of overhead telephone line, and hence it is not unreasonable to suppose that the theory of the propagation of electric impulses along telephone lines, should apply also to this case. The complete theory of the propagation of currents and electric impulses along a telephone line is very complex, but fortunately the large quantities introduced into some of the terms in the formulæ when the frequency is very high enable simplifying assumptions to be made. When an electric impulse is applied to such a line a wave will be propagated along it with a velocity which is a complex function of the electrical constants of the line, of the form of

$$V' = \frac{2\pi f}{\sqrt{\frac{1}{2}\left\{\sqrt{(R^2 + 4\pi^2 f^2 L^2)(S^2 + 4\pi^2 f^2 C^2)} - (SR - 4\pi^2 f^2 LC)\right\}}}$$

where $f$ = frequency of the currents
$R$ = resistance of the line per unit length.
$S$ = leakance of the line per unit length.
$L$ = inductance of the line per unit length.
$C$ = capacity of the line per unit length.

When the frequency $f$ is large as in the case of radio signals, the terms involving $R$ and $S$ become negligible compared with the $L$ and $C$ terms, so that the velocity of propagation then depends almost entirely upon the latter pair of line constants. For these high radio frequencies, the velocity $V$ becomes very close to the velocity of light ($3 \times 10^8$ metres per second) but is almost always slightly less than that limiting velocity.

When now a radio signal reaches a wire like the Beverage Antenna, which is stretched out in the direction of propagation of the wave, it will induce an impulse in the wire which will be propagated along the wire with a velocity determined by the electrical constants of the wire as just pointed out. Since the wave along the wire travels slower than the free wave in space, the impulse propagated along the wire will lag behind the electrical forces in the wave outside the wire and will absorb energy from the wave. The intensity of the electrical disturbance in the wire will therefore increase with the distance along the wire. Since the two velocities are different the lag between the wave on the wire and the free wave will increase the further we go along the wire, so that obviously a point will be reached when the phase difference between the two reaches as much as 90° or even 180°. When this occurs any further energy which passes into the wire from the free wave will be in the wrong direction to assist the growth of the impulse, and

* The essential features of this antenna are covered by U.S. Patent No. 1381089.

the resultant effect will then begin to decrease again. Obviously, then, when this occurs, and if the receiving apparatus is to utilise the impulse established in the line, no useful purpose will be served in increasing the length of the line beyond a certain amount.

In the case of an ordinary loop aerial, this maximum effective length is obviously one-half wavelength, since there the phase difference between the two ends of the loop is utilised, but with the Beverage Antenna functioning in the manner just described the length of wire for maximum effect may exceed a complete wavelength, and may often be as much as two or three wavelengths. The greater the difference between the velocities of the wave on the wire and the free wave outside it, the shorter must be the wire in order that the maximum effect may not be passed, and the less the difference of wave velocities the greater can be the length of wire, and consequently a greater effect can be obtained on the receiving apparatus. These differences are illustrated diagrammatically in Fig. 1, which shows the building up of the wave intensity on the wire, (A) when the velocity difference is small: and (B) when it is much greater.

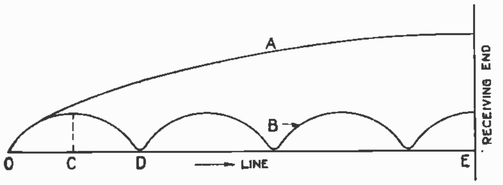



*Fig.* 1.

It will be noted from the foregoing that the impulse builds up on the wire *in the direction of propagation of the wave*, and that consequently the "free" end of the antenna, remote from the receiving apparatus, must point *towards* the transmitting station, and not away from it as in the case of ordinary bent or inverted L aerials. The curves in Fig. 1 may also be taken as representing the signal strengths that would be obtained in a receiving apparatus in the two cases, if the apparatus was gradually moved along the wire from the end O. In case (B), therefore, no advantage is gained by increasing the length of the aerial wire beyond that required to give the first maximum of signal strength, *i.e.*, beyond the length OC, but in case (A) the longer aerial is obviously advantageous.

If we remember that, as pointed out above, the falling off of signal strength that occurs when the wire length is increased from OC to OD (case B) or that would be obtained in case (A) if the length were made greater than OE, is due to the interference set up between the free wave in the space surrounding the wire and the wave propagated along the wire itself, it is evidently possible to make an estimate of the most useful length of aerial wire for any given signal wavelength and difference of velocities. For example, in the case of a signal of 200 metres wavelength, and a wave velocity along the wire of $2{\cdot}65 \times 10^8$ metres per second, the free wave velocity being $3{\cdot}0 \times 10^8$ metres per second, we should expect interference between the two to occur for a length of wire of about 3,000 ft., so that no useful purpose would be served in increasing the wire length in this case beyond 1,400 to 1,500 ft. Now the inductance per km length of a telephone wire of similar type to the aerial used by Godley at Ardrossan would be of the order of about 2·45 millihenries, and to obtain a wave velocity on the wire of $2{\cdot}65 \times 10^8$ metres per second as assumed above, would require that the wire have a capacity per kilometre length of about 0·0058 microfarad—a not unreasonable figure, considering the additional capacity that is unavoidable at each supporting pole.

These rough figures therefore indicate an approximate theoretical basis for the size of aerial used during the Tests.

Now, when a wave is propagated along a wire, and reaches the end of the wire, reflection of the wave will take place, and interference may occur between the initial and the reflected waves, with the production of a stationary or standing wave on the wire. This condition is evidently undesirable from the point of view of the proper operation of this antenna, and means must therefore be taken to eliminate, or at least to reduce this reflection.

Every line, such as we have been considering possesses what is known as a natural impedance or as a surge impedance, which expresses the effect exercised by the line upon a wave travelling along it. Since the energy of a travelling wave such as we are considering, is oscillatory in character, the energy may be regarded as being wholly magnetic at one instant, and later on as being wholly electrostatic, and as oscillating periodically between these two states. Assuming for the moment that the resistance losses in the line are negligible, the maximum magnetic energy will equal the maximum electrostatic energy, or $\frac{1}{2}LI^2 = \frac{1}{2}CV^2$ where $I$ = the maximum current, and $V$ = the maximum voltage, the quantities $L$ and $C$ being the same as already assigned to those symbols, above. Hence, we may write

$$\frac{V}{I} = \sqrt{\frac{L}{C}} = Z_0$$

The ratio $V/I$, which is the ratio of the maximum voltage to the maximum current in the travelling wave, has the dimensions of an impedance, and therefore this quantity $Z_0 = \sqrt{\frac{L}{C}}$ is termed the *natural impedance*, or the *surge impedance* of the line.

When an abrupt change is made in the electrical constants of a line at any point along it, the value of this natural impedance of the line $Z_0$ will usually be changed. This means that on each side of the point of change, the ratio of the maximum voltage to the maximum current in the wave must also have a different value, and consequently reflection of some of the wave energy will take place in passing across the transition point. If, therefore, in passing from a line, such as we have been considering, to some connected terminal apparatus, there is no change made in the natural or surge impedance no reflection of the wave will occur, but if, as is often the case, the apparatus connected to the line offers a different impedance to that of the line, then reflection will take place, and some of the available wave energy will be wasted.

For this reason, then, in the Beverage Antenna, arrangements are made to ensure that the apparatus connected to the line at each end offers the same impedance to the wave as the line itself. Reflection of the wave energy will then be reduced to a minimum. The surge impedance of a line having the constants quoted above works out at about 650 ohms. The value of the earthing resistance used by Godley on his line varied between about 250 and 400 ohms—so that the above rough calculations at least indicate the right order of magnitude for this resistance. Actually, he used the aerial over a band of wavelengths between about 200 and 375 metres, so that the resistance used was not a fixed one, but needed to be varied occasionaly to get the best working adjustments.

The adjustment of the aerial for the reception of different wavelengths is not done by tuning in the ordinary way—the only circuit tuned to the wavelength of the incoming signal being the closed circuit of the receiver coupled to the aerial. Adjustment of the earthing resistance and of the inductance coupling the aerial to the receiver is also necessary in order to secure the proper functioning of the aerial in the manner outlined above, when the wavelength is changed. If this is not done, reflections of the energy may take place, and loss of signal strength will then result. If, however, the resistance of the earth connection itself is large, or the resistance or leakage losses in the wire itself are high, there will be less tendency for the reflection of the wave, and less care will be necessary in adjusting the terminal constants of the line. Such additional losses, however, are likely to cause loss of signal strength as compared with what is obtainable with a low-resistance well-insulated wire.

# Concerning Patents

THE POST-WAR POSITION.

MANY important changes in the normal procedure of securing the protection of Letters Patent for invention necessarily came into being with the outbreak of war. These were originally intended to remain in force until six months after the official ending of hostilities, but actually they were prolonged by subsequent legislation until January 10th, 1921, a period of nearly six and a half years.

The result is that even at the present time, the situation presents many difficulties, both to the inventor who has obtained a patent grant, and to persons who may be anxious to know how they stand with regard to possible infringement of the rights of others.

It is proposed therefore to set out briefly the more important consequences of the changes referred to, with the object of throwing some light on the general position.

The present state of affairs arises from two principal causes:—Firstly, the war emergency measures which were passed at the very outbreak of the war. Secondly, the special legislation that was enacted, after the Armistice, in order to give effect to the provisions of the Treaty of Peace, so far as they related to matters affecting the patent rights of the nationals of the several contracting countries.

*War Legislation.*

It is well known that normally it is necessary to carry out the various stages in the procedure of applying for, and maintaining patent rights, in strict accordance with the specific times laid down in the Patent Acts.

For example, once a provisional application has been filed, the complete specification must be lodged not later than nine months afterwards (1919 Act). By paying an extension fee an additional month is allowed; otherwise the application is dead. Again, in the case where a complete specification is filed in the first instance, there is now an extreme limit of eighteen months within which either the application must be accepted, or it is lost.

Similarly where the holder of a patent has neglected to pay the renewal fees within the stipulated time, his grant is forfeited—unless he is prepared to initiate expensive and troublesome proceedings to obtain a restoration. Even should he be successful in these proceedings, the patent is only revived subject to drastic restrictions.

The upshot of the early war emergency legislation was largely to nullify these time limitations, by giving power to the Comptroller-General of Patents to extend "the times prescribed for doing any act or filing any document" in any case where the applicant or patentee concerned was prevented from complying with the normal procedure by "any circumstances arising from the war."

These extensions were granted in a liberal spirit, not only to British applicants, but also to inventors in allied and neutral countries. As previously stated, such extensions could be granted at any time up to January 10th, 1921, so that, in an extreme case, a complete specification which should have followed up a provisional application lodged some six months (1907 Act) before August, 1914, need only have been actually filed in January, 1921.

Taking into account the necessary time for examination and acceptance of such an application, the invention would probably not be made known to the public generally until towards the end of 1921.

The result might easily prove something of a bombshell to manufacturers or innocent users, say, of an improvement in wireless apparatus, who in face of a patent bearing an effective date early in 1913 might find themselves in danger of an action for infringement unless they promptly ceased to make or use the protected device. (It is hardly necessary, perhaps, to add that in no case can an action be taken for infringement of a patent whatever the original date of the application until the actual patent has been accepted, published and sealed.)

An even greater lapse of time might occur between an application and the grant of the relative patent in the case of applications made from abroad under what is known as the International Convention; but this point will be dealt with later, in considering the effects of the Peace Treaty.

Another important result of the "extension of time" powers is to be seen in its application to the revival or restoration of patent rights.

Take the case of the holder of valuable patent rights granted prior to the war. Owing to the general slump in trade, or to any other cause directly attributable to war conditions, the patentee may have found himself unable to pay the necessary fees at the stipulated time. His rights, in consequence, would lapse; and some astute manufacturer in happier circumstances than the inventor may have seized the opportunity to exploit the article in his own interests.

In such a case, the original holder, by making application, could have his patent restored practically "as a matter of right," and the intruder would at once be forced to abandon further manufacture under the penalties of infringement. He would have no claim whatever to compensation from the restored patentee (as he would in the case of the normal pre-war procedure for restoration) in respect of any money he might have expended on erecting plant, or for time and labour spent in exploiting the invention.

*Peace Treaty Legislation.*

Under the provisions of the Act which gave the force of law to those sections of the Treaty of Peace which concern the patent rights of the subjects of the several contracting nations, a period of six months after the end of the war (subsequently extended until January 10th, 1921) was allowed to both allied and enemy nationals within which they could file patent applications in this country under the terms of the International Convention.

In effect this means that an allied or enemy inventor who had secured a patent grant in his own country at any time within a period starting twelve months prior to the commencement of the war and ending in January, 1921, could apply for protection in this country for the same invention, and obtain an effective date of priority coinciding with that of the foreign patent. As may easily be imagined the resulting inflow of foreign invention which had accumulated during a period of seven and a half years was enormous. In a large number of such cases the patent grant has only quite recently been sealed, and in a few cases is still outstanding, though in the course of the next month or so the process will be completed.

America was not a signatory to the Treaty, but, in effect, citizens of the United States were granted similar privileges under the powers of the war emergency measure.

An important distinction was, however, drawn between the patent rights given in such cases (including American applications) and the complete monopoly grant normally issued to an inventor.

The Peace Treaty definitely provided that such "post-dated" patents should not prejudicially affect the rights of persons here who were already, on or before January 10th, 1921, "*bona fide* in possession of the same invention."

In other words, supposing a British subject to have patented, or even merely to have manufactured or used, a certain device prior to the date above mentioned, then even in the face of a convention patent under the Peace Treaty dating back to the year 1913, he can continue to manufacture or use the device in question *personally* without fear of infringement proceedings on the part of the foreign patentee. Further, suppose he had taken out a British patent for the same invention (but bearing a date later than the effective date of the original foreign patent) and he had prior to January 10th, 1921, issued licences to other persons under his patent, such persons or licensees would also be immune from the penalties for infringement.

This, at all events, is the *prima facie* interpretation of the safeguarding clause relating to "persons *bona fide* in possession of an invention"; but it must be added that the point has not yet been fully dealt with by the Courts, and it remains to be seen exactly what meaning will be imparted to the expression when the matter comes under full judicial consideration.

*Enemy Patents.*

Finally, it should be mentioned that all patent grants issued to enemy subjects before the war (and for a short period during the war) were subsequently vested in the Public Trustee.

They were ultimately restored to their owners in 1920 under certain restrictions regarding the allocation of any money obtained either by their sale, or in respect of licences issued in respect of them.

Apart from these restrictions, restored enemy patentees may now sue for infringement committed either *before* the war, or *after* the date of restoration. It is probable, however, that any damages so recovered would be claimed by the Clearing Office as a pledge against the enemy reparation debt.

The general limitations imposed upon enemy-held patents apply equally to patents held by any limited company the directorate or control of which was mainly in the hands of enemy subjects, even if the Company itself was actually registered in this country. M.A.L.

## Summer Time for Amateur Transmissions.

In reply to a letter addressed to the Postmaster-General, we are notified that, unless otherwise stated in the permit concerned, the hours for transmission allotted to amateur experimenters refer to Summer Time during the period when such time is in operation, and to Greenwich Time at other periods of the year.

# Discussion on Methods of Amplification*

**Mr. C. F. Phillips.**

I am glad we have called this a discussion, as it is no sense a lecture and it would not be quite fair to call it a lecture. My idea in choosing this particular subject was to set out some form of amplifying receiver that anybody could make. We have had quite a number of lectures on scientific subjects of very great interest, but perhaps we ought not to forget that we are an amateur society and sometimes it is as well to talk about things that some of us less technical amateurs really understand.

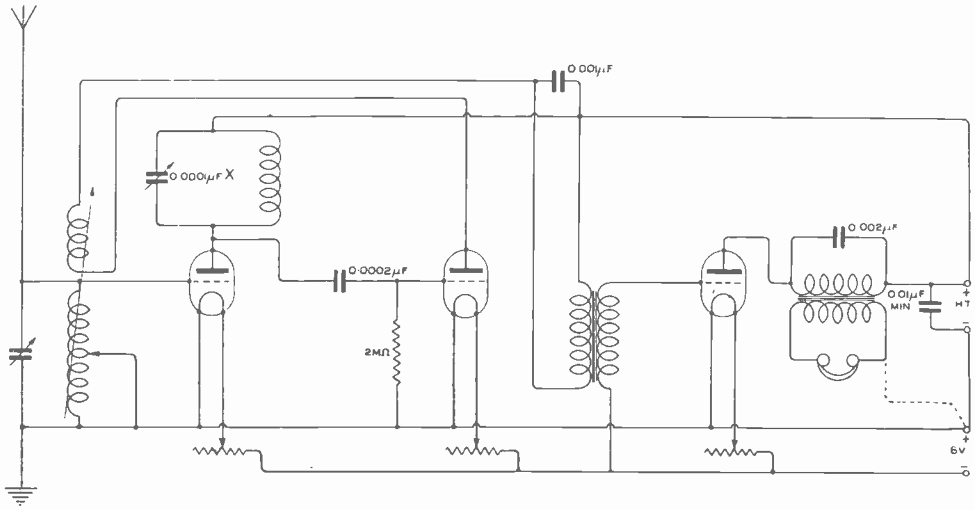



*Fig. 1.*

Now I think that most amateurs are more interested in the manufacture of their own apparatus than in anything else, so without any further delay I propose to describe a little three valve amplifier which can easily be extended into a five or seven valve amplifier and regarding which I propose to give data and my reasons for the selection of the particular methods I use as being preferable to other methods of attaining the same results.

In Fig. 1 we have three valves, viz. :—A radio frequency amplifier, a detector and a note magnifier. I want to draw your attention to the method of using the high frequency valve. I have something to say about both the grid and the plate, but we will deal with the plate first. There are three well-known methods of radio frequency amplification: the first consists in introducing a resistance between the positive side of the high tension battery and the plate in order that an alternating potential may be built up across it and impressed upon the next grid; that system will not work with short waves for reasons into which I will not enter for the moment. Another system which is extremely well known is to connect the plate of the high-frequency valve to the grid of the next valve through a transformer. That system is illustrated in Fig. 2. The third system, which I personally prefer, is very similar to the resistance coupling described above but instead of a high resistance you use a reactance coil. As shown in Fig. 3, the reactance coil is connected in much the same manner as the primary (or input side) of the high frequency transformer. Now I have always contended that ordinary high frequency transformers do not transform. I do not think they do at all. I am not going to say that *no* radio frequency transformers actually transform; if the two windings of the transformer are sufficiently far apart for the capacity between windings to be negligible, then the e.m.f. in the input winding will set up e.m.f.'s in the secondary by reason of mutual induction, but such transformers take up a great deal of space and are too cumbersome to build into sets. Commercially available transformers are never made in the above manner, and we have to come back to the type of transformer in which the two windings are placed one on the top of the other, or side by side in slots; in either case the coupling between them is very tight indeed. Look at Fig. 2 and imagine that the two windings are placed one over the other very close together; it seems to me that a potential created across the primary winding will not induce a potential across the secondary because the several turns of the primary are coupled by capacity to the several turns of the secondary by reason of their proximity; such intermediate capacitive coupling lowers the effective potential induced from coil to coil and can be likened to a tapped potentiometer effect. All that happens is that there is so much capacity between winding and winding that the potential across the primary is transferred to the next grid by capacity, and very imperfect capacity at that. Why not

* A Discussion before The Wireless Society of London, opened by Mr. C. F. Phillips on Tuesday, February 28th, 1922.

substitute a properly insulated condenser for the relatively poorly insulated capacity between windings ?

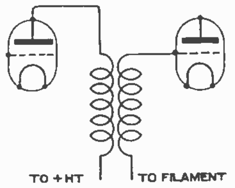



*Fig. 2.*

We will now deal with functions of the reactance coil shown in Fig. 3. Turning again to Fig. 1 the position of the coil in the circuit is indicated by the letter X ; it will be noticed that the coil is shown in parallel with a variable condenser, such a combination of inductance and capacity being known as a "Rejector Circuit." It is apparent that the function of the condenser is to *tune* the inductance to a particular wavelength ; when this circuit "X" is *tuned* to some wavelength, it will be found to possess a theoretically infinite resistance to alternating currents of a frequency corresponding to that wavelength : that is why the circuit is termed a "Rejector," *i.e.*, currents of the particular frequency cannot get through. We now see that my circuit operates in a very similar manner to resistance

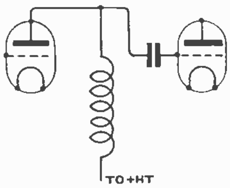



*Fig. 3.*

capacity coupling, and that the "Rejector" simply takes the place of the resistance. The resistance (or more properly, the "impedance") of the tuned rejector may be of the order of several 100,000 ohms to the frequency of the wavelength which it is desired to receive and therefore the largest possible P.D. will be set up across it, and transferred through the coupling condenser to the next grid. At the same time the direct current resistance of the inductance coil of the rejector is only a few ohms and so there is a low resistance path to the plate for the direct current supply from the H.T. battery ; this is a great advantage over resistance coupling as it allows a lower voltage H.T. battery to be used with a corresponding reduction of extraneous noises. The method I have described is known as "Reactance-Capacity" coupling, and is very efficient even for wavelengths as short as 100 metres, as also of course for the longest waves now in use. In practice in making up this rejector circuit it is possible commercially to buy tapped inductances and various other things of that nature which should perform the function quite well. I should not advise the amateur to try to make them if he wants to use them for short waves. The adjustment is extremely critical and the omission of a few turns may make all the difference to signals. I have found that a very simple way of providing that inductance is to use one of the multilayer coils on the market. The De Forest, Burndept and Igranic coils are all equally suitable and as they are mounted on plugs of similar gauge they are quite convenient ; a plug should be screwed to the valve panel and connected as shown in Fig. 1, when any of the above coils can easily be plugged in. I give tables showing the inductance and capacity of these various makes of coils and for what band of wavelengths they are suitable when used as reactances. (See tables in Figs. 4 and 5*.) Just to give you some slight idea, on 1,000 metres, a wave in which we are all interested, if we use

**Burndept Coils.**

| Coil No. | True Inductance Microhenries. | Distributed Capacity Micro-microfarads. | λ in metres (as anode coils) used with 0·0001 condenser. | |
|---|---|---|---|---|
| | | | From | To |
| 25 | 77 | 32 | 160 | 240 |
| 50 | 148 | 39 | 220 | 320 |
| 75 | 330 | 36 | 300 | 450 |
| 100 | 587 | 30·5 | 400 | 650 |
| 150 | 1,200 | 26·5 | 600 | 900 |
| 200 | 2,360 | 24 | 850 | 1,300 |
| 300 | 4,860 | 20 | 1.200 | 1,800 |
| 400 | 10,200 | 17 | 1.700 | 2 800 |
| 500 | 21,700 | 17 | 2.400 | 4,000 |
| 750 | -52,000 | 18·5 | 3.800 | 6,500 |
| 1,000 | 108,300 | 16·3 | 6.000 | 10,000 |

1,000 coil for longer waves. 0·0005 for 15,000 m : 0·001 for 20 000 m

*Fig. 4.*

Igranic coils we should need a No. 200 ; if we use a Burndept we should also need a 200 and for a De Forest, a No. 250. On 200 metres we should want a No. 35 Igranic or a No. 25 Burndept ; I have not measured the De Forest.

As regards the small variable condenser shown across the reactance coil, that condenser should be as small as possible : there are reasons into which I have not time to enter, because we want to get the Marconi telephony. I have found in practice that a condenser for short wave work should not exceed 0.0001 mfds. I call 600 metres short wave working. For long wave work it can be as large as 0.0002 mfds. Every single micro-microfarad across the reactance coil puts its wavelength up by a very appreciable amount, and if my tables (Figs. 4 and 5) are to be relied upon it is essential that the zero capacity of the condenser be kept very low indeed. In my own set I use a Sullivan Self-Heterodyne Condenser, which has a zero capacity of about 6 $\mu\mu$F and a maximum of 100 $\mu\mu$F (0·0001 mfds.). I believe that it has the lowest zero capacity of any condenser on the market.

* Author's Note. I regret that I cannot give any table of De Forest Coils, as I have not been able to borrow a complete set for measurement.—F.P.

**Igranic Coils.**
*(Also known as "North Eastern" coils, etc.)*

| Coil No. | True Inductance Microhenries. | Distributed Capacity Micro-micro-farads. | λ in metres (as anode coils) used with 0.0001 mfd. condenser. From | To |
|---|---|---|---|---|
| 25 | 37 | 32 | 110 | 170 |
| 35 | 65 | 36·5 | 150 | 220 |
| 50 | 135 | 45 | 210 | 300 |
| 75 | 290 | 40·5 | 290 | 400 |
| 100 | 520 | 36·5 | 390 | 650 |
| 150 | 1,190 | 31 | 600 | 900 |
| 200 | 2,160 | 32 | 850 | 1.200 |
| 250 | 3,370 | 29 | 1,050 | 1,500 |
| 300 | 4,900 | 25·5 | 1,300 | 1.900 |
| 400 | 9,000 | 23·5 | 1,700 | 2 800 |
| 500 | 14,470 | 22 | 2,100 | 3,300 |
| 600 | 19,700 | 23 | 2,500 | 4.200 |
| 750 | 31,130 | 22·5 | 3.700 | 6,000 |
| 1,000 | 57,820 | 20·5 | 4,000 | 7,000 |
| 1,250 | 94,500 | 21 | 6.000 | 9.000 |
| 1.500 | 138,675 | 23·5 | 7,500 | 12,000 |

1,500 coil for longer waves 0·0005 for 16,500 m ; 0·001 for 22,500 m.

*Fig. 5.*

Having finished with the plate, we will now turn to the grid. In the circuit given in Fig. 1 you will observe that the positive side of the low tension battery is connected to earth and, through the tuning inductance, to the grid of the first valve. That is rather unusual and at first sight seems ridiculous because you make the grid about 4 volts positive, and thus start up a large grid current of the order of about 3/10ths of a milliampere with a French R valve, or about 1/10th of a milliampere with a hard British R valve. Grid currents of this order mean that the impedance of grid to filament (*i.e.*, aerial to earth) has been lowered, and thus considerable damping of the signal takes place. Owing to the "damping," or more simply, the resistance of the circuit oscillations cannot persist and tend to die away quickly and thus the whole arrangement appears to be most inefficient and very absurd. That would certainly be the case were it not for the wonderful effect of regeneration as produced by the reaction coil. In my circuit, the reaction coil is connected between the detector plate and the H.T. battery and is coupled to the A.T.I. (or secondary coil in selective working). In the reaction coil amplified radio frequency oscillations are present which are exactly synchronised with the oscillations being impressed between the grid and filament of the first valve; these latter oscillations tend to die away rapidly owing to the grid current damping, but they are being reinforced continually by the oscillations in the reaction coil, the energy for which does *not* come from the aerial but from the H.T. battery. So in spite of grid damping, signals do not suffer, as the damping is neutralised by a slight additional current drawn from the H.T. battery. The reason for adopting this system, which by the way contrary to generally accepted opinion, does *not* introduce appreciable distortion in speech* is to obtain absolute stability of operation. Many of you may use radio frequency amplifiers with magnetic reaction, and if so, you will appreciate how easily such amplifiers fly into oscillation when least required and you often cannot control the degree of reaction at all. On the other hand, with positive grids you can use magnetic reaction from the detector plate to the first grid as easily and simply as in a single valve circuit. Thus in my circuit you have the advantage of high frequency amplification coupled with the very great advantage of completely controllable regeneration by magnetic reaction; that is to say by varying the coupling between grid coil and reaction coil you can increase regeneration until your set is just on the verge of oscillating when you get highest efficiency for spark or telephony, or by coupling more tightly you produce oscillations for autodyne reception of C.W. Now as regards the control of this first grid (see Fig. 6), I said that it was about 4 volts positive. It may be thought at first sight that the rheostat shown for the high frequency valve only controls the heat of filament; it does not, it very effectively controls the potential of the grid. The filament temperature of most modern hard valves is not a thing which matters very much, they are not very sensitive to temperature changes, not nearly so sensitive as they used to be. Looking at Fig. 6 we have a 6-volt battery, the positive side of which is connected to the filament and, through the tuning inductance, to the grid.

* Author's Note.—The reason is obvious to my mind. With negative grids the H.F. valve is being worked practically on the bend of its curve and may rectify when it should amplify *only* . . . rerectification by the detector valve would then produce distortion. With positive grids the valve works well up its curve and thus amplifies *only*.—F.P.

Denoting the positive end of the battery as +6 volts, and the negative end as 0 volts, the grid and one end of the filament are at +6 volts. The negative end of the battery is taken to the filament through a rheostat across which there is a drop of about 2 volts, therefore that end of the filament is at + 2 volts. From Fig. 6 the grid is + 6 volts and the most negative end of the filament + 2 volts, therefore the grid is 4 volts positive with respect to the most negative end of the filament. By varying this rheostat you can vary the potential of the grid but only so that it is more or less positive.

Now to deal with other details of the circuit: you will see that as we have a grid condenser between the first plate and second grid: although that condenser assists rectification, it is not otherwise a matter of much importance; it must be very well insulated as its function is to keep the positive H.T. off the grid of the second valve; its size (*i.e.*, capacity) is not important as long as it is large enough to pass freely the longest wavelength signals that you think you will get. It is quite all right if it is a lot too big for the short wave signals, provided that the size is not made so large that the charging time period would become appreciable. I have found 0·0002 or 0·0003 mfds. to be suitable for all-round use. The grid of the second valve must not be completely insulated or it will accumulate a negative charge; a grid leak is therefore required, but it cannot be connected across the condenser as that would connect the positive side of the H.T. battery to the grid, making it very positive. The leak must be connected to one of the filament leads and it really does not much matter to which. If you connect to the negative, the grid will be at zero potential, no grid current will be set up, and with no current flowing along the leak, there will be no drop of potential. Curiously enough if you connect the leak to the positive lead almost the same thing will

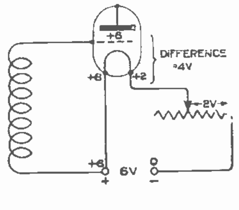



*Fig. 6.*

apply, and the grid will still be only a fraction of a volt more positive than it was before: the explanation is that the grid would *tend* to go 4 volts positive, *but* that would set up a grid current of some 200 microamperes; now a leak of 2 megohms at a pressure of 4 volts, will pass only 2 microamperes, therefore practically the whole of the 4 volts are dropped across the leak and the grid potential is hardly moved from zero potential.

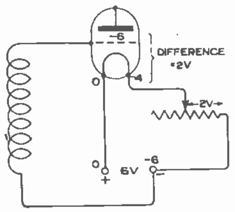



*Fig. 7.*

The third valve shown in the diagram is a low frequency amplifier more usually termed a "Note Magnifier." The connections are in accordance with standard practice and the only point of interest is the means adopted to give a slight negative bias to the grid, the desirability of which I will refer to later. In many circuits one or two dry cells are used in the grid-filament circuit to give the necessary bias, but they are a nuisance and there is a very simple manner of attaining the same end. In Fig. 7 you will see that the grid is connected, through the secondary of the inter-valve transformer, to the negative end of the filament battery; that end of the battery is connected to the filament through a rheostat across which there is a drop of, say, 2 volts; from the diagram it will be clear that the grid is 2 volts more negative than the most negative end of the filament, so we have attained our required negative bias. The reason for this bias is to prevent any grid current from starting and flowing through the secondary of the transformer, which might set up counter e.m.f.'s in the winding, opposing the e.m.f.'s transferred from the plate of the detector valve.

We will now deal with the various condensers used in the circuit. Condensers in wireless circuits can most conveniently be thought of as resistances (or more correctly "impedances"), and I am going to speak of them as such, but you must bear in mind that to *direct current* they are always of *infinite resistance*. There is a formula which gives the impedance of any condenser for any definite frequency. We need not cite the formula but you most probably know that the larger the condenser the lower is its resistance or impedance, the longer the wavelength the greater is the resistance of any definite condenser. The value of the grid condenser is 0·0002 mfds., which at 1,000 metres is equal to a resistance of 5,000 ohms, and at 10,000 metres to 50,000 ohms. It may seem that 50,000 ohms is a large resistance, but the alternative path for the oscillations is through the rejector (X in Fig. 1) which will have a "resistance" of many hundreds of thousands of ohms. The value of the condenser shown across the primary of the intervalve transformer is quite important, as that condenser performs a very delicate bit of "sorting out." It is given in the diagram as 0·001 mfds. The current flowing round from the plate of the detector, through the reaction coil and primary of the transformer to the H.T. battery, consists of two different components, which, however, are varying in exact phase one with the other; there is the radio frequency component which is flowing through the reaction coil to reinforce the incoming oscillations, and there is the rectified pulsating current of "note" frequency. We do not want to pass radio frequency current through the transformer at all, but we do want to pass the whole of the note frequency current through the transformer in order that it may be transferred to the grid of the third valve and so magnified. What we do is to place the primary of the transformer and a fixed condenser in parallel, and by proportioning the condenser properly we can make the condenser the easier path for the radio frequency component and the transformer winding the easier path for the note frequency component.

An average inductance value for the transformer winding is about 2 henries, and as inductances, like condensers, can also be thought of in terms of resistance (or impedance) varying with the frequency, the following table will make the matter quite clear.

IMPEDANCE IN OHMS.

| Wavelength or Frequency. | Of Winding 2 henries | Of Condenser ·001 |
|---|---|---|
| 1,000 metres } radio frequencies | *5,500,000 | 1,000 |
| 10,000 metres } | *550,000 | 10,000 |
| 1,000 cycles note frequency. | 19,000 | 150,000 |

The telephone transformer and its condenser do not require explanation; the function of the condenser being to improve the quality of the

*Theoretical value. Considerably less in practice owing to capacity between turns.

note and to bye-pass any slight radio frequency component that might have got through the intervalve transformer. The best value of the condenser is usually about 0·002 mfds.

The condenser across the H.T. battery is not usually thought much of, but it is really very important that it should be as large as possible. You will notice that the circuit carrying radio frequency components from the plates of the first and second valves to their filaments runs through the H.T. battery, or rather it *would* run through that battery if it were not for the condenser across it. We do not want any resistance in that circuit or else we shall get potentials built up across it, and the battery may well have a fairly high resistance when old; also to prevent the radio frequency component flowing through the battery (and so perhaps interfering with tuning), we must select a condenser that has a resistance lower than the battery. The resistances of different condensers at two different frequencies are given below in ohms. :—

IMPEDANCE IN OHMS.

| | 1,000 metres. | 10,000 metres. |
|---|---|---|
| 0·001 mfds. | 1,000 | 10,000 |
| 0·01 ,, | 100 | 1,000 |
| 0·1 ,, | 10 | 100 |
| 1·0 ,, | 1 | 10 |

In my opinion 0·01 is the smallest condenser that should be used, and 0·1 or even 1 mfd. is evidently better if you can get it. Incidentally a paper condenser is quite suitable in this position, provided that you test it occasionally to make sure that there is no leakage which would run your H.T. battery down very quickly.

I am showing on the table a compact little set that I have had made up according to the principles I have put before you. A plug is provided for plugging in coils for the "rejector circuit," but I have omitted the note magnifier valve as I wished to connect it up to other apparatus in my possession.

**Capt. H. de A. Donisthorpe.**

It is an understood practice that any degree of amplification can be obtained providing sufficient valves are employed, but with each additional valve the cost of maintenance and running is increased. This is a fact which must appeal to quite a number of amateurs and a commercial company has introduced a four-electrode valve to overcome this difficulty and amplification is

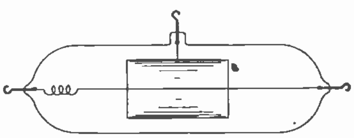


*Fig. 1.*

obtained using the four-electrode valve which is equal to three three-electrode valves, one as a high frequency amplifier, one as a rectifier and one as a low frequency amplifier.

It is not my intention to deal with this method of producing magnification of radio signals, but to deal with another method of attaining similar results and one which an amateur can experiment with on short wavelengths. The application of a magnetic field to the electronic flow of thermionic valves is a matter which at the present time is

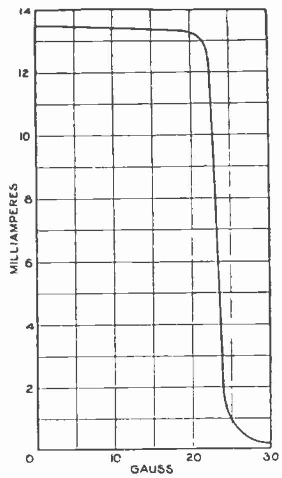



*Fig. 2.*

causing some considerable interest, and whereas Dr. Hull in America produced a hard valve where some interesting results are obtained by the exertion of an externally produced field, I personally, quite independently, have carried out some experiments in this connection with a circuit employing a soft valve, and one where the valve is subjected to a magnetic force with beneficial results.

In order to explain the magnetic device more clearly, I will briefly describe Dr. Hull's Magnetron (Fig. 1). It consists of a highly evacuated tube, an ordinary filament wire going right the way through, and an anode and a total absence in this case of a grid. Now if a milliammeter is connected in the anode circuit in the usual way, and the filament

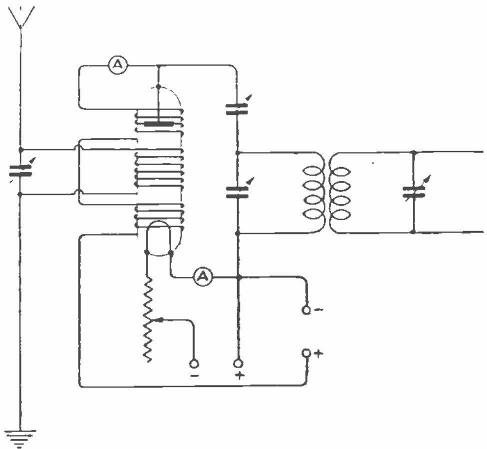



*Fig. 3.*

brought to incandescent, an electronic flow will be set up and a current will be registered in milliamperes. If a current is made to pass through an external coil placed about the top of the tube an effect will be produced on the value of the anode current. Fig. 2 shows you the effect of plotting the anode current against the magnetic field. Starting with a minimum magnetic field and then slowly increasing it, a point will be arrived at where there is a sudden falling off in the value of filament anode current. Further increase in field strength results in a complete cutting off of the

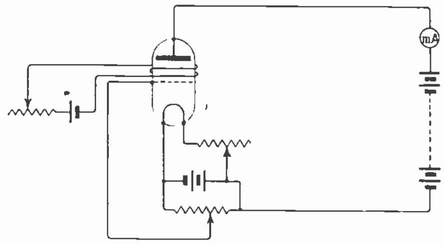



*Fig.* 4.

anode current. It will be seen that it is a very special curve and falls away at a point. The circuit shown in Fig. 3 is that which Dr. Hull employed in his " Magnetron " for amplifying signals. Here is the usual anode circuit and the coil across the

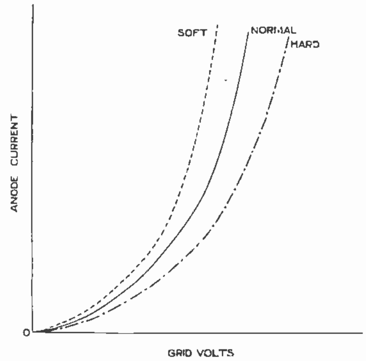



*Fig.* 5.

aerial condenser is placed around the Magnetron, and in addition there are two other coils arranged at each end of the tube which are rigged up with a battery for exerting the critical magnetic force on the valve. Oscillations in the aerial inductance produce fluctuations of the critical magnetic field, and signals are produced in the telephones of considerable magnitude as compared with those produced by an ordinary rectifying valve. This method can be carried on to a number of valves but one good valve (I, personally, have not used this circuit, so I cannot vouch entirely for its working), but the point that must be emphasised here is the fact that the magnetic field in the instance of a hard valve is made to decrease the electronic flow, while in the case of a soft valve a reverse action is produced, that is, there is an increase in the filament anode current as the magnetic field is increased.

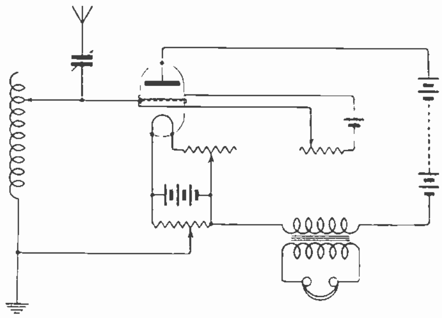


*Fig.* 6.

This illustrates the circuit which I myself am interested in. Fig. 4. Here is an ordinary three-electrode valve with plate connected to the H.T. battery and grid connected through a potentiometer to the filament. A coil for producing a magnetic field is supported over the valve and connected in series with a resistance and battery. If the ordinary characteristic curve of the valve without the magnetic field is plotted, and then plot a further curve with the magnetic field on, that is to say, having adjusted the current passing round the coil, results will be obtained you will see as shown in Fig. 5. It will be observed that in the case of the soft valve the anode current is increased while the anode current of the hard valve is decreased as explained earlier.

The application of this action in a receiving circuit is given in Fig. 6. It has an ordinary detector circuit, with aerial inductance and capacity arranged in the usual manner and potentiometer grid control. The potentiometer is adjusted to produce the best signals in the telephones. If then the magnetic field is applied, care being taken to adjust the position of the coil relative to the electronic flow and the value of current passing round the coil, both factors being rather critical, you will find that you get an increase in signal strength of about 100 per cent. About 300 ampere turns are required to produce the desired result. The interesting point which must be borne in mind here is that, whereas the actual negative electron flow is distorted and correspondingly weakened, yet the effect on the positive ions is sufficient to overcome this diminution and actually to increase the original filament anode current.

At this discussion there is not time to go into the matter fully, but it is advisable to just mention that in the case of the negative electrons, the magnetic field distorts their path, but in the case of the positive ions (which you see as a blue glow), they are set along the magnetic lines of force produced by the field. A rather pretty experiment in this connection is to blue the valve up by putting considerable high tension on the anode and then to exert the magnetic field near the top of the valve and notice how the position of blue glow changes its position.

Of course the magnification produced by the method just described is nothing like that given by the use of a large number of valves, but it opens up a field of research for amateurs. I hope that some of you will be able to try some experiments and let us know the results obtained.

*(To be continued.)*

# A Tuner and Three-Valve Amplifier for all Wavelengths

By Percy W. Harris.

(*Concluded from page* 16.)

## Wiring Up.

The wiring looks very complicated—really much more complicated than it need be. The reason is that every wire is kept well away from every other wire, to avoid induction and capacity effects. This arrangement may look clumsy, but is fully justified, as the instrument is remarkably silent in action, there being no "non-wireless" noises whatever, even at fullest amplification.

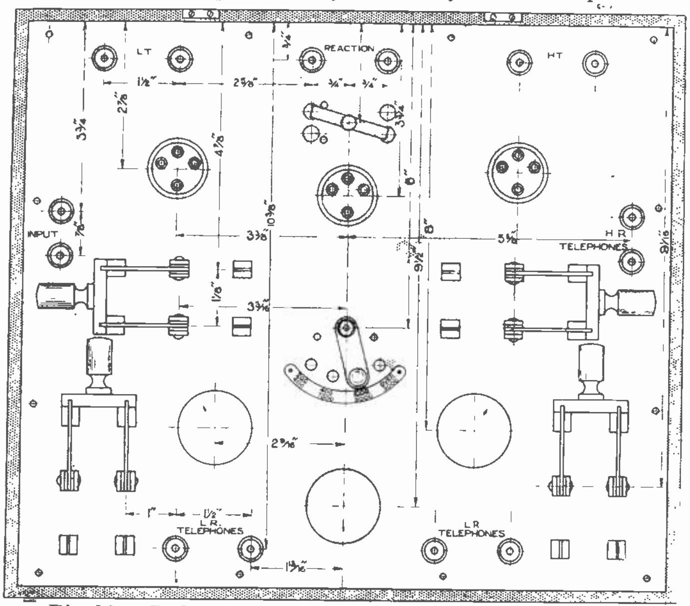



*Fig.* 10.—*Scale diagram of the top of the amplifier unit, with measurements. For photograph, see Fig.* 12.

Before any wires were connected, all connections were drawn out full size on the sheet of paper mentioned above. Coloured chalks for the various circuits are a help and save confusion. With this sheet as a guide, pieces of No. 18 tinned copper (this is stiff enough to hold up well) were cut and bent to shape and insulated tubing slipped over each wire before bending to its final shape. The longer leads present some difficulty in fitting the insulating tubing, owing to the tight fit, but no trouble will be experienced if the tubing is cut to lengths of about three inches, and slid on piece by piece. The point where the tubing joins is practically invisible. In a few cases, such as the wiring of the H.F. transformer switch, No. 22 wire was used.

In the particular instrument being described, yellow tubing is used for the filament circuits, green for grid circuits, and red for high-tension and plate circuits. Black is used for the telephone transformer primary connections. This arrangement looks neat and helps in subsequent tracing of circuits.

It is well to commence with the wiring of the input connections, making each lead to shape and then laying it by for later soldering. If the leads are made in one circuit at a time, nothing is likely to be overlooked. As leads are made they may be ticked off on the full-sized drawing.

Wherever possible, connections should be soldered. For this purpose a gas-heated soldering bit is a great convenience, for the temperature can be kept constant and connections very quickly made. The writer purchased such a tool after a whole evening struggling to solder but one or two connections with an ordinary bit, and thereafter the work became as child's play. One such is advertised in this magazine.

For the benefit of those who, like the writer, had had no previous experience in soldering such connections, it may be mentioned that the method adopted was to "tin" the

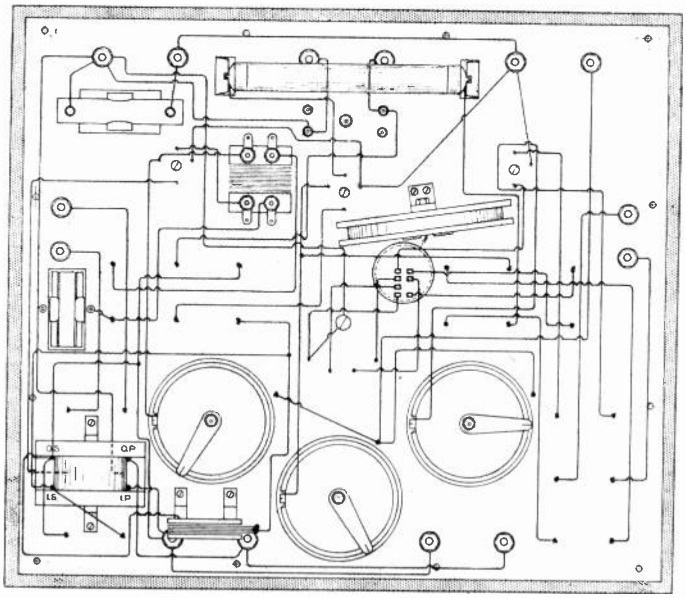



*Fig.* 11.—*Actual connections on underside of the panel. For photograph, see Fig.* 13.

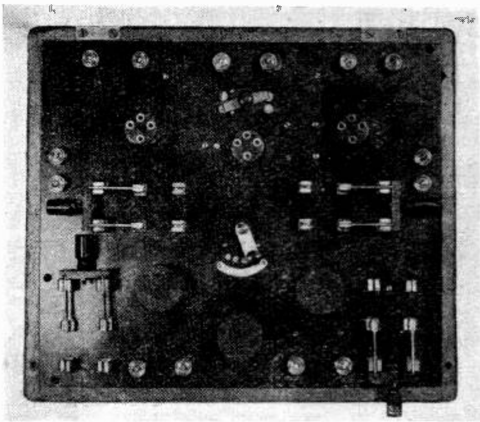


*Fig.* 12.—*Photograph of the top of the amplifier. The change-over switches are set for the use of all three valves, with the L.R. telephones. The H.F. transformer switch is set for waves over* 3,000 *metres.*

cleaned bolt by rubbing it with flux and solder until an even coating of solder adhered to the end, and then to press the end of the bolt on to the screw-head, on which a touch of flux had been placed. The surplus solder will run on to the screw-head and if the temperature of the bolt is correct will adhere after ten or fifteen second's contact. The end of the wire should previously be bent into a closed loop, slightly smaller than the head of the screw and held against the bit so as to make a film of solder cover the loop. The loop and the screw should then be brought into contact and the bit held firmly on to them until the solder on both melts. Withdraw the bolt and hold the wire steadily in place for a moment until the solder sets. This makes a neat and efficient joint with a minimum of solder.

When bending the wires to shape, care should be taken to keep them well away from one another—an interval of about an inch was aimed at in the instrument described. This makes the wiring look clumsy, it is true, but it avoids many troubles which otherwise occur in amplifiers.

Wherever it was necessary to attach a component to the ebonite panel from beneath, a hole was drilled to take a 6 B.A. cheesehead screw. A slightly larger drill, of the exact size of the cheesehead, was then taken, and the hold drilled a second time from the top of the panel for the exact depth of the head. The screw then dropped in flush, and the apparatus beneath was easily attached by nuts. The two transformers (high and low frequency) are both attached this way, as well as the clips for the condenser and grid-leak combination. The small shunt condensers were also held up in this fashion.

It will thus be seen that the whole work of constructing this amplifier can be carried out without the tapping of holes or the threading of screws, with practically no tools but a twist drill, with a set of drills from ⅛ to ¼ in steps of 1/32nd (all these are not actually required), a pair of wire-cutting pliers and a soldering bit. Actually, the particular apparatus described was assembled in comfort by the dining-room fire, the gas-pipe for the soldering bolt being attached to the tap designed for a gas fire.

It will be noticed that six terminals are fitted to the back of the instrument. The pair on the left are for the L.T. battery, those in the centre for reaction (shorted by the switch below them), and those on the right for the H.T. battery. On the left of the instrument are two terminals placed in such a position that they may be connected by two short wires to the valve terminals of the Mark III tuner. On the right side are another pair of terminals which can be used either for high resistance telephones or to connect to a further L.F. amplifier if necessary. Two pairs of terminals on the front of the panel are for two pairs of telephones (low resistance) in parallel, or for one pair of telephones and a loud speaker.

In use, the apparatus is set on a small portable table erected by the window, the Mark III tuner and the amplifier standing side by side (see Fig. 14). The lids are removed from both boxes by sliding them off the hinges The 6-volt, 30-amp. accumulator stands on the floor below and is connected by electric light flex to the proper terminals, while the H.T. battery (two 30-volt. units with wander plugs) stands on the side of the table by the amplifier. A complete set of duolateral coils (100, 150, 200, 300, 400, 500, 750 and 1,000 turns) is kept on the table ready for a quick exchange together with *The Wireless World* Regular Transmissions Sheet and the Wireless Board List of Radiotelegraphic Waves. This last publication is issued by the Government at the price of 1s. and is of foolscap size. The left-hand pages are devoted to spark stations and the right-hand to continuous wave stations. The stations on both sides are listed according to their waves in strict numerical order, and the book is very useful for recording the coil number and condenser reading of any station that is heard. If such notes are regularly made, the adjustment of a station not previously heard, but the wavelength of which is known, can be

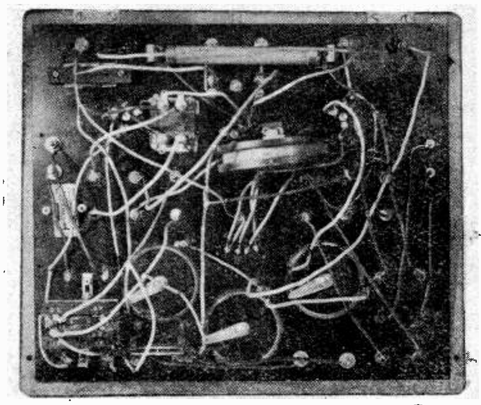


*Fig.* 13.—*Photograph of the underside of the amplifier. At the top is the tubular condenser and grid leak combination. The high-frequency transformer with its connections to the switch is immediately below this, and the low-frequency transformer on its left. The telephone transformer is in the bottom left-hand corner. Notice how the filament resistances are staggered to economise space.*

predicted from the readings of other stations whose waves are round about the same figure. The writer has found the book of great value in this connection.

Using this installation with all three valves working, the writer finds no difficulty in reading New York Central, Tuckerton, Annapolis, New Brunswick, Marion and Glace Bay, on any evening when the atmospherics are not too bad. Often when conditions are rather bad and transmissions to the continental stations from America are carried out by duplicating each word, the whole message can be taken with ease on the first words. It has been noticed that the British stations seem to receive far better than those on the continent.

On evenings when conditions are particularly good, New York Central can be read several feet off the telephones, or with one valve and the telephones on, and on the evening of the 13th January (to give but one example) Darien NBA was clearly readable with the 'phones on the table. A week later NZR (Cayey, Porto Rico), was heard on two valves. All European high-power stations are much too strong to be comfortable on three valves, and Nauen can always be read in the next room, as can Poldhu, Carnarvon, Stavanger, Eilvese, Paris and others. The H.F. transformer is very selective, and even with full amplification on all valves there is no suspicion of howling. The low aerial makes for considerable freedom from atmospherics—a point not always realised by amateurs. The Dutch concert, while audible on two valves, requires all three to give really comfortable strength. The station, it may be said, is situated in the Hampstead Garden Suburb.

Although lately, as indicated above, a set of duolateral coils has been purchased, bringing the total cost rather over the figure originally intended, excellent results had previously been obtained with a home-wound multilayer coil for wavelengths in the neighbourhood of 9,000 to 14,000 metres (see *The Wireless World*, October 2nd, October 16th, October 30th, and December 11th, 1920). For wavelengths of 600 metres and below, the windings of the tuner itself are used without external inductance. If reaction is required, a small coil is brought up against the outside of the tuner case and acts through the wood.

As to the valves, the writer has used several patterns, including, with adapters, the V24 and QX types—the latter for detecting. At the moment he is using a M-O " R " type for H.F., a M-O " B R" for detecting and a French " R " for the L.F. valve. Some of his best results have been obtained with this combination (including Darien reception).

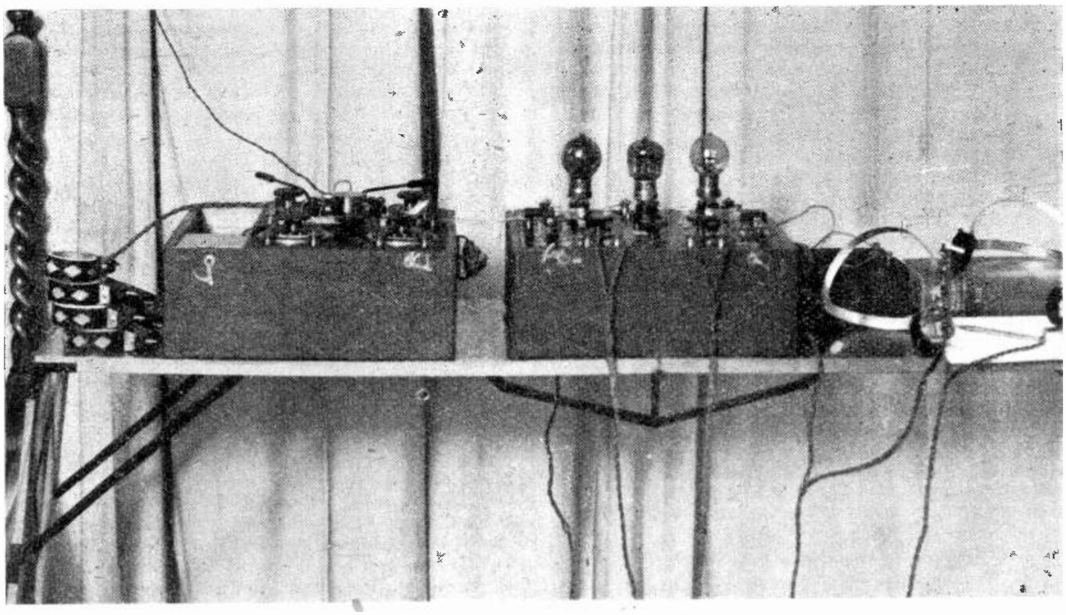


*Fig. 14.—The complete receiving station in use. Of the two cases, the left is the Mark III* Tuner. Extra inductances can be added to open and closed circuits, by means of the duolateral coils shown. Handles for varying the reaction and coupling with these coils can be seen at the back of the instrument. The amplifier is on the right, with two pairs of L.R. telephones and the H.T. battery. The L.T. accumulator stands on the floor and is connected by a flexible lead. American stations have been read on one valve and the West Indies on two, with this set.*

The actual cost of this amplifier and tuner set can easily be calculated by consulting the catalogues of the various dealers. More experienced readers will probably see several possible improvements, and practically all amateurs have at least a few of the components by them. If any reader should find himself in difficulties with the constructional work, other members of the local wireless society will be able to help him, or the writer will be pleased to answer any enquiries addressed through the Editor of this magazine.

The following is a complete list of the various components required for the amplifier. From this the reader, knowing what he already has, can readily calculate the cost, with the aid of the advertisement pages of this magazine.

One empty Mark III case.
One sheet of ebonite.
One dozen Mark III terminals.
Three rotary filament rheostats.
Three valve sockets.
One H.F. transformer and switch.
One L.F. transformer.
One telephone transformer.
Three ·001 microfarad condensers (fixed).
Four battery switches.
One combined condenser and leak (·0003 and two megohms).
One pair of clips for same.
One short circuiting switch for reaction terminals.
About four dozen 4 B.A. screws, ⅜ in. long, with about twice the number of nuts to correspond.
Two yards green Sistoflex tubing (6d. a yard or less).
Two yards yellow ditto.
Four yards red ditto.
One yard black or blue.
Solder and flux.
One or two pairs 120 ohm telephones.
Two 30-volt units high-tension battery.
6-volt 30-amp. (continuous rating) accumulator.
Three valves (if V24 and QX valves are used, adapters will be needed).
About ¼ lb. No. 18 bare tinned copper.
One ounce No. 22 bare tinned copper.

Many variations are possible in the design given. The writer has named the actual components used by him, but there is no reason why others should not be substituted. As mentioned previously, it would be quite possible (and indeed simpler) to mount a fourth valve socket in the place of the H.F. transformer switch, and to use this for the removable transformers described by Mr. Campbell Swinton and purchasable from several dealers. Again, other types of L.F. transformer are quite suitable. Neater switches are obtainable, but the battery type of switch is very certain in its action, and the parts are well separated.

If V24 and QX valves are used, and it is not desired to try others, the four-pin type of socket is not needed, and clips for the former valves can be substituted in the design. This saves the cost of the adapters and in addition has the advantage that the valves can be left in place when the lid is put on. With the four-pin sockets and valves, the latter must be removed when "packing up." On the other hand, if the four-pin sockets are used, any type of valve desired can be tried, with the aid of adapters.

A point about this receiving set which will appeal to many is that when packed up it consists of nothing more than two neat cases, two small boxes (the h.t. units), a box containing the set of coils on plugs, and a small accumulator. The connecting wires (including flexible leads for earth and aerial terminals), together with the telephones, go into the compartment of the Mark III Tuner, and are therefore not likely to be mislaid. The set can be fitted up in about five minutes on a small table and is not unsightly in appearance, and instead of working upstairs in a cold room as many amateurs are compelled to do, the possessor can sit by his fireside in comfort.

# Resistance Capacity Amplification

By B. L. Stephenson.

(*Concluded from page* 19.)

If the grid condenser and leak of the rectifying valve are of correct proportions, the set should go quite sharply from the oscillating state to a loud and constant howl, when the reactance coupling is tightened. Sometimes, if these proportions are not correct, the howl will come on faintly at first and then louder as the reactance is tightened. Also, in some cases, the howl occurs as a hammering sound, with quite a space between each noise. Both these lose a great deal of efficiency, particularly for C.W. reception, for then it is impossible to work the set just short of the howl point.

Resistance-Capacity amplifiers are badly affected by atmospheric disturbances, owing largely to the intervalve condensers getting charged up above normal, and in this case, if the set is only just clear of the howling point, a strong atmospheric or even a loud signal will start it off howling. The only way to avoid this is to work rather further away from the howling point when "X's" are bad. This, however, I should think, is more or less the same with any amplifier.

Static reactance is frequently used with Resistance-Capacity amplifiers, and although it is far more stable than magnetic reaction, it does not allow for nearly the same amount of amplification. By this method all the boosting effect of coupling the anode and aerial circuits together is lost.

Another question is whether to use H.R. or L.R. 'phones, when amplification is adopted. A step-down telephone-transformer and L.R. 'phones certainly avoid most of the parasitic noises caused by the H.T. battery and variation of resistances; and also do away with one of the greatest of all troubles—which is the capacity effects caused by movements of the body. This is most noticeable when receiving telephony. I have known telephony, so to speak, totally disappear when 'phones have been handed from one person to another. This has been caused by the change of wavelength due to alteration of capacity. A certain loss of sensitiveness is, however, unavoidable when using L.R. 'phones, and personally I always use H.R. 'phones, being careful to connect them up in the correct way with regard to the H.T. battery. This is, however, rather a strain on their insulation.

A good point about Resistance-Capacity amplifiers is that they rather tend to limit the strength of strong signals, and greatly intensify weak signals, and make otherwise inaudible signals of good readable strength. The amplifier can be made relatively stable by employing anode resistances of between 30 and 50 thousand ohms. In this case, however, it will be readily seen that more valves will have to be used, than when 80 or 100 thousand ohm resistances are adopted, in order to obtain the same signal strength.

A somewhat curious feature of these amplifiers is their extreme susceptibility to the reception of harmonics, particularly, of course, from C.W. stations. In many cases high-powered stations can be read on their 2nd, 3rd and 4th harmonics, and sometimes even higher than this. It will be readily seen that this becomes extremely troublesome, particularly with such stations as that at Leafield, near Oxford. This station, when sending press on a 9,000 metre wave, has more than once been clearly readable on 600 metres, and apparently about every multiple of 600 metres, up to the true wavelength, and certainly on a double harmonic above that. This was when using only a two-valve Resistance-Capacity amplifier.

I will now come to a few of the troubles which are likely to be met with when making anode-resistances and grid-leaks.

It will be observed that there is a continual and relatively large current flowing through the anode-resistances. This is probably the chief cause of trouble in their operation, for under these conditions it becomes very difficult to keep their resistance value constant. A pencil line between two terminals on ebonite, seems to work well for a short time, but then, amid much crackling in the telephones, it varies until its resistance may reach a value several times as high as it was originally. This is probably caused by the coherer action of the particles of graphite, which move along with the current, and thus greatly vary the resistance. In my own case I avoided this to some extent, by using slate-pencil instead of ebonite. This allowed the graphite to obtain a firmer bedding, and thus stopped the coherer action. Here, however, there is another difficulty, for the slate-pencil cannot very well be sealed up by any other means than varnish. This, of course, changes the resistance and great trouble is found in obtaining the desired value. In the case of the ebonite resistances another piece of ebonite was used as a covering, thus avoiding touching the actual pencil line with varnish.

It is essential that the resistance should, in some way, be protected from damp and the varying humidities of the atmosphere, and to do this, at the same time as keeping the resistance value constant, will probably be found extremely awkward. In any case these resistances can be purchased for quite a small sum, and I have found them satisfactory in every respect, although they have now been in use for some months.

In the case of the grid-leaks we have a much simpler proposition, for the current passing through the resistance is negligible. An ordinary pencil line on ebonite seems to act quite well, and will keep constant provided it is protected from damp. This can easily be done by a covering of ebonite, and a coat of shellac varnish round the edges.

A thing which should most certainly be paid great attention to in Resistance-Capacity amplifiers is the relative position of the various parts of the set. These amplifiers are extremely prone to self-oscillation, and any stray capacities or magnetic linkage between the various parts is liable to make the circuit oscillate even more readily than usual. This trouble becomes greater and greater as the number of valves is increased, and when even a moderate number such as four are used it becomes rather difficult to stop the set oscillating, for spark and telephony reception.

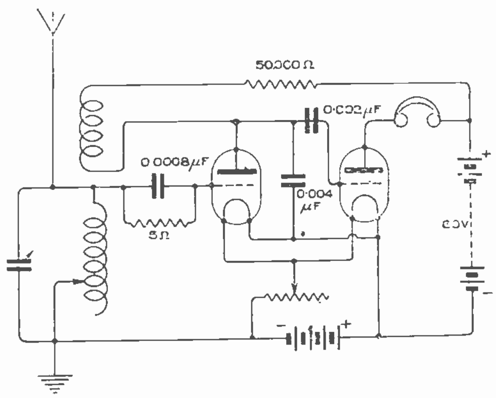
Strong self-oscillation may also be caused by an unsuitable selection of valves, and in my own opinion it is advisable to fit out an amplifier throughout with ordinary "R" type valves, which have fairly constant properties, and seem to be extremely sensitive.

*The following description was then given of a two-valve detector amplifier exhibited.*

I have used a rather special circuit, shown herewith, which departs in certain details from the usual form of Resistance-Capacity amplifier.

Here the anode-resistance is of 50,000 ohms, the first grid-condenser of 0·0006 mfd., the second grid-condenser of 0·002 mfd., and the extra condenser, which is placed between the grid of the second valve and earth, is of 0·004 mfd. capacity.

This panel has given good results, particularly in the reception of signals from distant stations. Upon several occasions American stations have




been read when using only a short indoor aerial. The result of the Carpentier-Dempsey fight was received from New Brunswick (WII), and the whole of President Harding's message, sent from the New York Central Station (WQK) was read.

The high-powered European stations at Carnarvon, Clifden, Leafield, Eiffel Tower, Lyons, Nauen, Hanover, Rome, etc., come in so loudly that they can be heard all over a large room. The American stations at New York, New Brunswick, Annapolis, Marion and Tuckerton, can also, under good conditions, be heard at quite a distance from the 'phones. All the above are when using an outdoor aerial, of course.

Telephony from Koenigswusterhausen (near Berlin), and from the Eiffel Tower has been heard well, as also have several of the 900 metre air-stations such as Croydon.

The fact that telephony from the Mersey Bar Light-vessel and the Liverpool dock offices has been clearly received, on a wavelength of about 450 metres, largely dispels any idea of the inefficiency of this circuit on low wavelengths.

# Notes on the Design of Radio Frequency Intervalve Amplifier Transformers using Iron Cores*

By A. S. Blatterman, B.Sc., E.E.

## General

Numerous engineers have built and used radio frequency amplifiers in which the coupling between stages was provided by iron core transformers. M. Latour seems to have been the pioneer in this work and during the World War his lead was followed more or less in an imitative, cut-and-dry manner by others. No analytical treatment of the subject, however, nor formulæ or data for design have thus far appeared. The writer some time ago worked out a rational method of designing these transformers which has proved useful, and it is the purpose of the present communication to describe this method as well as to discuss briefly some of the more important though somewhat obscure factors which enter into the design of this type of apparatus. All of the work referred to has been conducted at the U.S. Signal Corps Laboratories at Camp Alfred Vail, N.J., U.S.A.

The problem of designing intervalve amplifier transformers for radio frequencies is essentially one of coupled tuned circuits. The primary circuit comprises one winding of the transformer constituting principally an inductance, and a composite capacity involving the several capacities between the elements

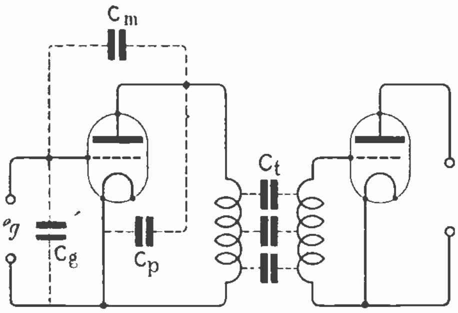



*Fig.* 1.

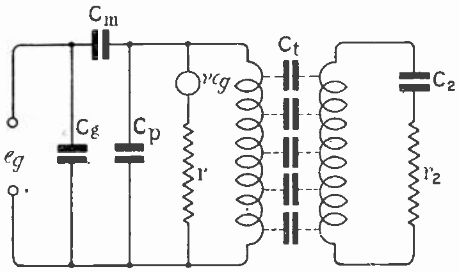



*Fig.* 2.

of the input tube. The secondary circuit comprises the inductance of the other transformer winding and the grid circuit impedance (usually capacity and resistance of the output tube). The actual circuits are those of Fig. 1 and their analytical equivalent is shown on Fig. 2.

It is evident from Fig. 2 that the primary and secondary circuits can be reduced to the simple form of Fig. 3, in which as will be shown later $C_2$ and $r_2$ comprise the effective input impedance of the grid circuit of the second or output tube depending upon the load in the plate circuit of that tube, as has been shown by Dr. J. M. Miller.

The analytical treatment is considerably complicated by the existence of the capacity $C_t$ between the transformer windings, which moreover is not generally necessary for the successful functioning of the amplifier. We shall, therefore, limit the present discussion to the case of pure inductive coupling and hence consider only a transformer in which the capacity between windings is negligibly small. Such a transformer comprises thin pancake wound coils rather than overlaid solenoidal primary and secondary.

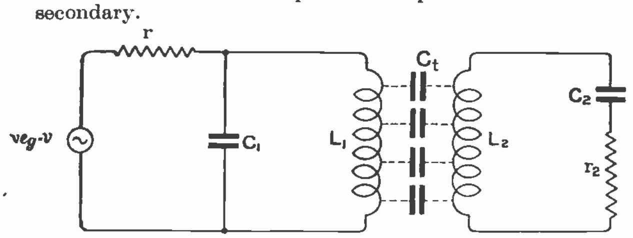



*Fig.* 3.

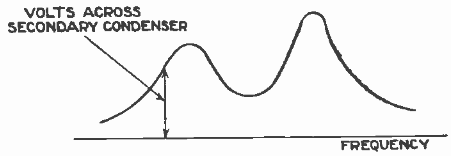



*Fig.* 4.

The pair of coupled circuits as here presented have in general two frequencies at which maximum voltage is obtained across the secondary terminals. When the frequency impressed upon the primary is varied, the resonance curve presents two peaks as indicated roughly in Fig. 4. The separation between the peaks depends upon several factors of which very important ones are the coefficient of

* Received August 29th, 1921.

coupling and the internal resistance of the input tube. The latter quantity is fairly well fixed for a given tube while the former is under control according to the design of the transformer. If the coefficient of coupling is very small the peaks become closely identified with the separate frequencies of the primary and secondary circuits. As the coupling is increased the peaks become more widely separated. By properly proportioning the time constants of the two circuits as well as the coefficient of coupling the two peaks may be made to coalesce, or one may be relegated to zero frequency. In either case the system then behaves as one responsive to but a single frequency.

In practice it may be desirable to produce either the single or double hump characteristic depending upon whether or not the amplifier is required to be effective over a narrow or a relatively wide range of wavelengths. The predetermination of the coupling coefficient is therefore of great importance. This obviously involves the calculation of leakage flux in the transformer. The determination of the inductances of the transformer windings is also necessary in order to discover the effective region of operation with respect to wavelength. This likewise requires that an estimate be made of the various magnetic fluxes. It is found that practically any desired characteristic can be obtained by suitably adjusting the turns, the spacing between primary and secondary, and the air gap in the core of the transformer.

### Determination of Leakage Flux

The type of transformer to be considered is shown in Fig. 5; other cases where the windings are split into several sections will be discussed later. The leakage flux is indicated in dotted lines. The width of the pancake windings is negligibly small compared with the separation of primary and secondary elements. In practice the size of the central core leg is somewhat larger than the two side legs, although on account of the corner drilling for clamping screws and consequent stricture of iron section at these points the difference in cross-section between central and side members is not great. The section is square for convenience.

In order to simplify the analytical problem it will be assumed (1) that the size of the side and central core members are equal and (2) that the section is circular instead of square. It will be seen from the formulæ developed that such assumptions give results which differ only slightly from those to be expected from a rigorous treatment using the actual transformer core.

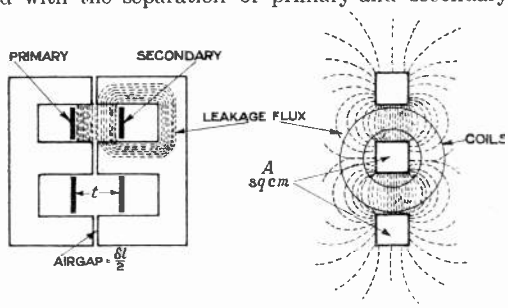



*Fig.* 5.

Let $N_1$ = number of primary turns.
$N_2$ = number of secondary turns
$l$ = mean length of iron core circuit (cm)
$\delta l$ = total length of air gap (cm)
$t$ = separation of prim. and sec. (cm)
$A$ = cross-section of iron in core (sq. cm)
$\mu$ = permeability of iron core
$R$ = radius of assumed round core (cm)
$b$ = width of window in core (cm)

The leakage flux $\phi$ passes through the air space between primary and secondary windings from the central core leg to the two side legs and returns (principally) through the iron end pieces. The return path being through iron can thus be neglected as far as its reluctance is concerned and the problem centres only upon the calculation of the reluctance of the air paths between central and side core legs. Such paths are shown in Fig. 6.

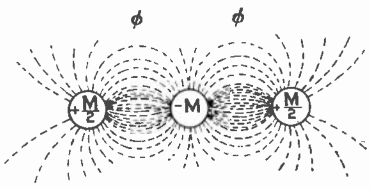



*Fig.* 6.

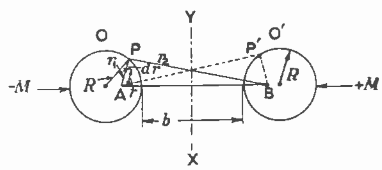



*Fig.* 7.

In order to get information on the method of calculating this problem let us first consider the simpler problem where there are only two cylinders as in Fig. 7 instead of three. In this case the magnetic charges on the two cylinders are equal but of opposite sign $+M$ and $-M$ respectively. Let the two cylinders be considered as of infinite length and more specifically indicate by $M$ the magnetic charge per unit length. Designate by $\phi'$ the number of lines of flux passing between the cylinders per cm of their length. Then

$$\phi' = 4\pi M$$

All points in the surface of each cylinder are at the same magnetic potential. The plane XY midway between the cylinders is at zero potential and hence a reference for all potentials in the system.

A and B are the inverse points for the system, and as such can be considered as the locus of the entire charges — $M$ and $+ M$ respectively, which reside upon the cylinders O and O′. The potential at P, a point on core leg O due to — $M$ at A is

$$\int_0^{r_1} \text{Intensity of field at } r \times dr = \int_0^{r_1} -\frac{4\pi M}{2\pi r}\,dr = -2M\int_0^{r_1}\frac{dr}{r}.$$

The potential at this point due to $+M$ at B is similarly $2M\int_0^{r_2}\frac{dr}{r}$

The resultant potential at P due to both A and B co-acting is therefore

$$V = \left\{-\int_0^{r_1}\frac{dr}{r} + \int_0^{r_2}\frac{dr}{r}\right\}$$

$$= 2M\log\frac{r_2}{r_1} \quad \ldots\ldots\ldots\ldots \quad (1)$$

This is the potential at all points on the cylinder O.

In a similar way the potential of P′, a point on O′ and hence the potential of all points of O′ is

$$V' = -2M\log\frac{r_2}{r_1} \quad \ldots\ldots\ldots\ldots \quad (2)$$

Therefore the magnetic potential between the two core legs is

$$V - V' = 4M\log\frac{r_2}{r_1} \quad \ldots\ldots\ldots\ldots \quad (3)$$

Since the reluctance is

$$\Re = \frac{\text{magnetic potential}}{\text{flux}}, \quad \text{and flux} = 4\pi M \text{ per cm length of core}$$

we get

$$\Re = \frac{4M\log\frac{r_2}{r_1}}{4\pi M}$$

$$= \frac{1}{\pi}\log\frac{r_2}{r_1} \text{ per cm} \quad \ldots\ldots\ldots\ldots \quad (4)$$

By the theory of inverse points the ratio $r_2/r_1$ is constant, and it may be otherwise expressed in terms of the constant dimensions of the system. Thus it is easily shown that—

$$\frac{r_2}{r_1} = \frac{2R}{b + 2R - \sqrt{b^2 + 4bR}} \quad \ldots\ldots\ldots\ldots \quad (5)$$

and the reluctance between two infinitely long parallel magnetic cylinders per cm of their length becomes

$$\Re = \frac{1}{\pi}\log\frac{2R}{b + 2R - \sqrt{(b^2 + 4bR)}} \quad \ldots\ldots\ldots\ldots \quad (6)$$

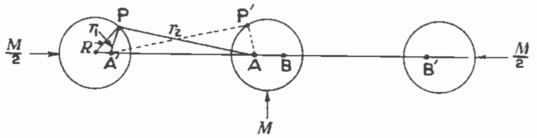


*Fig.* 8.

Turning now to the problem of the three-legged core, Fig. 6, we have the inverse points A and A′ for the central and left hand cores and B and B′ for the central and right hand cores. (See Fig. 8.)

The magnetic potential at P due to $\frac{M}{2}$ at A′ is $V_1 = -M\log r_1$

Potential at P due to $-M$ at A is $V_2 = 2M\log r_2$

Potential at P due to charges at A′ and A co-acting is

$$V = V_1 + V_2 = M\log\frac{r_2^2}{r_1} \quad \ldots\ldots\ldots\ldots \quad (7)$$

Potential at P′ due to $+\frac{M}{2}$ at A′ is $V_1' = -M\log r_2$

Potential at $P'$ due to $-M$ at A is $V_2' = 2M \log r_1$.

Potential at $P'$ due to charges at $A'$ and A co-acting is

$$V' = V_1' + V_2' = -M \log \frac{r_2}{r_1^2} \qquad (8)$$

Therefore the potential between the middle and the side legs is

$$\begin{aligned} \overline{V} &= V - V' \\ &= M \log \frac{r_2^3}{r_1^3} \\ &= 3M \log \frac{r_2}{r_1} \end{aligned} \qquad (9)$$

Therefore the reluctance per cm length between one side leg of the core and the central number is

$$\Re = \frac{\overline{V}}{\text{flux}} = \frac{3M \log \frac{r_2}{r_1}}{2\pi M} = \frac{3}{2\pi} \log \frac{r_2}{r_1}$$

The total reluctance between the central core and the two side legs is evidently one half of this or

$$\begin{aligned} \Re &= \frac{3}{4\pi} \log \frac{r_2}{r_1} \text{ per cm} \\ &= \frac{3}{4\pi} \log \frac{2R}{b + 2R - \sqrt{b^2 + 4bR}} \end{aligned} \qquad (10)$$

It is interesting to note by comparing (6) and (10) that the reluctance of the three-legged system is only three-fourths that of the two-legged one.

If, instead of 1 cm of core length we consider a length $t$ cm as, for instance, the distance between primary and secondary coils the formula for reluctance becomes

$$\Re = \frac{3}{4\pi t} \log \frac{2R}{b + 2R - \sqrt{b^2 + 4bR}} \qquad (11)$$

An idea can now be had from this formula of the extent of the error made in assuming that the central and side core legs are of equal size. It is seen that the function involving their dimensions is a logarithm, and hence the reluctance is but slightly affected by small changes in the radial measurement.

*(To be continued.)*

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# "The Wireless World and Radio Review"

In connection with the amalgamation of *The Radio Review* and *The Wireless World*, and the weekly publication of the combined journal, the following additional communications have been received :—

**From Professor G. W. O. Howe, D.Sc., M.I.E.E.**

I am very pleased to fall in with the Editor's suggestion that I should write a short note for publication in connection with the issue of the combined *Wireless World* and *Radio Review.*

As Editor of the *Radio Review* from its inception until January last I cannot but regret that it should now cease to enjoy a separate existence. At the same time I believe that the amalgamation of *The Wireless World* and *The Radio Review* will make it possible to produce a magazine of more general interest to the readers of both. *The Wireless World* has become the recognised organ of the great amateur wireless organisation ; a great number of the members of the various Wireless Societies are, however, keenly interested in the scientific and commercial development of the subject and are able to appreciate the writings and work of those who are engaged in the wireless industry or of those who are endeavouring to develop the subject from the mathematical or experimental side. On the other hand much valuable work is being done by many amateurs and nothing but good can come of a literary *rapprochement* between those who have previously confined their attention to one or the other journal.

It is with considerable misgivings that I learn that the abstracts of Wireless Literature, which formed such an important part of *The Radio Review*, are not to be made such an important feature of the new magazine. There is no doubt that many contributors regarded this as the most important feature of *The Radio Review* and will miss it very much. I have no doubt, however, that in some form or other, the readers of the new journal will be kept informed as soon as possible of any important publications bearing on radio telegraphy which may appear from time to time in various foreign periodicals.

One of the most welcome features of the new journal is its weekly publication ; this will enable the announcements of meetings and the reports of papers and discussions to appear without the delay which is unavoidable with a monthly magazine.

I should like to conclude by expressing the hope that the new *Wireless World and Radio Review* may have the full support of every one connected in any way with British Radio-Telegraphy, whether amateur or professional, commercial or academic, so that it may become representative of the part taken by this country in the development of Radio-Telegraphy.

**From Mr. E. H. Shaughnessy, M.I.E.E., of the Engineer-in-Chief's Office, General Post Office.**

The amazing growth of interest in the radio art and the manner in which the successive issues of *The Marconigraph* (1911) and *The Wireless World* (1913) have advanced in step with the progress of the art augurs well for the future of the enterprising venture of the issue of *The Wireless World* as a weekly magazine. I think we can safely leave it to the Editors of *The Wireless World* to see that those who were particularly interested in the class of literature dealt with by *The Radio Review*, the decease of which is a matter of regret, will find sufficient space devoted to their wants in the new issues.

It is certain that *The Wireless World* will now more than ever form an essential part of the engineering literature of the day, and I wish the new venture every success and continued support from an extended number of subscribers.

# Notes

**Prof. H. Fassbender** has relinquished the editorship of the *Jahrbuch Zeitschrift für drahtlose Telegraphie* on his appointment as Professor of Electrical Engineering at the University of La Plata. His editorial duties have been taken over by Dr. Eugen Nesper. The title of the publication has now been changed to *Jahrbuch der drahtlosen Telegraphie und Telephonie : Zeitschrift für Hochfrequenztechnik.*

**Wireless Patent Actions.**

In an action brought by Marconi's Wireless Telegraph Company, Ltd., against F. O. Read & Co., Ltd., an order was made in the High Court of Justice, Chancery Division, by Mr. Justice Russell on February 17th, 1922, restraining Messrs. F. O. Read & Co., Ltd., from infringing letters patent Nos. 13636 of 1913, 28413 of 1913, 252 of 1914, and 126658. Messrs. F. O. Read & Co., Ltd., were further ordered to destroy all infringing apparatus made or used by them, and to pay the Marconi Company damages and costs.

In an action brought by Marconi's Wireless Telegraph Company, Ltd., against A. C. Cossor, Ltd., an order was made on March 1st, 1922, restraining Messrs. A. C. Cossor, Ltd., from infringing letters patent Nos. 284133 of 1913, and 126658, except so far as they manufacture for H.M. Government. Messrs. A. C. Cossor, Ltd., were also ordered to destroy infringing apparatus manufactured or used by them (except that constructed to the order of H.M. Government) and to pay damages and costs. Abridgements of Patents 13636 of 1913, and 28413 of 1913, appeared on page 685 of the issue of *The Wireless World* for February 4th, 1922.

Patent No. 252 of 1914 relates to valve circuits in which reaction is employed for generation, heterodyning, etc.

Patent 126658 relates to the type of valve which is usually referred to in wireless circles as the French type.

**Dutch Concerts.**

It has been brought to our notice that a good number of amateurs conduct experimental transmissions during the period of the Dutch Concerts on Sunday afternoon, and as numerous complaints have been received on the subject, particularly regarding transmissions originating in Yorkshire, we think that readers may care to have the matter brought to their notice.

**Scouts' Concert Party and Display.**

The 16th Bournemouth Troop (St. Paul's) gave a successful concert and display in St. Paul's Gymnasium recently before a large audience that filled the hall.

A special feature of the evening was a demonstration in wireless telegraphy and telephony received on the aerial attached to the wireless section of the St. Paul's Scouts.

The telephony transmissions of music and speech were sent by Mr. H. C. Binden from his station, and the receiving apparatus enabling the results to be heard over the large hall were kindly supplied and operated by Mr. T. H. Dyke, of Winton, for this occasion.

**Rhondda Valley Amateurs.**

Mr. D. V. Briggs, of 5, Llwynmadoc Street, Graigwen Road, Pontypridd, Glam., states he is in touch with several amateurs in his district, and it is desired to start a wireless society for the Rhondda Valley. All those in this district who are interested are invited to communicate with Mr. Briggs.

**Correspondence.**

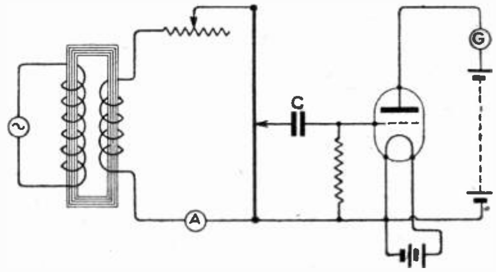
In Mr. B. S. T. Wallace's letter, published under "Correspondence" in the issue of *The Wireless World* for March 4th, "200 miles" should read "2,000 miles."

**SHARE MARKET REPORT.**

| | | | |
|---|---|---|---|
| Marconi Ordinary .. .. .. | £2 | 2 | 3 |
| ,, Preference .. .. | 1 | 18 | 6 |
| ,, Inter. Marine .. .. | 1 | 8 | 9 |
| ,, Canadian .. .. | | 8 | 6 |
| Radio Corporation of America :— | | | |
| Ordinary .. .. .. .. | | 14 | 0 |
| Preference .. .. .. .. | | 13 | 0 |

**A CORRECTION.**

In the article entitled "A Sensitive Direct Reading Voltmeter and Ammeter for High Frequencies," by E. B. Moullin, M.A., which appeared in the last issue, the figure given below should be substituted for Figure 1, page 2.



# Calendar of Current Events

**Tuesday, April 11th.**

Transmission of Telephony at 7 *to* 7.25 *p.m.* on 700 metres followed by C.W. Calibration Signals on 1,000 metres, by 2MT at Writtle, near Chelmsford.

**Wednesday, April 12th.**

Cowes and District Radio Society.

"Semi-Aperiodic Amplifiers and the Reaction Principle."

Radio Scientific Society, Manchester.

At 61, High Street, Manchester. Open evening.

**Thursday, April 13th.**

Liverpool Amateur Wireless Society.

At Colquitt Street, Liverpool, "Accumulators, How Made, Used and Abused," by Mr. S. K. Wilkie.

Ilford and District Radio Society.

Social evening.

**Friday, April 14th.**

Leeds and District Amateur Wireless Society.

8 *p.m.*—At University of Leeds, College Road, Leeds, "Samuel Morse," by Mr. W. R. Plowers. "High Frequency Intervalve Transformers," by Mr. G. F. Kendall, B.Sc.

**Wednesday, April 19th.**

North Middlesex Wireless Club.

8 *p.m.*—At Shaftesbury Hall, Bowes Park, "Electro-Chemistry," by Mr. R. Maxwell Savage, B.A.

Cowes and District Radio Society.

"Independent and Self Heterodyne Methods."

**Friday, April 21st.**

Wireless Society of Highgate.

7 *p.m.*—Lecture and demonstration by Lieut. Walker.

Bradford Wireless Society.

7.45 *p.m.*—At 5, Randallwell Street, Bradford. Meeting.

# Correspondence

*To the Editor of* The Wireless World and Radio Review.

Sir,—After reading Mr. Ellison's letter in *The Wireless World* of February 18th, I believe that I can give you some information concerning amateur work in America that will be of interest to your readers.

It seems to be the impression of Mr. Ellison that spark transmitters are used chiefly in America. Eighteen months ago CW transmitters were almost unknown to amateurs. Up to that time I had never heard an amateur CW. Since then we have been changing over to CW very rapidly, and the CW is far in the lead of the spark now, but the sparks are not entirely out of use. The prospects are that the sparks will soon be entirely out of use.

As for ability to tune a set to 180 metres, we consider that the CW is easier to make operate on short waves than the spark. Without apparatus CW allows a shorter wave to be used than can be easily used with a spark set. Any of our receiving or transmitting tubes will oscillate as low as 100 metres, and the General Electric Co. have had tubes in their laboratories that oscillate as low as 6 metres.

Regarding the receiving of short waves, the difficulty of a high frequency amplifier to operate on so short a wave has prevented any use whatsoever of radio frequency amplification. All amateur stations here are equipped with low frequence amplifiers, if any. The usual equipment is a detector tube and two low frequence amplifiers. There are now iron core radio frequence transformers advertised, which are expected to make great changes in our receiving equipment, but as yet the manufacturers have not started deliveries of them, so we have only their word for what they will do.

As Mr. Ellison stated, there are very few amateur telephone stations. There are many for short range work, with a range of a few miles, but none to compare with the telegraph stations. The great ambition of an American amateur is to cover the greatest distance possible, so he prefers to use any telephone transmitter as a CW telegraph transmitter, with a much greater range.

We have dozens of radio telephone stations operating on about 360 metres, sending concerts, speeches, market reports, and other broadcasts. These stations have commercial licences, and most of them have an output of ½ kW. They are operated every evening by commercial companies who manufacture receiving apparatus. The prospects are that with a few months there will be one hundred men with receiving sets intended solely to get music to every amateur we have now. All of these stations are new, except the one at Pittsburgh, Pennsylvania. This station, owned by the Westinghouse Electric and Manufacturing Co., has been operating since January 1st, 1921. When this station had been operating one year there was a receiving set in every sixth home in Pittsburgh. The prospects are that within a very few months it will be that way all over America. Just now the rush for receiving apparatus is so great that all manufacturers are swamped with orders, and every manufacturer, distributor, and retail dealer is entirely out of stock of receivers and parts. We have to wait from weeks to months to get any parts for receiving sets. Within the last few days several of my friends have driven by auto to numerous cities within fifty miles in a search for vacuum tubes, but there are absolutely none to be had.

Victor Andrew.

Wooster Radio Store,
Wooster, Ohio, U.S.A.
*March 6th*, 1922.

# Books Received.

The Year Book of Wireless Telegraphy and Telephony, 1922 (London: *The Wireless Press, Ltd.* Pp. 1476. Demy 8vo. Price, 15/- net.)

Marine Wireless Pocket Book for the Practical Operator and Student. By W. H. Marchant. (London: *Sir Isaac Pitman & Sons, Ltd.*, 1922. Pp. 180. 6½″ × 4″. 138 diagrams. Price 6/- net.)

Lektrik Lighting Connections. Seventh Edition. (London: *A. P. Lundberg & Sons.* Dec. 1921. Price 1/- net.)

# Wireless Club Reports

*NOTE.—Under this heading the Editor will be pleased to give publication to reports of the meetings of Wireless Clubs and Societies. Such reports should be submitted without covering letter in the exact form in which they are to appear and as concise as possible, the Editor reserving the right to edit and curtail the reports if necessary.* **The Editor will be pleased to consider for publication papers of unusual or special interest read before Societies. An Asterisk denotes affiliation with the Wireless Society of London.**

## The Wireless Society of London.

The Forty-sixth Ordinary General Meeting was held on Wednesday, March 22nd, at the Institution of Electrical Engineers, at 6 p.m.

**The President,**

The balloting list is being circulated and will be collected at the end of the meeting. I am glad to see another lady is going to join us. Four Wireless Societies have also been affiliated. This concludes the business.

Capt. Donisthorpe who had proposed to give us a lecture this evening on "Harnessing Electrons," has unfortunately been prevented from attending owing to pressing business. He will, however, give his lecture at a later date. In the meantime Mr. G. G. Blake has kindly offered to take his place by giving us a paper entitled "The Modern View of Electricity and the Three-Electrode Valve with Experiments."

I call upon Mr. Blake to give his lecture.

(For Report of this paper see next issue.)

At the conclusion of the paper and discussion, the President announced that the following had been elected to membership of the Society:—Members: Henry Alexander Sherwin Gothard, Alfred Edward Joseph Symonds, Miss Florence Parbury, Albert Edward Grocott, John Francis Atherton, Herbert Lee Serjeant. Assoc. Member: Douglas Sisson Relph, and that the following Societies had been accepted for application:—The East London Radio Society, The Wallasey Wireless and Experimental Society, The South London Wireless and Scientific Club, The Southend and District Wireless Club.

The meeting adjourned at 7.15 p.m.

## The West London Wireless and Experimental Association.*

The attendances at the weekly meetings have of late greatly improved, much to the satisfaction of the officers of the Association, and new members are still joining the flock of experimenters.

At the General Meeting, on January 26th, the new rules which had been previously framed by the Committee were fully discussed, and each rule was passed by the members present. At the completion of business, Mr. R. Cole gave a very interesting paper entitled "Aerials and Circuits for Amateurs," which was very much appreciated, especially by the younger members.

Meeting held February 2nd.—Morse practice was taken by a large number of the members and afterwards the Vice-President, Mr. F. E. Studt, gave a very interesting lecture and demonstration, entitled, "The Oscillating Wavemeter and the Uses of Harmonics in Wireless." A very hearty vote of thanks was accorded the lecturer for the great trouble he had taken in preparing the demonstration.

Meeting February 9th.—Morse practice was well attended after which Mr. C. W. Hirst read a paper and demonstrated "The Making of Lattice Coils of Various Designs." This was a very useful subject, especially for the junior section.

Meeting February 16th.—The President, Mr. Geo. Oxford, announced that the committee had decided that one meeting a month would be set aside for open discussion after the Morse practice class. Mr. I. F. Bruce took the opportunity of presenting to the Association a Morse practice set, comprising an efficient buzzer connected to a special form of loud speaking telephone. Incorporated with the set was an addition of Mr. Bruce's own design and manufacture. This consisted of a silent buzzer furnished with an adjustable secondary circuit, to which a series of telephones can be connected. The fluctuations of current in the buzzer circuit are, by induction, impressed on the telephone circuit and a signal which exactly simulates a musical spark note is obtained. The intensity of the signal can be varied from very strong to an almost inaudible limit. After a description of the instrument by Mr. Bruce—a very hearty vote of thanks was expressed to the donor in the usual manner. Mr. L. V. Clarke also presented four pairs of headphones for use with this instrument, and was also accorded a hearty vote of thanks by those present.

Meeting February 23rd.—Mr. F. E. Studt continued his series of theoretical papers.

Meeting March 2nd.—The Librarian announced that he had purchased a few new books, which would be available for members the next week. Mr. L. Shepherd was appointed Instrument Steward. Mr. Mullings read a very interesting paper entitled "Construction of Electric Motors and Generators."

Meeting March 16th.—The President announced that the Committee were expecting to arrange for demonstrations to be given by Messrs. H. D. Butler & Co., also the Marconi Scientific Instrument Co., shortly, and all members are asked to make a special effort to be present. Any gentlemen desiring particulars as to membership and objects of the Association should communicate with the Hon. Secretary, Mr. Horace W. Cotton, 19, Bushey Road, Harlington, Middlesex, who will have much pleasure in sending information by return.

## North Middlesex Wireless Club.*

Hon. Secretary, Mr. E. M. Savage, "Nithsdale," Eversley Park Road, Winchmore Hill, N.21.

The 4th Annual General Meeting of the Club was held at Shaftesbury Hall, Bowes Park, on Wednesday, March 22nd, Mr. A. G. Arthur being in the chair.

The minutes having been read and passed, the Chairman called on the Hon. Secretary to read his report for the year. Mr. Savage said that the Club had made good progress during the year under review, as regards its position as a Club. Meetings had been well attended, and it had been the Committee's endeavour to provide an attractive programme at each meeting.

The Hon. Treasurer's report showed a balance in hand of £7 16s. 4d. This amount, although not large, was sufficient to meet any expenses which were likely to arise in the near future. At the same time, there were a number of subscriptions due for renewal, and when these were in, the position would be better still.

The Installation Officer's report showed that the Loan Scheme was working well, and a number of valuable instruments had been added to the Club's installation, the Committee having felt that this course was the one most calculated to serve best the interests of members, rather than to keep a large reserve of cash in hand.

The Librarian reported that the library books were in great demand, particularly the most up-to-date ones.

All the foregoing reports were adopted.

A vote of thanks was moved to the retiring officers by Mr. A. J. Dixon, and seconded by Mr. Symons, who spoke in a very appreciative manner of the work done by them during the year. Mr. Savage spoke a few words thanking Mr. Symons on behalf of the Officers and Committee, and said how grateful he was for the help given by Mr. Arthur. The following were then elected as officers for the year :—

President, Mr. A. G. Arthur ; Vice-Presidents, Mr. Wm. Le Queux and Mr. C. Midworth, A.M.I.E.E. Chairman, Mr. G. Evans ; Hon. Secretary, Mr. E. M. Savage ; Hon. Treasurer, Mr. W. A. Saville ; Hon. Installation Officer, Mr. A. J. Dixon ; Hon. Librarian, Mr. H. A. Beers.

Committee, Messrs. Gartland, Green, Holton, Symons, and Wordham.

### Wireless and Experimental Association.*

At a meeting held at the Central Hall, Peckham, on March 15th, Mr. Joughin, a member, gave an account of how he had made a milliamperemeter capable of measuring almost anything in volts and amperes. Major Webb was in the chair.

Mr. Kirkby followed by giving several new points on short wave reception.

### Dartford and District Wireless Society.*

Hon. Secretary, Mr. E. C. Deavin, 84, Hawley Road, Dartford.

The usual fortnightly meetings of the above Society were held on the following dates, Mr. J. R. Smith, A.M.I.E.E., Vice-President, in the chair, on each occasion.

Friday, February 24th, 1922.—This meeting was well attended and several matters appertaining to the Society's work were discussed. Several members produced sketches of valve circuits with a view to deciding a suitable circuit for completing a valve receiving set to be permanently installed at the Grammar School. An experimental set with sketches of circuit was demonstrated by Mr. Watt, and it was eventually decided to make up the Club set on these lines.

"H.T. Cells and Their Manufacture" was among the subjects discussed, the matter being treated more from an amateur than professional point of view.

The secretarial duties in connection with the Society having greatly increased, Mr. J. R. Prangnell was elected Assistant Secretary.

Friday, March 10th, 1922.—The minutes of the two previous meetings were read and confirmed at this meeting, and the Hon. Secretary also read a letter received from the Editor in connection with the new issue of *The Wireless World*, commencing on April 1st, next. A resolution was passed to the effect that the Hon. Secretary write a letter of thanks to the Editor for information, instructive and interesting, given in the past, and also best wishes for success of the weekly magazine.

The Hon. Secretary also read a letter from the Wireless Society of London regarding matters of importance discussed at the Conference of Wireless Societies. Good progress is being made with the Society's receiving set and it is hoped that same will be ready for test at the next meeting.

### Sheffield and District Wireless Society.*

Hon. Secretary, L. H. Crowther, A.M.I.E.E., 156, Meadow Head, Norton Woodseats, Sheffield.

On the 24th March at the Department of Applied Science, George Square, Sheffield, Mr. G. Hollingworth, of the National Physical Laboratory, gave a most interesting lecture on "Modern Wireless Problems," to a large and appreciative audience.

In a fluent and masterly manner he made clear many of the difficulties experienced in wireless research work and indicated their probable solutions.

In listening to the lecturer, one felt justly proud of the men who carry out valuable work so quietly and efficiently at the National Physical Laboratory.

The full discussion which followed showed the amount of interest taken by our members in all that appertains to radio activities and Mr. Hollingworth was evidently well pleased with the enthusiastic reception and hearty vote of thanks which he received.

### The Leeds and District Amateur Wireless Society.*

Hon. Secretary, Mr. D. E. Pettigrew, 37, Mexborough Avenue, Chapeltown Road, Leeds.

A General Meeting took place on March 24th at the Leeds University, Mr. A. M. Bage (Vice-President) taking the chair at 8 p.m. The Chairman called upon Mr. J. Croysdale to deliver his paper on "Accumulators and High Tension Batteries." Mr. Croysdale arranged his lecture so that the junior members as well as the more advanced members should have benefited considerably as a result of his remarks. He explained in a very clear and concise manner the theory of the accumulator, paying special attention to lead cells. Passing on to high tension batteries, the lecturer recommended the use of small primary cells in order to obtain anode potential. He had constructed a very successful wet primary battery of Leclanche cells, using the sacks and carbons of old dry cells in place of the usual porous pot. Cylindrical zinc sheets formed the negative pole. The containers were made from waxed cardboard. Such a battery was stated to be very silent even with L.F. valves, and was extremely durable. A specimen of these cells was passed round for examination. At the close of the lecturer's remarks, the Chairman declared the discussion open, which was joined into freely by the meeting. A hearty vote of thanks was accorded to Mr. Croysdale.

The Chairman then called upon Mr. S. Kniveton to deliver a paper entitled "Home-Made Three Valve Amplifiers." Mr. Kniveton had on view two three-valve sets which were almost entirely home-made. One set included a stage of H.F. magnification with reaction, a rectification stage, and a L.F. magnification stage. With this set it is possible to use the rectifier alone, or in conjunction with the H.F. valve and/or the L.F. stage. The H.F. intervalve transformer is "tuned" by means of a condenser and functions successfully over a wide range of wavelengths. This inductive coupling is displaced on the longer waves by resistance capacity connections, the change-over being made readily by use of valve pins and sockets. Diagrams of connections were distributed to those present. The other three-valve set was not a complete receiver in itself, and was used as a L.F. amplifier. Switch-gear, which consists of one multiple pole switch, does all the necessary making and breaking of the circuits when one desires to use a certain number or combination of valves. At the cessation of the lecturer's remarks the discussion was opened. This gave rise to some very interesting practical points, which were gone into further, when, after a hearty vote of thanks had been given to Mr. Kniveton, the meeting broke up to examine the apparatus on view.

The Chairman had three variable condensers with ebonite dielectrics on view, these instruments being home-made also.

### Birmingham Experimental Wireless Club.*

Hon. Secretary, Mr. Frank S. Adams, 110, Ivor Road, Sparkhill, Birmingham.

At a meeting held at Digbeth Institute on February 17th, the Hon. Secretary gave a short talk on the conversion of obsolete "Crystal" sets for valve work. A partially-converted Marconi "Type 31" receiver was exhibited and passed round for inspection. A description was also given by Mr. Adams of the methods he had employed in converting a "Type 16" receiver.

A discussion took place, the merits of different types of coils being argued by their respective supporters.

A meeting was held at Dibgeth Institute (the Club headquarters) on March 3rd. The Hon. Treasurer, Mr. A. Woodcock, gave a very instructive lecture on "Recording Wireless Signals." The lecture, which was much enjoyed, was very practical, and included descriptions of original ideas of Mr. Woodcock's own invention. The lecturer has devoted many months to research in this direction and has had great success. On conclusion he was accorded a hearty vote of thanks, and was asked many questions concerning the circuits and relays used in his experiments.

### Bradford Wireless Society.*

A meeting was held in the Club-room at 7.45 p.m. on March 24th, Mr. W. C. Ramshaw in the chair. After the business of the meeting, the Chairman called upon Mr. T. Brown-Thompson to give his lecture entitled "Types of Valves."

In a very lucid manner the lecturer dealt with the Theory of Valves from the inception up to the present day. The lecture was admirably illustrated by diagrams and also a series of characteristic curves of various types of valves, including the N.P.L. and Weagant type. Touching upon the Four Electrode Valve, Mr. Thompson explained how its action depended upon "the Secondary Emission of Electrons from the Plate." This portion of the lecture was of immense interest to those present, judging by the number of questions asked at the close of the lecture and which were adequately replied to by Mr. Thompson.

At the conclusion a hearty vote of thanks was proposed by Mr. Evans, seconded by Mr. J. Bever and carried unanimously.

After the lecture a demonstration of Messrs. Burnham's "Ultra III" set was given, good signals being obtained.

Meetings take place every alternate Friday evening at 7.45 p.m. in the Club-room, 5, Randall-well Street (just above the Empire), Bradford. Next meeting, April 21st.

Organising Secretary, Mr. N. Whiteley, 8, Warrels Terrace, Bramley, Leeds.

### Croydon Wireless and Physical Society.*

On Saturday, March 4th, the above Society paid a visit to the Croydon Aerodrome and had an opportunity of inspecting the W.T. Station, the Flying Ground, Meteorological Dept., etc. Some of the members took advantage of the occasion and had a short flight.

The Society owes a deep debt of gratitude to Capt. Guest and the members of his staff, who so kindly explained all the important points connected with the working of the Aerodrome.

The members afterwards had tea at the Greyhound Hotel, Croydon, and all decided that they had spent a very enjoyable and instructive afternoon.

A few members of the Anerley Wireless Society were also present at the Aerodrome and tea.

The Secretary, Mr. B. Clapp, "Meadmoor," Brighton Road, Purley, will be glad to receive applications from intending members.

### Plymouth Wireless and Scientific Society.*

On Wednesday, March 8th, a sale of apparatus was held. Quite a quantity of "old junk" appeared and a considerable amount changed hands. The sale took the form of a Dutch auction, and Mr. Graves proved an efficient and valuable auctioneer.

The following Wednesday we were favoured with a most interesting and instructive lecture on "The Electron Theory," by Mr. Mitchell. This subject led to a lively discussion on some of the points raised, among others the vexed question of which way a current flows. A very enjoyable evening was spent, and a hearty vote of thanks was accorded to the lecturer.

On Wednesday, March 22nd, the Secretary gave a lecture on X-rays. The phenomena accompanying the electrical discharge through air at decreasing pressures, the formation and probable structure of the cathode stream, and ultimately the formation of the X-rays were described. Reference was made to the experiments and investigations of J. J. Thompson, Sir William Crookes and Professor Röntgen. At the conclusion of the lecture, by means of a tube he had brought and a 10-in. coil belonging to the college, the Secretary gave a demonstration, and curious members were enabled to investigate one another's anatomy.

Full particulars of the Society will be furnished upon application to the Hon. Secretary, Mr. G. H. Lock, 9, Ryder Road, Stoke, Devonport.

### The Wireless Society of Hull and District.*

Mr. W. J. Featherstone presided at the fortnightly meeting of this Society in the absence of the President and Vice-President.

After the minutes of the previous meeting had been read and confirmed a member brought forward a proposal that the Librarian of the Central Library be written to, with a view of ascertaining if it was possible for a copy of the "Year Book of Wireless Telegraphy and Telephony, 1922," to be placed in the Reference Library for the use of wireless enthusiasts in Hull, who wish to consult such a work at any time. This was duly seconded and carried, and the Hon. Secretary was instructed to write accordingly. The rest of the evening was profitably occupied in taking down code and press, the Chairman ably manipulating the buzzer at various speeds.

The Hon. Secretary, 16, Portobello Street, Hull, would welcome more intending members, and will be only too pleased to furnish full particulars on request.

### The Willesden Wireless Society.*

At our meeting on March 7th Mr. T. Key lectured on galvanometers, giving his interested audience descriptions of the various kinds in use and information for making and using a simple but sensitive instrument. The lecturer was accorded a very hearty vote of thanks. On March 14th Mr. W. Jones gave an elementary lecture upon "Magnetism and Electricity," it was received very well, especially by the newer members, and it has been decided to give elementary lectures and talks to the non-technical members every Friday in addition to the usual Tuesday meetings. Mr. A. Arnoll has kindly undertaken the teaching.

### Southampton and District Wireless Society.

Hon. Secretary, Mr. T. Cutler, 24, Floating Bridge Road, Southampton.

At a meeting of the above Society held at the Kingsland Assembly Rooms, on Wednesday March 15th, a large and enthusiastic gathering of members was recorded. Buzzer practice was indulged in for 30 minutes, after which Mr. Cutler's three-valve set was on exhibition for members, and was the centre of attraction. Leafield was tuned in at 8 o'clock and was heard with remarkable loudness all over the large concert hall. Various other stations were tuned in, and the signals were all that could be desired. At 8.45 general business of the Club commenced. Rules, etc., were passed and the Club put on a proper working basis.

On March 22nd a most enjoyable and pleasant evening was spent and a large attendance of members was recorded. The evening was devoted to experimental and research work, demonstration on a three-valve L.F. receiver, and also a three-valve amplifier. A Club receiving set will shortly be installed and also, it is hoped, a C.W. transmitter.

The following are the officers of the Society :—*Chairman*, Mr. R. Freeman; *Vice-Chairman*, Mr. Eastman; *Hon. Secretary and Treasurer*, Mr. T. H. Cutler. *Committee*, Messrs. C. Callanan, R. Reeves, J. Knott, R. Spear, F. Wainsboro. *Auditors*, Messrs. R. Francis, M. Oxford. *Trustees*, Messrs. C. A. Hopkins, C. D. Medley.

Meeting every Wednesday, 7.30 p.m.

### Wolverhampton and District Wireless Society.

A meeting of the above-named Society was held on Wednesday, March 22nd, at Headquarters, 26, King Street, Wolverhampton. A very interesting demonstration on a B.T.H. Portable Set and loud speaker was given by Mr. H. Taylor. The Leafield Station was particularly assertive, but other more modest stations were heard quite well, and with the aid of an outside aerial Annapolis could be received. A practical illustration of "jamming" was afterwards given by Messrs. Taylor and Jones, the latter using a converted Mark III set.

Hon. Secretary, Mr. Geo. W. Jones, 8, Roseberry Street, Wolverhampton.

### Smethwick Experimental Wireless Club.

Hon. Secretary, Mr. Ralph H. Parker, Radio House, Wilson Road, Smethwick, Staffs.

At a meeting held on February 17th, at the Club's headquarters, Municipal Technical Institute, Mr. L. Lee gave a very interesting lecture on "High Frequency Transformers for Long Wavelengths," followed by a demonstration of a three-valve set of his own structure. The lecturer was accorded a hearty vote of thanks.

A meeting was held on Friday, February 24th, Mr. A. C. Hulme in the chair, and after the previous minutes had been read and confirmed, the Secretary kindly lectured on the "Evolution of the Valve."

Starting from the investigations made by Ebster and Geitel, 1882-89, he outlined the evolution of the modern three-electrode valve. Judging from the discussion which followed, his lecture proved to be beneficial to all. Mr. C. Grew proposed a vote of thanks which was carried with acclamation.

At a meeting held on March 3rd Mr. C. Grew gave a demonstration on his four-valve receiver which was greatly appreciated.

The Club has now procured a Tingey receiver and hope to arrange a demonstration.

### North Essex Wireless Society.

Hon. Secretary, Mr. F. J. Smith, Rutlands, Felsted.

Pending arrangements for a permanent Headquarters and Club-room, informal meetings of members are held at 15, Rayne Road, Braintree, every Saturday evening from 7 to 10 p.m., and the Secretary, Mr. Castagnoli, is in attendance. It is hoped by this means to arrange for the future of the Society and to arrange an interesting programme. The first meeting was held on Saturday, March 18th, and was devoted to a discussion on "Wireless" topics.

### The Wireless Society of East Dorsetshire.

A lecture, principally for beginners, was given in the Wimborne Council Schools on Wednesday, 22nd March, by the Secretary on Crystals and the practical application to receiving circuits, with explanations of the fundamental principles of oscillations.

Members are notified that these lectures will continue to be held monthly, the next be fixed for April 19th.

Members and enthusiasts in the Poole and Branksome districts are invited to meet and use the Branksome Liberal Club as Headquarters, *pro tem.*, on notifying the Secretary, Mr. T. Chapman, Associate I.R., Abbotsford, Serpentine Road, Poole, who will also be glad to hear from any amateurs wishing to become members.

# Questions and Answers

*NOTE.—This section of the magazine is placed at the disposal of all readers who wish to receive advice and information on matters pertaining to both the technical and non-technical sides of wireless work. Readers should comply with the following rules.—(1) Each question should be numbered and written on a separate sheet on one side of the paper only. (2) Queries should be clear and concise. (3) Before sending in their questions readers are advised to search recent numbers to see whether the same queries have not been dealt with before.* **(4) The Editor cannot undertake to reply to queries by post.** *(5) All queries must be accompanied by the full name and address of the sender, which is for reference, not for publication. Queries will be answered under the initials and town of the correspondent, or, if so desired, under a "nom de plume."* **(6) Readers desirous of knowing the conditions of service, etc., for wireless operators will save time by writing direct to the various firms employing operators.** *(7) Four questions is the maximum which will be accepted at a time.*

**C.S.B. (Cullompton)** *asks* (1) *The best way to add two valves to a single valve set.* (2) *If a single valve set radiates much.* (3) *What results to expect with additional valves.*

(1) and (2) It will be much better to add one H.F. valve with resistance capacity coupling, and one L.F. magnifier to the present oscillating detector valve. **PCGG** will then be much stronger.

(3) This circuit does radiate feebly, and the "seven valve man's set" cannot be very efficient if he could not detect it. Normally this feeble radiation does not cause much interference unless there are several stations close together on the same wavelength.

**H.P. (London)** *asks* (1) *If a 3-valve transformer coupled set will work satisfactorily.* (2) *Which is the rectifying valve, and why.*

(1) Set will be better with reaction coil in the grid of the third valve. 4-volt filament may be lighted from the 6-volt cell if extra resistance is added in the circuit.

(2) All the valves are rectifying somewhat, but the third valve is the main rectifier, chiefly because the circuit arrangement permits the previous H.F. valves to amplify, but does not allow the last to do so.

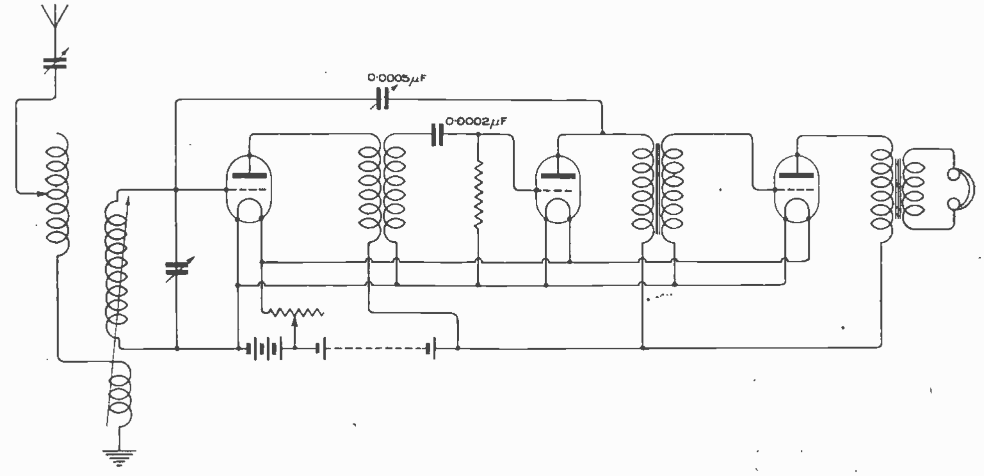



*Fig.* 1.

**"ELECTRON" (Elland)** *has a collection of apparatus and asks* (1) *For a suitable circuit.* (2) *Where to use an "Ora" valve.* (3) *If* **PCGG** *will be heard on a set in Yorkshire.* (4) *If additional apparatus is required.*

(1) and (4) See diagram Fig. 1.

(2) Use it as rectifier.

(3) Yes, if the H.F. transformer is suitable for 1,050 ms., and the adjustment of the circuits very carefully carried out.

**"NIPPER" (Poole)** *hears clicking noises on his crystal set, and asks for advice.*

These are probably signals from the high power C.W. station at Leafield on harmonics as well as the fundamental of its wavelength. Or possibly the source may be some nearer C.W. station. In either case you will have difficulty in tuning them out.

**G.W.M. (Croydon)** *asks for particulars of a loose coupler for 4,000 ms., and a loading coil for longer waves.*

If a 0·0003 mfds. condenser is used across the secondary, the following windings should be satisfactory. Primary 6″ × 12″, wound with No. 24. Secondary 5″ × 10″, wound with No. 28. No loading coil will be of any use, as there are no spark stations working on longer wavelengths, except **MSK.**

**"INTERESTED" (Walford)** *asks for the essential parts of a receiving station for 600 to 30,000 metres.*

A single valve set would be best, and for this wavelength we should advise slab coils. You would obtain better results with more valves up to 2,000 metres. The following parts will be required .

1 Valve.
1 6-Volt accumulator.
1 50-Volt dry cell battery.
1 3-ohm filament resistance.
1 Pair telephones.
1 0·001 Mfd. condenser.
1 Grid condenser and leak.
1 0·0005 Variable condenser, together with tuning and reaction coils.

**"J.K." (Hillingdon)** *asks* (1) *Wavelength to which certain coil will tune.* (2) *Number of turns on 3″ former for 1,200 metres.* (3) *If two basket coils connected as a variometer, gives sufficiently fine tuning for telephony.*

(1) Inductance is 2,400 mhys, and it will tune a standard aerial to about 1,300 metres.

(2) About 300 turns of No. 26 with a reaction coil 2½″ diameter wound with 4″ of No. 28.

(3) This should be quite satisfactory.

**"E.R.M." (Inverness)** *has a two-valve spark set which oscillates above 3,000 metres. He asks* (1) *why this is.* (2) *What stations precede messages by "PR" and a number.*

(1) This may possibly be due to capacity reaction due to leads from the plates and grids of the valves being run too near together. Try separating them. It is possible that interference from Stonehaven or Aberdeen C.W. sets may cause your set to appear to oscillate.

(2) "PR" is a Service signal.

**"WOLF" (Wolverhampton)** *asks* (1) *For diagram of the M.15 receiver.* (2) *How to attach an additional note magnifier.*

(1) We regret we do not possess this diagram, but you will be able to obtain it from the makers, or you could trace it yourself by taking off the bottom of the instrument.

(2) Introduce the step-up iron core transformer between the telephone terminals and the grid and filament of the magnifying valve.

**"AMPLIFIER" (Norwich)** *Is constructing a four-valve set and asks for advice.*

(1) The reaction connection is correct. Connect a 0·001 mfd. condenser across the telephones.

(2) 40,000 Ohms should be sufficient for a plate resistance for these valves. If a valve requires 30 volts on the plate for normal working it will require about 60 when used with a resistance in this way, owing to the big volt drop across the resistance.

(3) The intervalve condensers should be about 0·0003 mfds. The condenser across the potentiometer about 0·05 mfds. Make the intervalve condensers up with two foils overlapping for about 8 square centimetres separated by a 2 mils. sheet of mica.

(4) A potentiometer should be wound to several hundred ohms with No. 36 Eureka wire. This potentiometer is not strictly essential.

**"CARBORUNDUM" (Monkseaton)** *asks* (1) *For relative values for inductances and condensers in a two-circuit set.* (2) *If in his set the aerial is liable to oscillate.* (3) *If there is any likelihood of damage to the 4,000 ohm telephones in a 50-volt circuit.*

(1) Generally speaking the inductances and capacities can be the same in each. In your case both condensers should be 0·0005 mfds., A.T.I. 8″ × 6″ of No. 22, closed circuit inductance 6″ × 5″ of No. 28.

(2) As you show no reaction the aerial will not oscillate, but if you couple back from the closed circuit into the A.T.I. you will get oscillation which can only be stopped by loose coupling.

(3) There is no danger, particularly as you have a crystal in series with the telephones.

You may get **PCGG** very weakly if you use reaction. You should get **FL** on telephony.

**"G.H.B." (New Cross)** (1) *Queries the dimensions given for condensers in the single valve set described in March, 1921.* (2) *Asks if DCC wire may be used instead of DSC.* (3) *If a multivalve H.F. amplifier may be used with this set without alterations to the connections, and, if so, for a diagram.*

(1) For the 0·0015 mfd. condenser five foils will be sufficient. The other value was given in error.

(2) DCC may be used but will curtail the range somewhat owing to the greater thickness of the wire.

(3) The set is not suitable for this alteration without complete re-arrangement. The tuning circuit can be used for any of the multi-valve circuits shown recently.

**"P.C." (Watford)** *asks re the reply to* **"C.C.W." (Woolwich),** *in January 7th issue.* (1) *The total number of turns of wire for each coil.* (2) *For a diagram of connections.* (3) *The wavelength of the set.* (4) *How to determine the wavelength of slab-coils.*

(1) We fail to see the use of this information, but the A.T.I. will contain about 300 turns; coupler primary 120 and coupler secondary about 400.

(2) See diagram Fig. 2.

(3) Maximum about 3,000 metres.

(4) There is no simple rule, but you will find a formula which gives fairly good results for close-wound coils on page 22 of Nottage's "Calculation of Inductance and Capacity."

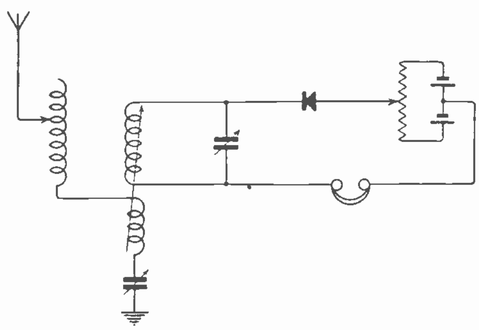


*Fig. 2.*

**"H.G." (Sparkhill)** *asks* (1) *What results, if any, he will get with certain gear.* (2) *For a diagram of connections.* (3) *For a suitable aerial.*

(1) You should get fair results from any near station and should also get **FL** and Poldhu.

(2) See diagram Fig. **3**.

(3) Aerial should be as high and long as possible. Results will be poor unless it is practically the P.M.G. maximum.

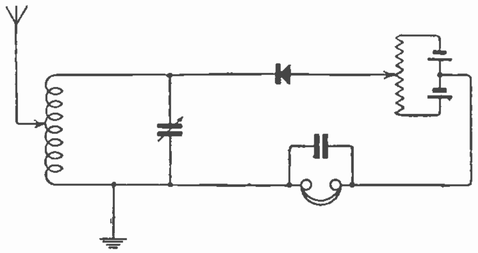


*Fig.* 3.

**"ACK-ACK" (Greenwich).**—As you do not specify sufficiently clearly what set you are referring to we cannot answer in detail. A 6-volt accumulator is sufficient for "V.24" or "R" valves. The filament resistance should be used in either case. Failure to oscillate is probably due to insufficient reaction. The capacity across transformer primary may be 0·0001 mfd. if transformer is H.F., and 0·001 mfd. if L.F.

**"H.M." (Stamford Hill)** *asks* (1) *Dimensions for rotary condensers for school set described in October 29th issue.* (2) *Best value of grid leak for this set.* (3) *If he can receive* **PCGG** *with it.*

(1) Only one condenser will be necessary. It should have 12 fixed plates and 11 moving; 4″ diameter, space 1/16″ apart.

(2) About 5 megohms, but the best value must be determined by experiment.

(3) You may get this station very weak with careful tuning.

**"W.F." (Romford)** *asks* (1) *For windings for a single circuit reaction tuner for about* 150 *metres.* (2) *Where to put tappings for certain wavelengths.*

(1) Wind the 3½″ × 6″ former with No. 22 for the A.T.I. and the 3″ × 5″ with No. 28 for reaction. Use the 0·0005 mfd. condenser, which must be of variable type, in series with the A.T.I.

(2) It is impossible to predict tappings accurately on a set of this type, and in any case you will not require more than two or three to each coil.

**"L.J.E." (Kingston)** *asks whether a tuner with basket coils has been described in any previous issue, and if not, for the date of an issue describing a good all-round set.*

A slab inductance tuner is described in the issue for October 15th, 1921, on page 438. A more ambitious set is described in the September 3rd issue, page 344.

**C.G. (Clapham)** *asks* (1) *If a 4-valve circuit diagram is O.K.* (2) *For switching connections to vary the number of valves in use.* (3) *If the capacity reaction connection is correctly shown.* (4) *For suggested improvements.*

(1) Yes.

(2) A switching arrangement suitable for varying the number of L.F. valves is shown in the circuit given to **H.W.K. (Greenwich)** above.

(3) Yes.

(4) Whenever an iron cored transformer is placed in an H.F. circuit it should have a small condenser 0·001 mfds. across the winding in the H.F. circuit.

**"GRATEFUL" (Lytham)** *asks* (1) *For criticism of a set.* (2) *For particulars of a variometer to give exactly* 2,600 *ms.* (3) *Diagram of a Mark I tuner.* (4) *Method of calculating capacity.*

(1) Set will be O.K. if the reaction condenser is kept very small, say 0·00005 mfds.

(2) Determination of a variometer to fulfil such a requirement is quite impossible by calculation. It could only be done by experiment.

(3) See page 64 of this issue.

(4) Capacity $= \dfrac{nKa}{4\pi d.900000}$ mfds.

where $n$ is the number of sheets of dielectric.

$K$ is the specific inductive capacity of the dielectric.

$a$ is the overlap of the plates of opposite polarity, in sq. cms.

$d$ is the thickness of the dielectric in cms.

**"WARWICK" (Berkswell)** *shows two circuits, both transformer coupled valve sets, and asks* (1) *Why neither of them give* **PCGG.** (2) *Why four of a certain set of slab coils do not give any results.*

(1) As you give no particulars of aerial circuits or transformers, we cannot say for certain. Apart from the fact that very careful adjustment and tuning are required for this station it is very probable that the natural wavelength of the transformers is unsuitable for 1,100 metres.

(2) This is probably due to a few turns being short-circuited in the coils. This is a common defect in coils of this type now offered and is fatal to good reception.

**"ENTHUSIAST" (Enniskillen)** *sends a circuit for criticism and asks* (1) *For amended diagram to cover addition of another valve and crystal rectification.* (2) *If grid condenser could be variable.* (3) *If he would have difficulty in obtaining a licence.* (4) *If a frame aerial will be of any use with the set as altered.*

(1) The set is all right as shown except that we do not like coupling through both the slab coils and the loose coupling. For amended diagram see page 398, September 17th issue.

(2) Grid condenser may be variable up to a maximum of 0.0003 mfd.

(3) We do not know. Write to the Secretary of the G.P.O.

(4) You may get fair results with ship stations in the Irish Channel.

**"G.W.D." (Durham)** *asks re the frame aerial set described in No.* 16 *to* 21, *Vol.* 8 (1) *If Burndept coils may be used in place of the coils described.* (2) *If a* 0·005 *mfd. variable condenser may be used in place of the fixed condensers.* (3) *If Mullard "Ora" valves may be used in place of "V.24."* (4) *If the wavelength will be seriously altered by these changes.*

(1, 2 and 3) Yes, in each case.

(4) No. If the Burndept coils have the same inductance as those for which they are substituted.

**"C.M.B." (Nice).**—(1) Make the aerials as high as possible whatever the length may be.

(2) Yes.

(3) Not appreciably, unless the hill is very steep.

(4) About four.

**"H.D." (Hornsey)** *asks* (1) *Whether a certain aerial will be suitable for use with a certain set.* (2) *When previous questions of his were answered.*

(1) Yes.

(2) February 18th, 1922, page 743.

**"KHABAR ANGIN" (Lew)** *asks* (1) *For criticism of set.* (2) *How to arrange for shorter wavelengths.* (3) *How to increase wavelength.* (4) *If adding a crystal will give* **PCGG.** (5) *How to attach a Morse inker.*

(1) Set is quite good as it stands.

(2) Put condenser in series instead of in parallel with A.T.I.

(3) Increase the capacity of the condenser to 0·005 mfd.

(4) This is possible; but if obtained, signals will be very weak indeed.

(5) Impossible without the addition of several valves.

**"B.H.E." (Shoebury).**—(1) We believe that in this valve an increased grid potential still gives an increase of plate current.

(2) We do not think that these valves are obtainable in this country. Enquire of the De Forrest Company.

(3) We are unable to explain this effect entirely without a detailed examination. but the symptoms point to bad contact in the secondary winding of the transformer referred to, allowing the grid of the first valve to discharge intermittently.

**"RADIO" (Battle)** *is adding a H.F. valve to a single valve panel and asks* (1) *If an inter-valve H.F. Transformer is necessary.* (2) *If grid condenser on panel should be shorted.* (3) *If results will be as good without a filament resistance for the first valve.* (4) *Relation between inductances in two circuits, if the condenser in the first is* 0.001 *mfd. and in the second* 0·0005 mfd.

(1) Transformer is necessary unless resistance-capacity coupling is used.

(2) Preferably leave it as it is.

(3) Yes, until the valve burns out, which will probably happen fairly quickly.

(4) Inductance in the second circuit should be twice that of the first.

**"A.H.S." (Belmont)** *asks* (1) *How to arrange a tuner.* (2) *If a circuit sketched is O.K.* (3) *What results he is likely to get.*

(1 and 2) Arrange your circuit as in your sketch, which is quite correct except that a bigger capacity, say 0·001 mfd., should be used across the H.T. battery and telephones. Put the larger coil in the aerial circuit and keep the A.T.C. as low as possible at all wavelengths.

(3) You should get ships and land stations, spark and C.W. and also telephony up to about 2,500 metres.

**"INTERESTED" (Nottingham)** *sends diagram of set and asks* (1) *If he will get good results.* (2) *If we recommend any alterations.* (3) *How to make one valve H.F., and if this will be an advantage.* (4) *If his telephones are suitable.*

(1) Subject to alterations given below results should be very fair, but would be improved by one stage of H.F.

(2) For short wavelengths, put the A.T.C. in series with the A.T.I., also condenser between C and positive of H.T. should be between D and the H.T. battery. A potentiometer to the first grid will improve results.

(3) This can be simply done by making the first transformer H.F., omitting the condenser between D and the H.T.

(4) Brown's type "A" 2,000 ohms telephones will be suitable without transformer, although the resistance is rather low.

**"SELENIUM" (King's Lynn)** *asks* (1) *Approximate resistance of a Selenium cell in the dark and when exposed to light.* (2) *How much current will be passed through it by a 2-volts cell.* (3) *Resistance of a suitable relay for use with such a cell.*

(1) Depends on the type of cell. Is usually very high—say 20,000 ohms in the dark and 5,000 ohms in the light.

(2) This can be determined by elementary application of Ohm's law.

(3) Approximately the same resistance as that of the cell when exposed to light.

*N.B.*—These cells are very difficult to work with and we should advise you to consult special works on the subject before trying them.

**"J.M." (Cadiz)** *asks* (1) *If the power radiated from an aerial depends only on the current in it.* (2) *For an explanation of a case in which the range was considerably increased without any considerable increase in the aerial current.*

(1) Yes, provided that no other factor is varied, but it does not follow that the range will be the same with different type sets because, for instance, one set may be radiating a wave much freer from harmonics than the other. A pure wave form will carry much further than a bad wave form. In your second case the substitution of C.W. for spark with the improvement in reception thereby made possible is quite sufficient to explain the increased range in one case.

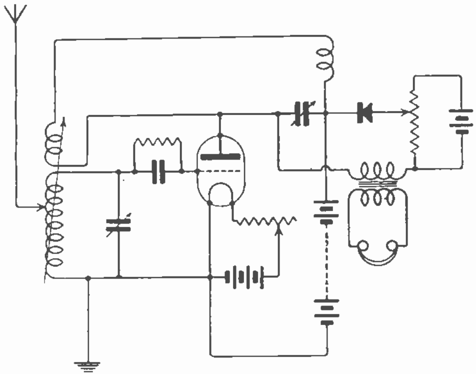


*Fig.* 4.

**"H.T." (Cardiff)** *sends sketch of valve set and asks* (1) *How to add a crystal to it.* (2) *What additional apparatus will be necessary.*

(1) Circuit may be as in diagram Fig. 4, which will also show you what additional apparatus is necessary.

**"BOBBY" (Cardiff).**—(1) Make the reaction coil as big as you can and wind it with No. 30 wire.

(2) For a two-valve set with capacity reaction connect up the valves in any usual way and then introduce a condenser of about 0·00005 mfd. between the grid of the first valve and plate of the second.

"**D.H.B.M. (Leicester)** *asks* (1) *For a three-valve circuit to meet with certain requirements.* (2) *Data for duolateral coil to be used instead of the pile wound coil in the single valve set described in the last volume.*

(1) One method of obtaining the required result is shown in the diagram, Fig. 5, but you will get better results with a simpler set.

(2) The No. 1 unit is best left as it is. For the No. 2 unit use a former about 3″ in diameter, put on one thousand turns in about ten layers; tap the coil in the same proportions as before.

"**C.M.L.**" **(Brighton)** *asks* (1) *How to eliminate induction from a heavy three-phase supply running past his house.*

We are afraid there is no known way of stopping induction of this sort in as bad a case as yours, particularly as you have found screening not successful. Your only hope is to move the set further from the cable.

(3) This condenser is necessary but there may, of course, be some other fault.

(4) You should get **PCGG**, but not if your set is oscillating.

"**T.W.J.**" **(Huddersfield)** *asks what alterations and additions will be necessary to convert the separate heterodyne described in October 29th issue for use up to 9,000 metres.*

This can be done without altering the circuit by increasing the condenser C.7 up to about 0·002 mfd. and providing additional coils to bring the inductance L.7 up to 12,000 mhys., and the reaction coil up to about 5,000 mhys. It will also be necessary to increase the size of the pick-up coils, for long waves.

"**A.H.**" **(Stone)** *asks* (1) *If it is possible to receive wireless telephony with a three-valve detector amplifier.* (2) *If so, the greatest distance signals will be heard with a "decent aerial."* (3) *The greatest distance telegraph signals will be heard.*

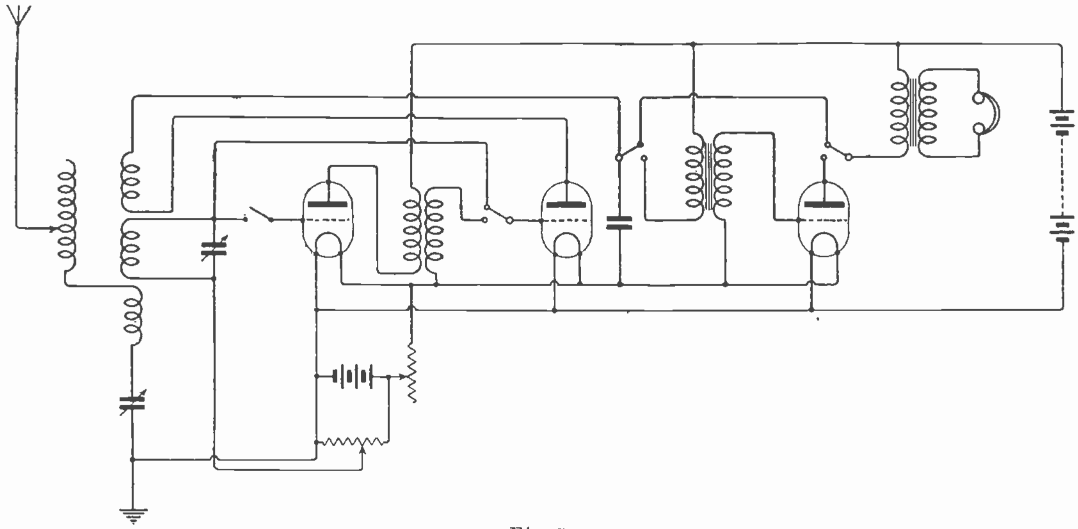


*Fig. 5.*

"**J.E.S.**" **(Oundle)** *asks* (1) *What a variable vernier condenser is.* (2) *Approximate range of a crystal set.* (3) *What capacity to use with 7,000 ohm telephones.* (4) *What crystal combination to use.*

(1) This term is usually applied to a small variable condenser, capable of giving very minute adjustment to the capacity in a circuit.

(2) About 4,000 metres with the A.T.C. shorted

(3) About 0·0015 mfd.

(4) Carborundum for general purposes, or zincite-bornite for special sensitivity.

"**BILL**" **(Holt)** *asks* (1) *The best course to obtain a second-class P.M.G.* (2) *Correct values for coupling condensers in an L.F. resistance coupled amplifier.* (3) *Whether failure to oscillate in a circuit sketched is due to absence of a condenser across primary of an inter-valve transformer.* (4) *If it should receive* **PCGG** *when it oscillates.*

(1) A course of training at one of the schools advertising in *The Wireless World.*

(2) About 0·0005 mfd. as a rule.

(1) Yes, with suitable tuning circuits.

(2 and 3) Quite impossible to give ranges as there are various conditions, such as earth resistance of set and design of circuits which affect it considerably. With suitable circuits you should get British telephone stations, continental telegraph stations and possibly even American stations under favourable conditions.

"**SPARKS**" **(Bloxwich).**—(1) Rewind coil with No. 22 wire.

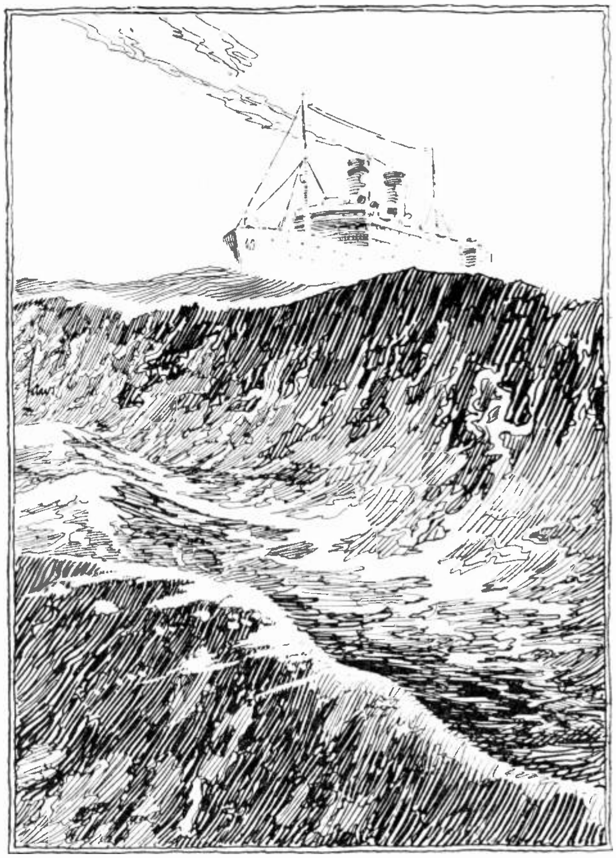
(2) Reduce capacity of condenser to not more than 0·002 mfd.

(3) Zincite-Bornite will be satisfactory.

(4) Tap the crystal and telephones across the inductance only, not the condenser as well.

**J.G.B. (Fife)** *asks if he can add three valves, resistance coupled, to an "M9" panel.*

Without a diagram of the panel it is not possible to advise you. There is no reason why additional valves should not be added. Ascertain wiring diagram and if necessary, amend to fit in with one of the many circuits given in *The Wireless World*, or seek advice from the makers.



**"H.J.M." (Thetford)** *refers to the transmitting circuit on page 671, January 21st issue, and asks* (1) *The range of the set.* (2) *Capacity of condensers.* (3) *The H.T. and L.T. voltages.*

(1) For amateur purposes the power is limited to 10 watts and the range is therefore also limited. With a good receiver a range of 20 miles telephony will probably be obtained; C.W. range will be considerably more.

(2) Condenser across the microphone transformer may be 0·001 mfd., and that across the H.T. about 0·005 mfd.

(3) L.T. 6 volts, H.T. about 100 volts.

**"H.S." (Slough)** *asks* (1) *For the windings for a coupler for a reaction circuit.* (2) *Windings for iron core chokes for sets described on page 533, November 25th issue.* (3) *The difference in efficiency between a single strand and a seven strand aerial wire.*

(1) For the A.T.I. 6″ × 10″ of No. 24 wire. Reaction coil 5″ × 8″ of No. 28.

(2) We have no further information regarding these sets, but for long waves a coil similar to a telephone transformer secondary should be satisfactory. A smaller coil may be used for short waves.

(3) The stranded aerial will certainly be more efficient than the single wire, but the improvement will not be very great unless all the aerial circuit is similarly stranded. It is impossible to give a figure for the improvement.

**"PROSPECTIVE" (Dublin)** *asks for information regarding the 50 watt D.C. Trench Set.*

This is a combined short wave transmitting and receiving set. Transmitting wavelengths are 350 to 450 and 550 metres on an aerial smaller than the P.M.G. The spark coil is worked off a 10-volt accumulator, maximum transmitting range 5 to 10 miles. It has a two-circuit receiver; the secondary inductance with a 0·0005 mfd. air condenser across it being coupled to the transmitting A.T.I. Its wavelength range is from 300 to 600 metres, and it is therefore only useful for spark signals from ships.

**"W.R.G.P." (Droitwich)**—See reply to **"Prospective" (Dublin).** Increase the height of the aerial above 12 feet, if possible. The telephone lines should not affect your signals seriously.

**"M.D.V.S." (Putney)** *has a crystal set on which he cannot get any results. He asks for advice, etc.*

Your set is only suitable for short waves up to about 1,500 metres. You should get ships and Croydon telephony. The fact that you are using 60 ohm telephones probably explains lack of results. The transformers advertised will be suitable if they are telephone and not intervalve type. Connect the high resistance winding in the crystal circuit and the low resistance to the telephones.

**"ANNAPOLIS" (Coventry)** *wishes to use an indoor aerial in a room about 50 ft. long, and asks if suitable for crystal or valve reception.*

You might get a few very weak signals on a crystal set, but it would be better to start with at least two valves.

**"P.McM" (Cricklewood)** *asks* (1) *If a single valve diagram shown is correct.* (2) *How to improve it.* (3) *Whether to use home made slab coils or single layer coils for 4,000 metres.*

(1) and (2) Connections are correct, but set will be greatly improved by a reaction coil which will enable you to receive C.W. Either type of coil may be used. If the range is not to exceed 4,000 metres, and compactness is not essential, we somewhat prefer single layer coils.

**"P.J.W." (Durrington)** *asks for a diagram of a 5-valve set.*

The diagram does not convey much information, we therefore refer you to an article by Mr. Campbell Swinton in the June 25th issue, on a 6-valve set. If you omit one of the H.F. valves the set will then be of the type you require. It should be capable of very good results.

**"D.U.D." (Barnes)** *asks for information about a crystal set.*

The coils you describe would probably give fair results, but we should much prefer single layer coils on formers of reasonable size, say 4″ to 6″ diameter, for crystal work. Galvanised iron wire is very bad for an aerial; use copper or bronze. Earth the telephone side of the A.T.I. to the nearest water pipe. Half a jar is quite sufficient capacity for this circuit. Set should be useful up to 3,000 metres.

**"R.G.T." (Fulham)** *asks* (1) *For criticism of 2-valve circuit.* (2) *Why the Air Ministry on 1,680 metres is received on 650 metres.* (3) *Effect of a small condenser in the grid of the first valve.*

(1) The set would be much improved if the reaction coil were connected in the plate of the second valve without its variable condenser. If "R" valves are used with resistance capacity coupling the H.T. should be at least 80.

(2) This is because the station radiates a harmonic on exactly half its normal wavelength. It is this harmonic you are receiving. Most C.W. sets radiate harmonics to a greater or less extent. They are generally much weaker than the fundamental and therefore are only noticed quite close to the transmitter.

(3) Would cause the first valve to rectify, but would probably not improve the set much.

**"R.J.P." (Acocks Green)** *wishes to make a loose coupled tuner for 300 to 1,200 metres with a 0·0003 mfd. condenser and two ebonite formers.*

For a loose coupler with reaction you will require three ebonite formers. Wind A.T.I. 7″ × 5″ with No. 20. Closed circuit inductance 4″ × 4″ of No. 26; reaction 3½″ × 4″ about 30. Dead end effects will not be a nuisance on such short wavelengths, and you will therefore not need switches to minimise them.

**"R.J.G." (Dovercourt)** *asks for criticism of valve and crystal set.*

The set should work satisfactorily without the crystal, but we should prefer to take the lower end of the loading coil to the slider of coil B, keeping the whole of coil B across the variable condenser. This will allow weaker coupling to be used. The set would be much improved by the addition of a reaction coil. The coil should be 3″ × 6″ of No. 28, sliding inside B. Reaction coil should be between plate of valve and positive of H.T.

**"A.G." (Sutton)** *asks* (1) *For a single valve circuit.* (2) *If water-pipe connection is sufficient for an earth.* (3) *If twin flex would be suitable* *for earth and aerial leads.* (4) *Wavelength range of set.*

(1) See diagram.

(2) Yes.

(3) If used, the strands should be separated. It is undesirable to run aerial and earth leads as close together as the two wires of a flex.

(4) With the small coil you suggest the maximum wavelength will only be about 1,500 metres.

**"H.N." (West Bromwich)** *has a single valve set and asks how to improve it for receiving telephony.*

The simplest way of doing this will be to add one or two valves as L.F. magnifiers. Details of construction of such magnifiers are given in May 28th and June 25th issues. We are unable to say why you do not get telephony without more detailed information about your set.

**"V.526" (Australia)** *asks* (1) *For a formula of honeycomb coils.* (2) *For criticism of single valve short wave set.*

(1) A good formula is as follows :—

$$L \text{ (microhys)} = \frac{4\pi^2 a^2 N^2}{b + c + R} \times F_1 F_2 \times \frac{1}{1000}$$

where "$a$" is the mean radius of the winding, "$b$" is the aerial length of the coil, "$c$" is the thickness of the winding, "$R$" is the outer radius, "$N$" is the total number of turns.

$$F_1 = \frac{10b + 12c + 2R}{10b + 10c + 1{\cdot}4R} \text{ and}$$

$$F_2 = 0{\cdot}5 \log_{10} \left\{ 100 + \frac{14R}{2b + 2c} \right\}$$

We should not care, however, to guarantee the accuracy of this formula to within 20 per cent. for any particular case of this sort of coil.

(2) As you show it this is a transmitting circuit. For the correct circuit see reply to "A.G." **(Sutton).**

**"ARPON" (Bangor)** *wishes to use a public electric light supply for purposes of experimenting in electricity and magnetism and asks for advice.*

This question, which does not relate to wireless in any way, is hardly within our scope. You will be well advised to buy an elementary text-book on practical electricity, and use dry cells for your experiments instead of a power main. We doubt if you will pass the London Inter Science at all easily if you do not know that D.C. supply cannot be transformed with a transformer.

**"H.J.B.P." (Edinburgh)** *asks if a "dancing contacts" relay sketched is likely to be efficient.* (2) *If rubber suspension of the relay would be advisable.* (3) *For a diagram of a 3-valve impedance amplifier.*

(1) The scheme suggested appears feasible, but will probably require a good deal of experimental development to obtain satisfactory proportions of the parts. We should be interested to hear the results obtained.

(2) We should certainly advise this.

(3) Diagram will be exactly the same as for resistance amplifier with a substitution of chokes for the anode resistances. We think you will find finer wire than No. 36 desirable for very long wavelengths. We would suggest 2 ozs. of No. 40 or No. 42 on an iron wire core ½″ in diameter.

**"F.A.P." (High Wycombe).**—(1) 0·001 mfd.

(2) Core ½″ diameter by 3″ long of iron wires; primary 1 oz. of No. 44; secondary 3 ozs. of No 44.

(3) Either type may be used.

(4) You cannot get a range of 300 to 20,000 metres on one coil. You should make, or buy, a set of honeycomb coils for such a range, the biggest having about 1,000 turns with a mean diameter of 3″.

**AERIAL (Camberley)** *asks* (1) *For a single valve diagram.* (2) *If slab inductances may be used with a crystal detector.*

(1) See page 584, December 10th issue.

(2) Yes, if efficient slabs suitable for wavelengths below 4,000 ms. are selected.

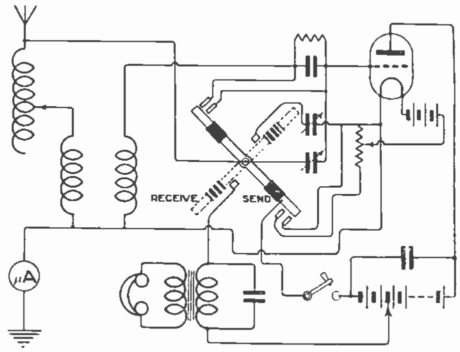



*Fig.* 6.

Diagrams (Figs. 6 and 7) show the connections of the Mark I. and Mark I.** R.A.F. Combined Transmitter and Receiver, and are given for the benefit of those who have recently asked questions relative to the manipulation of these sets.

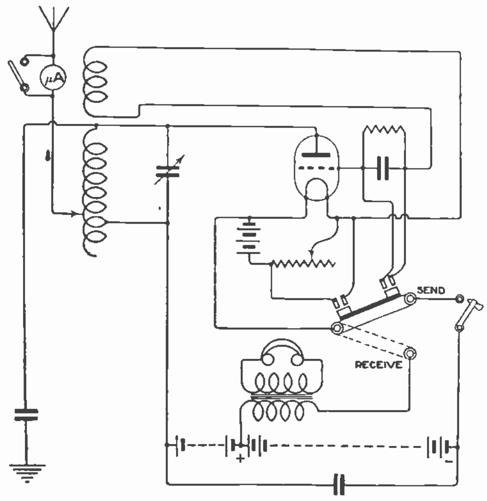



*Fig.* 7.

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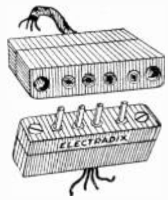


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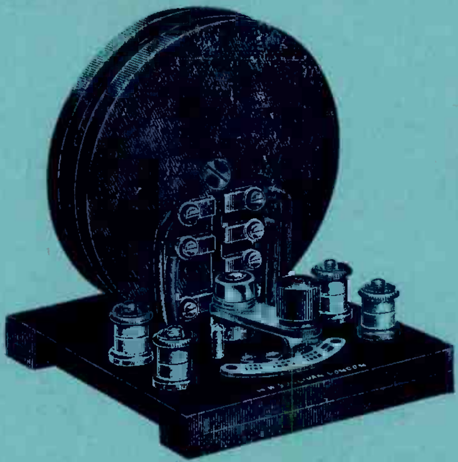

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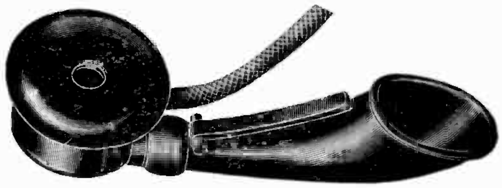

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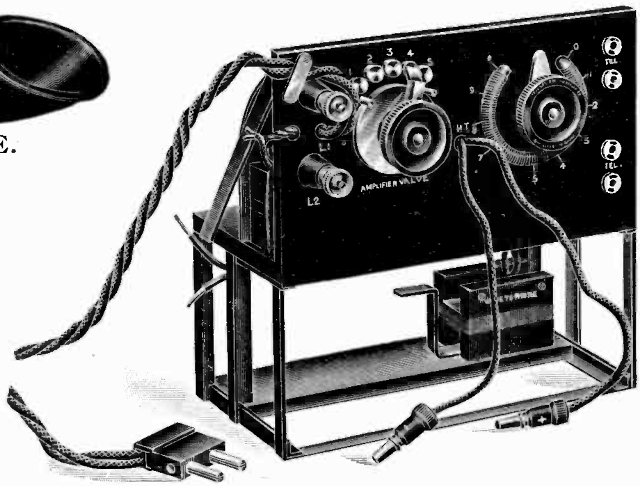

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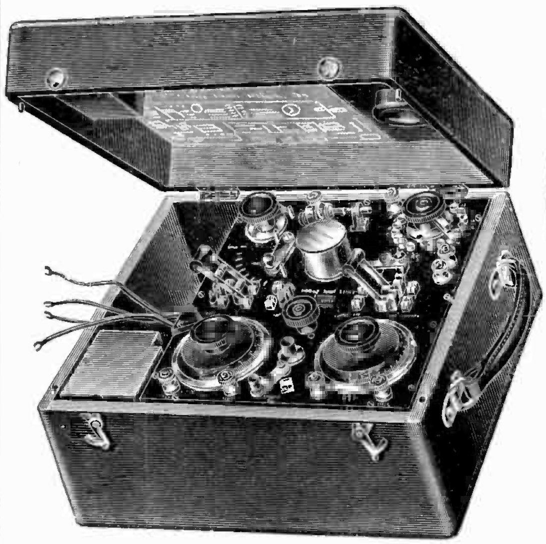

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VOL. X. No. 3. APRIL 15TH, 1922 WEEKLY

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THE present high-power radio station at Königswusterhausen which belongs to the Post Office has developed from one originally designed by and built for the Military Authorities. Immediately upon the cessation of hostilities the postal authorities decided to relieve the telegraph lines by the institution of a wireless network. A considerable part of the telegraph business is now carried in this way. Königswusterhausen was taken over and fitted up as the central transmitting station for Germany and the neighbouring states, leaving Nauen and Eilvese to handle the transoceanic business.

Other transmitters must carry out the broadcasting, and others of higher power the communication with Rome, Budapest, etc.

In order to be able to work duplex, the receiving station is situated at Zehlendorf, 20 kilometres from Berlin. Special cables connect both transmitting and receiving stations with the Central Telegraph Office in Berlin, where the transmitting keys and recorders are actually operated.

In order to carry out this multiplex and technically difficult programme, it was necessary to instal a number of independent transmitters with their respective antennæ in a relatively small area.

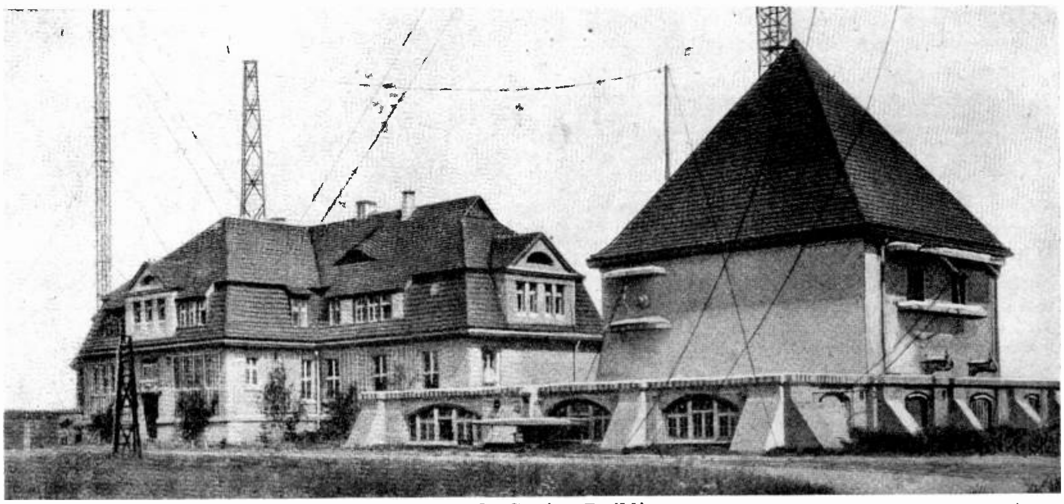

*Fig.* 1. *The Station Buildings.*

Königswusterhausen has the following functions to perform :—

1. Communication between Berlin and the various radio stations in Germany.
2. Broadcasting of weather and financial reports at fixed times.
3. Communication with England, Italy, Norway, Hungary, etc.

To carry out this programme it is essential to operate a number of transmitters at the same time, of which, for example, one works to Breslau, another to Hanover, a third to Frankfort, and so on. The difficulties of this novel problem were solved in a relatively short time and Königswusterhausen has become the most highly developed station of its kind in the world ; it has been working for months in the projected manner, and is being systematically further developed. Fig. 1 shows the buildings and Fig. 2 a model of the ten small T aerials for the interior and three large aerials for the European communications. These aerials are carried by five steel masts of 150 metres and one of 100 metres high.

They are arranged to affect each other as little as

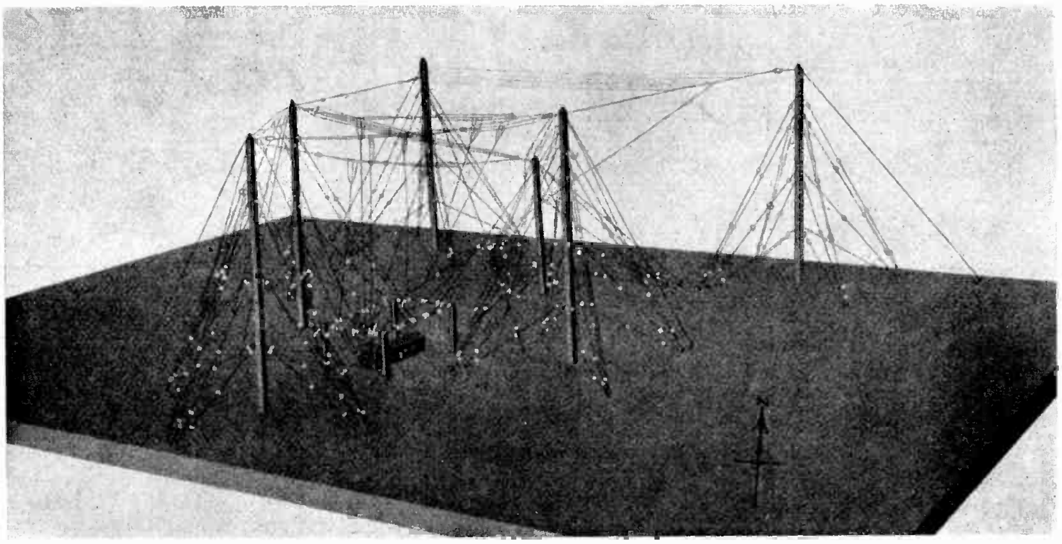

*Fig. 2. Model of the Aerial System showing the arrangement of a number of separate aerials.*

possible, so that transmission on one does not affect any other. To minimise variations of capacity due to the aerials swinging about in the wind, the leading down wires are fastened to wire ropes carried between four wooden masts 30 metres high. Any aerial can be taken down independently of the others.

The transmitters are not connected directly to

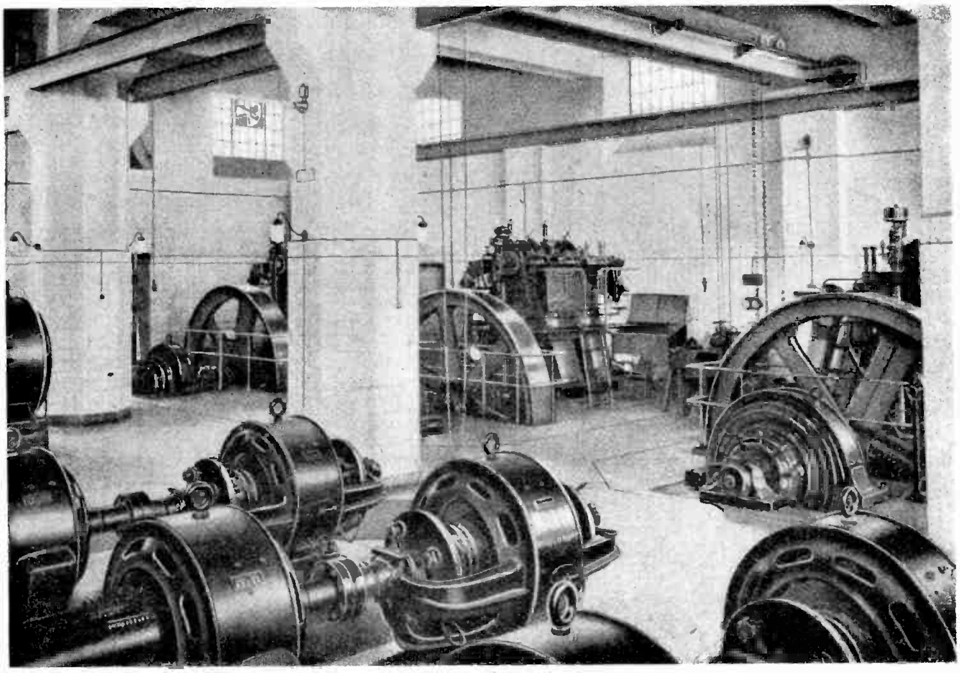

*Fig. 3. View in the Engine Room.*

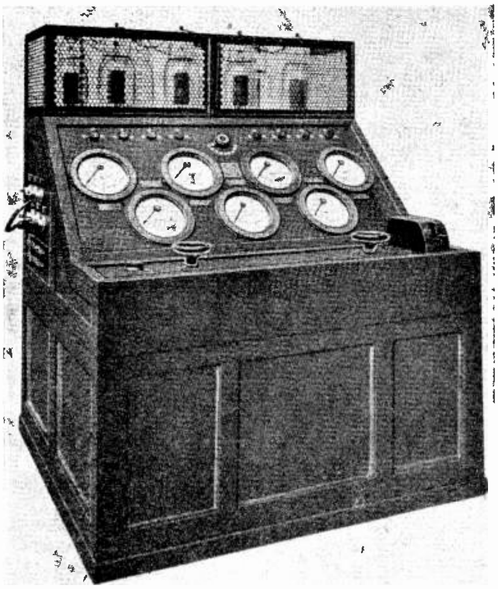

*Fig. 4. A 5 to 10 kW transmitting unit*

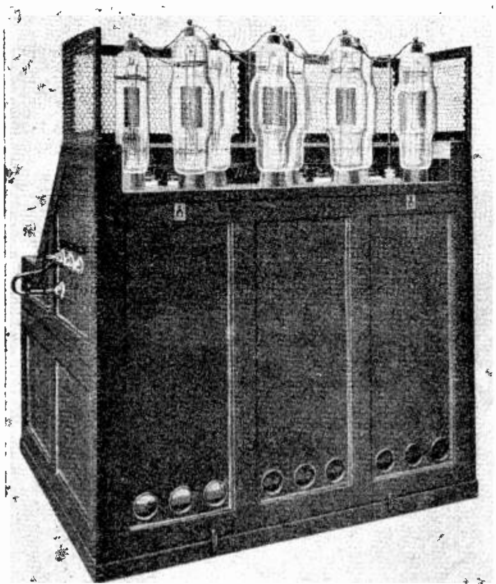

*Fig. 5. Rear view of transmitting unit.*

the aerials but through intermediate tuned circuits to avoid harmonics which would interfere with the duplex reception at Zehlendorf.

The following conditions were imposed on the transmitters :—

1. Wavelength continuously variable from 2,000 to 5,000 metres for the small, and to 8,000 metres for the large sets.
2. The greatest possible constancy of wavelength, and
3. Keying the smallest possible power.

The first condition was essential in view of the impossibility of knowing beforehand what wavelength any set would be called upon to use.

The constancy of wavelength is a condition for highly selective reception and for independent working on two waves of slightly different length, which is necessary in view of the large number of waves to be simultaneously employed. The third condition was imperative, seeing that the keying had to be done by relays over lines from the main telegraph office in Berlin.

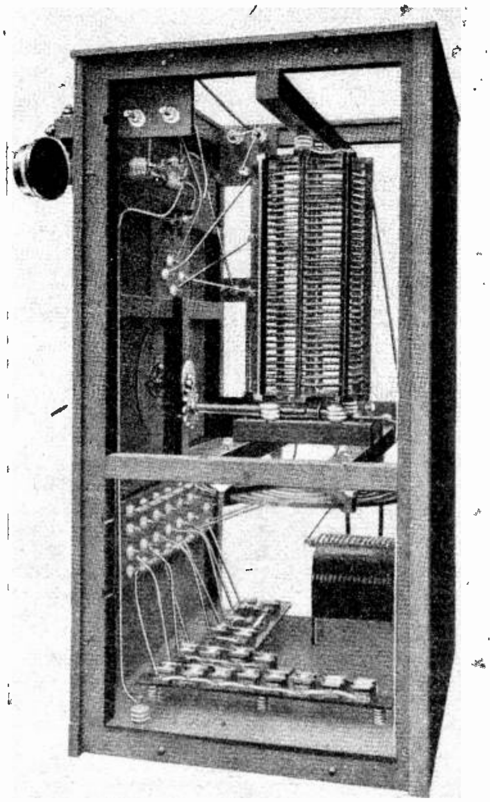

*Fig. 6. A Wave Change Panel of the 5 to 10 kW transmitter.*

The only system to meet these conditions is the three-electrode thermionic transmitter. and the smaller aerials were therefore fitted with Telefunken 0·5—1 kW valve transmitter sets, in which the keying is done by opening and closing the grid lead which carries only one per cent. of the antenna power. The anodes are supplied with D.C. at 3,000 volts, obtained either directly from a high voltage dynamo or by rectification of 500 cycle alternating current. For the small transmitters the former is preferable as being the more economical. In either case the machines are driven by 220 volt

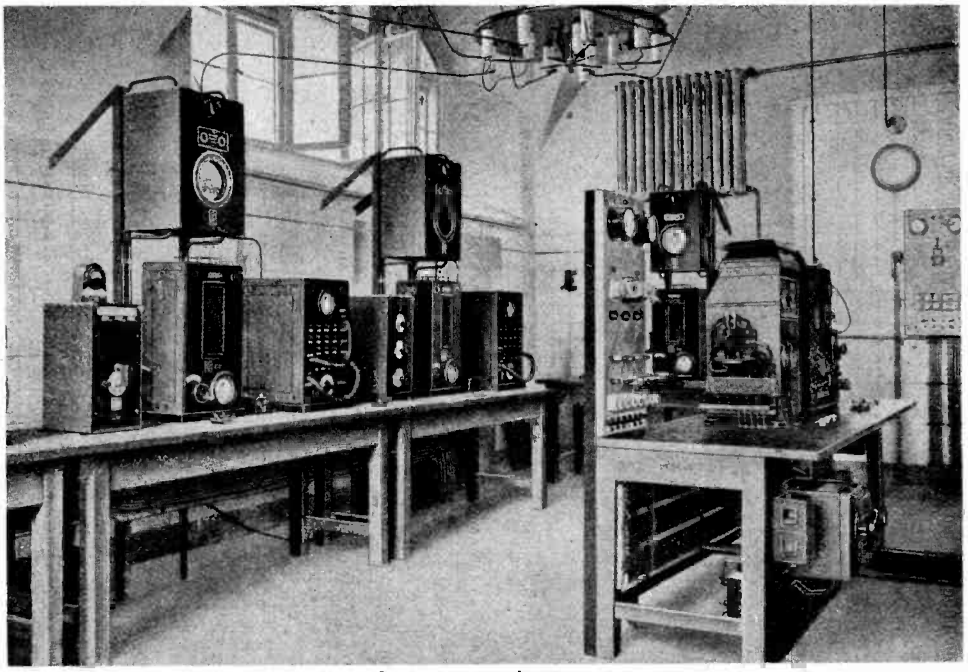

*Fig. 7. The 0·5 to 1 kW transmitting sets.*

D.C. motors supplied from generators driven by Diesel engines. Fig. 3 is a view in the engine-room, and Figs. 7 and 8 show the room containing the small transmitting sets. In addition to these ten sets there are two large sets supplying 5 to 10 kW to the aerial. One of these sets has been in operation for over six months. It gives 10 kW to the aerial if directly coupled and 5 kW when used with

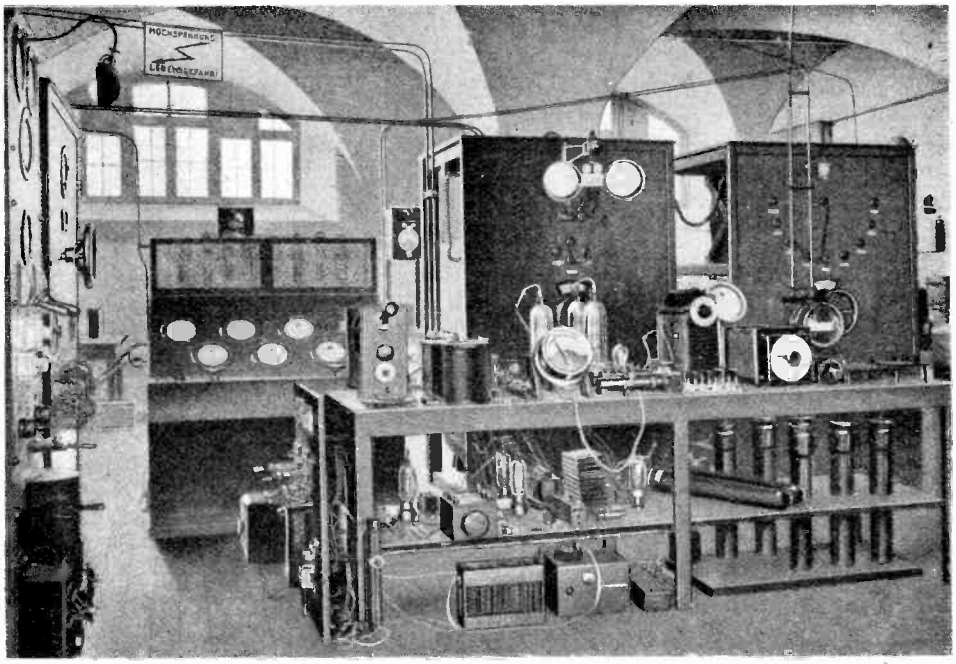

*Fig. 8. Tuning gear of the 0·5 to 1 kW transmitters.*

an intermediate circuit, that is, as usually employed. In order to get as much data as possible it was arranged so that it could be connected up in many different ways to work with self or separate excitation, with or without an intermediate circuit, and therefore with 5 or 10 kW in the antenna. Over the continuously variable range of wavelength from 2,000 to 8,000 metres, it gives results with separate excitation superior as regards constancy to those obtained with any other system. The separate excitation consists in the use of a generator of only 0·5 to 1 kW to set up high frequency current in a closed circuit from which power is supplied to the grid circuit of the large valve which merely acts as an amplifier supplying power to the antenna. The frequency is thus not affected by any changes in the antenna, and this system has the added advantage that the keying can be done in the grid circuit of the small valve. Some details of the components of one of these sets may be seen from Figs. 4, 5 and 6.

employs for this purpose has given good results. Communication has been obtained over 3,600 km with such clearness that the voice of the speaker could be identified. In this system the voice modulates the D.C. supply to the valve; in the 5—10 kW transmitter with separate excitation, the modulation operates on the D.C. supply to the 0·5—1 kW exciting valve. A 3-electrode valve is inserted in the D.C. supply circuit (filament-anode), and the grid potential is controlled by the voice, thus causing a large variation in the resistance thus inserted in the D.C. circuit.

The advantages of this sytem, in which the actua telephonic apparatus has no connection with the high-frequency apparatus, but only with the D.C. supply of the small exciting valve, are obvious. In the tests in which a range of 3,600 km was obtained, the transmitter was working on reduced power, the antenna power being modulated between 0 and 8 kW.

The source of power for the 5—10 kW set is a

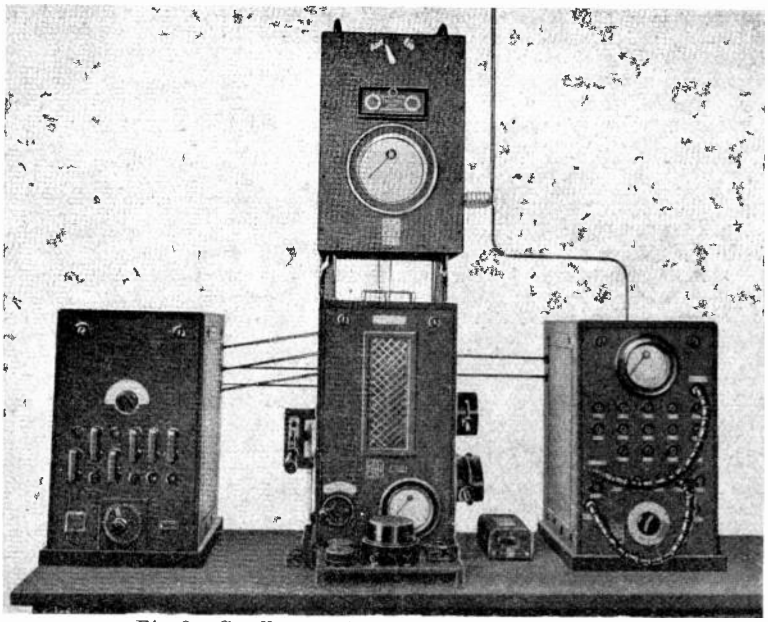

*Fig. 9. Small transmitter set with intermediate unit.*

Fig. 9 is a view of one of the small transmitter sets with intermediate circuit.

A large and a small Poulsen arc of an earlier date are still in working order, and are also used for the foreign traffic; the 80 kW spark transmitter has been removed.

The radiated energy can be controlled by a microphone and the voice, instead of by the Morse key. The broadcast service for which private persons may subscribe (about 1,000 receivers were installed by the end of last year) will consist both of telegraphic and telephonic communications. For this purpose the 5—10 kW valve transmitter has been fitted for wireless telephony. The most difficult problem in this connection was the modulation of the power between 0 and 10 kW. The Schäffer system which the Telefunken Company

500 cycle 200 volt alternator, with a 4,000 volt mercury rectifier equipment.

The former station of the German army has thus, since its transfer to the Post Office, undergone a number of modifications which not only make it suitable for new applications, but which also make it a mirror of the progress in that the 80 kW musical spark has been replaced by a great number of modern valve transmitters. The station is a proof that wireless telegraphy and telephony are able very effectively to assist and perfect the part played by wire telegraphy and telephony in the life of the nation.

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Abstracted from *Telefunken Zeitung*, pp. 23–32, Sept. 1921.

# The Modern View of Electricity and the Three-Electrode Valve*

By G. G. BLAKE, A.M.I.E.E., A.Inst.P.

MY lecture this evening is intended primarily for the more amateur members of this audience. We have had many excellent lectures and discussions on the various applications of the three-electrode thermionic valve; but so far as my memory serves me, it has always been taken for granted that we are all of us familiar with its functions, and the laws which govern its action.

I therefore thought that a brief outline of its mode of action, illustrated as far as possible by experiments, might be helpful to those who have been using ready-made sets, or have constructed their own apparatus from well-known diagrams, without knowing how their sets function.

I will ask you to picture to yourselves throughout this lecture that we live in the midst of an infinite ocean of ether which pervades all things. Matter, as you know, is made up of groups of atoms known as molecules, each atom, according to present theory, consisting of a positive nucleus, around which are arranged a number of electrons (negatively charged).

We can compare each atom to a tiny solar system; between the positive nucleus and its electrons there are relatively vast spaces, which, like the interplanetary spaces of our universe, are permeated by the ocean of ether. In a fragment of any elementary substance, it is believed that there are millions of atoms of that particular element, each made up of a definite number of electrons grouped round a positive nucleus, like planets around a sun, the forces of the whole system being in a state of equilibrium.

It is the definite number and grouping of the electrons which gives to the substance the properties by which we can distinguish it from other elements. In addition to the electrons in each atom, there are vast numbers of free (or unattached) electrons in the interatomic spaces, which, on the application of a suitable electro-motive force, can be caused to move like a swarm of gnats in a summer breeze. This movement of electrons constitutes an electric current.

*Charged Bodies.*

In Fig. 1 is shown the effect of a charged body upon an electroscope. On the left-hand side of the diagram you will see a drawing of the electroscope before you on the lecture table. The rest of the slide shows a number of diagrammatic sketches to illustrate the effect of a charged body upon the free electrons ever present in the metal of the electroscope (which are represented by dots).

(1) The first diagram (on the top left-hand corner) gives an idea of the grouping of the free electrons when the electrical forces in the metal parts of the electroscope C are in a state of equilibrium, in which state no condition of charge is exhibited.

* Paper read before the Wireless Society of London on Wednesday, March 22nd, 1922.

(2) If a negatively electrified ebonite rod R i.e., a rod which has been rubbed with wool and has thereby acquired an excess of electrons, is brought near to the electroscope C, the other strains set up by the excess of electrons on the rod, reach into the interatomic spaces in the

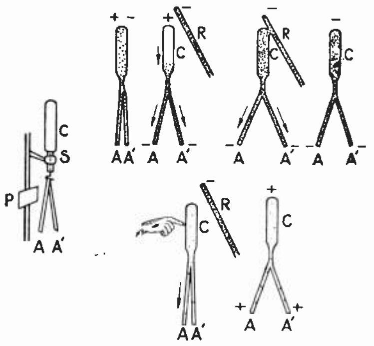



*Fig. 1.*

metal of the electroscope and repel the free electrons there, into the leaves of the electroscope so that they acquire an excess of electrons and repel one another, thus exhibiting a state of charge. If rod R is removed the electrons flow back into their original positions and again the electroscope shows no charge.

(3) If the electroscope C is touched with the charged rod R (see 3rd diagram) the excess of electrons from rod R pass into the electroscope, and when the rod is removed (diagram 4) the electroscope remains in a state of negative charge.

(4) If while a negatively charged rod is held near to the electroscope, we touch the latter (see diagram 5), the free electrons being repelled by rod R, find a path to earth, so that when both my hand and the rod are removed, the electroscope is left with less than its proper number of free electrons, and exhibits a positive state of charge.

(An experiment was shown to demonstrate the effects illustrated in Fig. 1.)

If a piece of any substance is given an excess of electrons, the ether in its neighbourhood becomes strained, and will affect other substances in its vicinity.

If a piece of any substance be robbed of some of its electrons, it is said to be positively charged, and again strains are set up by it in the surrounding ether.

A charged body attracts other bodies in its neighbourhood because the electric strain set up by it in the ether extends into the ether in neighbouring bodies, disturbing the normal distribution of electrons in them. The ether strain then tends to make the charged and neutral bodies move together in order that the strain may disappear, in a similar way that when a strain is put upon one end of an elastic thread, having a small weight attached to its other end, the weight moves towards the source of the strain, and so removes the tension.

A body with an excess of electrons (−) attracts a body with a deficiency of electrons (+), and *vice versa*, while two bodies of like sign repel one another.

Charges or currents are not only carried between the atoms by the drift of free electrons ; it is believed that as the free electrons move along, some of them collide with the atoms, knock off electrons and take their places ; so that a constant interchange is taking place along the length of a conductor, during the passage of a current.

In the case of a liquid or a gas, charges may be carried by ions. Ions are broken fragments of atoms and molecules. Picture to yourselves for one moment a perfect atom, held together by equal and opposite positive and negative forces, which act so as to neutralise one another, so that externally it exhibits no sign of electrical charge ; if this atom collides with great violence with another atom, both may become broken, and some of the electrons may be knocked off the one, so that it remains deficient in electrons and exhibits a positive charge, while the other may have acquired an extra number of electrons and show a negative charge.

There are always great numbers of such ions present in all gases and liquids, due to many causes, some of which I will endeavour to explain. Possibly the greatest known source of ionisation (or splitting up of atoms) is the radio-activity of radium.

I have in my hand a small applicator, containing 5 milligrams of radium bromide. This radium, as you know, is gradually disintegrating, and in the process, is shooting off millions of Alpha and Beta particles into the air, carrying respectively, positive and negative charges. The Alpha or positive particles have about twice the mass of a hydrogen atom, and travel at about 1/10th the speed of light, and can only be deflected from their course very slightly by the application of a magnetic field, as was shown by Rutherford in 1903.

The Beta particles carry a negative charge, travel at about 9/10ths the speed of light, and have a mass of about 1/1000th of a hydrogen atom. They are, in fact, electrons ; but they are emitted at an enormously greater speed than the electrons in a vacuum tube, and are much more easily deflected in a magnetic or electric field than are the Alpha particles.

The Gamma rays are really not particles but resemble the X-rays in all respects, and are tiny ether waves.

You can readily therefore picture to yourselves the havoc which is taking place in the molecules of air, anywhere within reach of a sample of radium ; they are being bombarded by Alpha particles, comparatively so large that it is like throwing brickbats at eggs, and also by the Beta particles.

Then, again, the Gamma waves cause the molecules in the air to vibrate with great violence until they strike against one another and ions are formed.

Certain wavelengths cause maximum commotion amongst the molecules of the air, and therefore maximum ionisation. I may be able to make this more clear to you by an analogy :

Think for a moment of a number of corks floating on the surface of a pool. The corks represent the molecules or atoms, and the water represents the ether. If we create very large wave motion in the pool, the corks will ride up and down gracefully, and all together as the waves pass them, and they will not collide with one another ; but if we create very small waves comparable in magnitude to the size of the corks, there will be a general mix-up, and they will all strike against each other.

(An experiment was then shown to demonstrate the ionisation of air by radium and the discharge of an electroscope.)

The explanation of the discharge of the negatively charged electroscope was that its negative charge set up strains in the surrounding ether which repelled the negative ions in its vicinity, and attracted as many positive ions as were required to neutralise it and bring it once more to a state of equilibrium. We have here two spirals of wire coated with radium, kindly lent me by Mr. Harrison Glew, who showed this experiment before the Physical Society this year (this experiment was first shown by Mr. Glew, I believe). One spiral is fastened above an electroscope, and the other, which is some yards distant, is attached to the negative pole of a small influence machine ; or it could be connected to the negative terminal of a small induction coil as shown in Fig. 2.

The radium is hard at work ionising the air around the machine and the electroscope ; so that there are crowds of negative and positive ions all mixed up somewhat as indicated by the plus and minus signs on the slide.

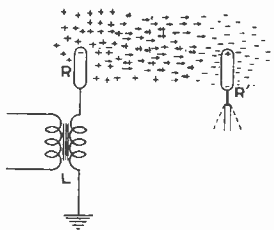



*Fig. 2.*

If we now charge the pole of the machine negatively (*i.e.*, give to it an excess of electrons) it at once begins to repel the negative ions in its vicinity, and to attract a sufficient number of positive ions to neutralise its charge ; so that the ions in the air are sorted out and a negative cloud forms in the neighbourhood of the electroscope which expels the electrons from the metal conductor of the electroscope into its leaves causing them to diverge in exactly the same way as did the negatively charged rod which I showed you just now.

(An experiment was then performed to demonstrate the effect just described, which was also illustrated by means of a mechanical lantern slide to show the migration of the ions in opposite directions.)

This experiment could be repeated with the charge on the machine reversed, in which case the electroscope would show a positive instead of a negative charge, the negative ions being attracted by the machine and the positive repelled.

It might interest you to see an experiment illustrating ionization by means of ultra-violet rays. In this case the ionization is due to wave motion in the ether, causing the molecules of the air to collide.

(An experiment was arranged to show ionization by ultra-violet rays, using a spark gap fed from a small induction coil. Incidentally, fluorescence of butter, candle, Willemite, X-ray screen, etc., was also shown. A flame will also set up vibration in surrounding atmosphere and cause ionization.)

The molecules in liquids and gases are, when at any temperature above absolute zero, all in a state of motion, moving about amongst themselves. When we say that a liquid evaporates, we mean that some of its molecules move to the surface with such a velocity that they escape into the air, and become dispersed into it. As the temperature of the liquid is increased, there is an increase in the rate of evaporation (or the greater will be the number of molecules emitted).

Evaporation of electrons from the surface of a substance takes place in a very similar manner.

We have now reached a point when we should be able to more easily comprehend what happens inside a three-electrode valvé when in use. Fig. 3 shows the form of some typical three-electrode valves.

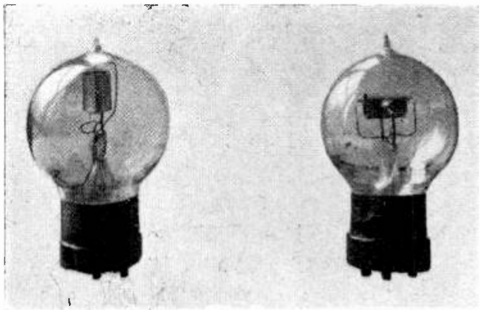


*Fig.* 3.

As you know, the "hard" valve is exhausted so greatly that we can for practical purposes consider it as a still silent pool in the ocean of ether. Although it is, of course, impossible to remove all molecules of gas from its bulb, so few remain that their presence can be neglected.

We now heat the filament, by the passage of a current, and as its heat increases it emits an increasing number of electrons. These will rapidly create a negative electric field (which we call the space charge) round the filament, which will repel further negative charges and so tend to stop further emission of electrons from the filament. If, however, we now supply a sufficient positive charge to the plate of the valve, the electrons in the "space charge" will be attracted along the strain lines which exist in the ether between the plate and the filament, making room for others from the filament, so that a negative flow of electrons or current passss from filament to plate. The high tension battery connected between filament and plate acts like a pump, and carries away the electrons from the plate, keeping its potential positive and passing the electrons along to the filament and so keeping its potential negative so that we have a perfectly continuous flow of electrons.

Now let us once more return to our analogy of water evaporation. Consider the surface of the water to represent our heated filament, and the heat of the atmosphere to represent the positive high tension on the plate.

If we raise the temperature of the atmosphere and keep it steady, it will take up more and more molecules of water until a point is reached when it can no longer take up any more, and as many molecules are condensed back into the water as are emitted from it. The atmosphere is now said to be saturated.

A similar phenomenon is observed in the operation of a valve. For any given positive potential applied to the plate of a valve, as the heat of its filament is increased, a point is at last reached where the valve is so charged with electrons that they constitute a negative field strong enough to repel the new electrons coming from the filament, and therefore stop all further increase, the excess of electrons being returned to the filament.

This is called saturation point.

If we raise the plate voltage we shall have to increase our filament temperature, in order to reach saturation point. In other words, if we make the plate more positive, we shall have to supply a larger number of electrons to balance the forces in the tube.

Let us now consider the functions of the grid.

The grid, which is placed in the electron stream, between the plate and filament of a three-electrode valve, is employed to control the electron flow in several ways. In order to study its action, let us examine a circuit connected up as in Fig. 4a, where P is a potentiometer. When connected as shown, the grid is at zero potential. If the slider S is raised, the grid will become negative to the filament, and if lowered, positive.

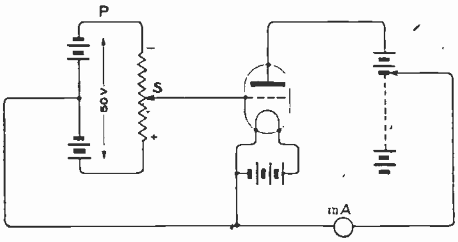



*Fig.* 4a.

Let us imagine that an electron stream is passing from the filament to the plate (below saturation point); so long as the grid is kept at the same potential as the filament, the electron flow will go to the plate as usual. If, however, we give the grid a positive potential, we shall assist the flow of the electrons to the plate, and a portion of them will pass into the grid circuit constituting a grid current. If we make the grid negative, it will repel electrons, which will accumulate in the space between the grid and filament, forming a space charge, or negative field, which will, if the grid be made sufficiently negative, entirely cut off the electron flow to the plate. By suitable arrangement of filament heat and plate potential, matters can be so arranged that very small changes of grid potential will produce large variations of plate current. The valve then acts as a delicate relay, and has a great advantage over all mechanical relays in that it exhibits no lag effects.

In Fig. 4b, you will see a series of curves. During the making of these the filament temperature was kept constant, and seven curves were plotted for different values of plate voltage.

You will observe :—

(1) That increasing the plate voltage lengthens out the straight portion of the curve.

(2) Also, if our valve functions at a point near the centre of, say, 33·5 volt curve, and we wish it to function at the same point, on a higher plate voltage, it will be necessary to make the grid more negative, the reason being that with the higher plate voltage the space charge is reduced, therefore the grid needs to be made more negative to take its place.

There is another very useful piece of information which we can obtain from a study of these curves, *i.e.*, the amount of amplification of which the valve is capable. You will observe that if we keep our grid at zero potential, an increase of plate voltage of 20·5 negative gives us a rise of about 7 M.A. in the plate current. We could obtain this same rise of plate current, without any increase of plate potential, by making the grid 3 volts positive; therefore, if we divide the 20·5 by 3, we find that we are obtaining an amplification of 6·83· by use of its grid.

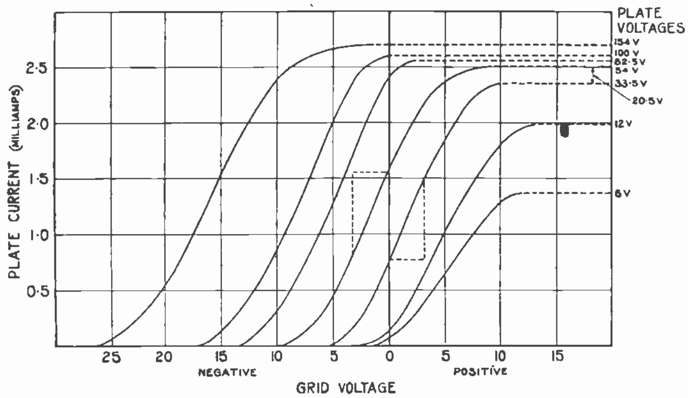
As Fig. 4b shows, by making the grid 3 volts negative we shall obtain a similar decrease in plate current.

(An experiment was performed illustrative of the voltage amplification of the valve, and of the grid current characteristic. The experiment showed that the same increase of plate current could be obtained, by adding 6 volts to the plate current, as by keeping the plate current constant and making the grid 1 volt positive, showing for this particular valve an amplification of 6.

Fig. 5 illustrates the effect on the characteristic curve of the valve if we vary the filament current.

If we plot a series of curves with a fixed plate voltage, showing grid potential against filament current, we shall see that the increase of filament temperatures gives great increase of plate current, and that if we wish our valve to function, at the same point, on a higher filament current curve, we must make the grid more positive.

The reason for the above becomes more clear, if we remember the negative space charge between the filament and the plate, and that when the plate voltage is increased, it becomes more rarefied, so that a negative charge will be required on the grid to take its place, and that when the filament current is increased it becomes denser, so that a positive voltage will be required on the grid to reduce it.




*Filament current* ·6 *amp.* $\frac{20·5 \text{ volts plate}}{3 \text{ volts grid}}$ = 6·833 *amplification.*

*Fig.* 4b.

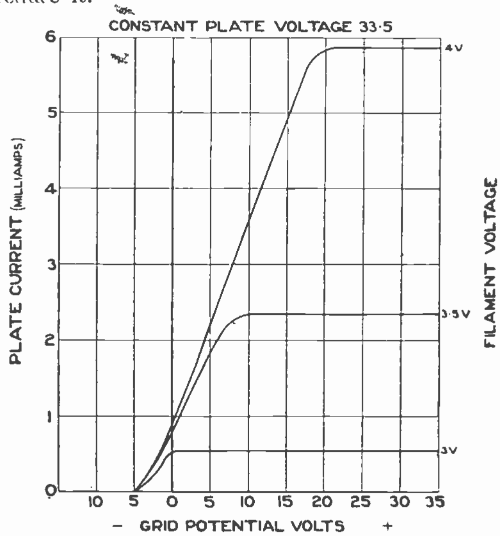



*Fig.* 5.

Stanley has shown that if a galvanometer in the grid circuit shows that a reversed grid current is flowing when the grid is made increasingly negative, that this reversed current must be due to ions in the valve, and that the vacuum is therefore soft. This is a ready method of testing the vacuum of a valve.

*(To be continued.)*

# Discussion on Methods of Amplification

(*Concluded from page 42.*)

**Mr. G. P. Mair.**

Mr. Phillips has given us a very interesting diagram of connections, and there are one or two questions I should like to ask him. I have been working a three-valve set made up much on these lines, but I do not use a condenser to tune the secondary of the high-frequency transformer, and I get good results. I have not tried Mr. Phillips' arrangement of the detector circuit, but I rather agree with him as to the theory and action. In connection with the set I, personally, connect the negative of the high tension to the negative of the low tension and earth the low tension positive. I get much better results on spark stations and telephony like this than if I earth the negative of the low tension. Personally, I have not been able to explain why it is although I have tried. Another point in connection with the circuit is the question of making the grid of the low frequency valve negative, I have tried it at times and got pretty good results by putting a resistance (somewhere about 1 ohm to 1½ ohms) in the filament lead, to which the grid side of the transformer is connected. By putting in the filament circuit of a low frequency amplifier, a resistance of about 1 to 1½ ohms, and having a variable resistance in the other lead, varying the filament rheostat and this other resistance, enables me to get the maximum intensity of signals. Personally, I am using V.24 valves, and I have also used the same arrangements with the ordinary R type of valve, but with the V.24 I have always thought it necessary to put in a small resistance in the manner described.

**Mr. C. F. Phillips.**

Referring to Fig. 7 (*see* p. 40), it will be seen that the grid is about 2 volts more negative than the most negative end of the filament. In Mr. Mair's arrangement I understand that he puts a fixed resistance between the bottom of the grid coil of the transformer and the negative of the L.T. battery; he would, of course, reduce the value of filament resistance shown in Fig. 7; the result is to bring the grid back to about zero volts and that is evidently the particular potential required by the V.24.

With regard to Mr. Mair's other point; provided that the insulation of the H.T. battery to earth is good, I do not think that it matters, as regards signals, to which end of the L.T. battery it is connected. If the H.T. negative is connected to the L.T. negative, the effective potential between plate and filament is less than when the H.T. negative is connected to L.T. positive. That is the only effect I can think of.

**Mr. C. S. Dunham.**

I should like to ask Mr. Phillips a few questions. The first is that I cannot agree with Mr. Phillips as regards the non-amplification of the high frequency transformer. I have done a good deal of work with high frequency transformers, and I have found that the amplification is quite good, very good in fact. Regarding Mr. Phillips' method, which, I imagine, commercially goes under the name of reactance capacity coupling, I do agree that the coupling condenser more or less takes the place of the capacity that you get between the primary and secondary winding of your intervalve transformer, but at the same time I think that the two windings of the transformer can be kept a reasonable distance apart and the capacity reduced in that manner.

Some time ago our past President, Mr. Campbell Swinton, gave us a lecture in which he demonstrated very well the effect of high frequency transformers. He wound his transformers with the secondary wound over the primary. Of course, that gives good coupling, but, at the same time, if one takes into consideration the length and mean diameter of the primary coil and the secondary coil that is going to vary, and therefore the number of turns on the transformer may be the same, but the inductance has a tendency to alter. I, myself, prefer the transformer with the secondary coils placed side by side for one can then know the exact amount of wire on the secondary and primary. Regarding Mr. Phillips' method of plugging in coils to obtain difference of the anode inductance values, that seems to me quite a good method, but I do not like the idea of using the multilayer coil for short waves. It seems to me that the multilayer coil is a device for getting a large inductance in a small space, and the degree of coupling, it seems to me, must be less efficient than if one uses the pancake coil where the surface area is much greater, the coupling consequently much better. That is all I can say with regard to low frequency.

I notice that in Mr. Phillips' design he does not earth the iron of the transformer, which is supposed to get rid of a lot of noise, due generally I consider, to eddy currents that circulate in the iron. A thing which seems to me rather foolish is that if one earths the iron by connecting together with a strip of copper or whatever material you may choose, one gets rid incidentally of the insulation that exists between the transformer core laminations, and, therefore, although you have a path to earth of eddy currents it seems to me that the tendency of that circulation of eddy currents is increased because the core becomes one solid block of iron without any insulation between the laminations. Doubtless I am wrong, but perhaps Mr. Phillips will put me right on a few of these points.

**Mr. C. F. Phillips.**

First of all I think Mr. Dunham must have misunderstood my remarks about high-frequency transformers. I did not suggest that they did not *amplify*, I said that they did not *transform*. I quite agree that they do amplify, but I maintain that the method of using two coils instead of one is rather unnecessary in most instances.

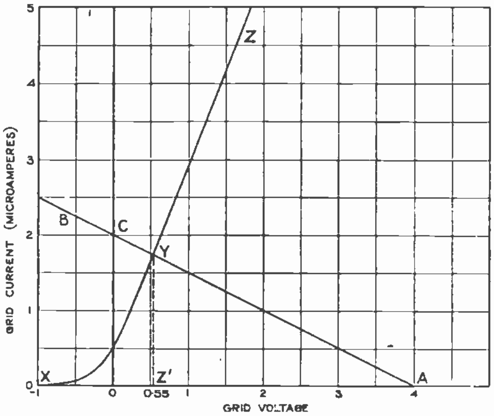
You spoke of multilayer coils not being suitable for short waves. With regard to the advantages of multilayer coils, the first is that they have an appreciable distributed capacity, and also a somewhat large high-frequency resistance. Leaving out the high-frequency resistance for the moment, it may be of interest to note that one needs a considerable capacity across any coil used in my circuit as a rejector of *short* waves. If you do not have enough capacity, preferably distributed and not external to the coil, you get such very sharp resonance points that the actual working of the circuit becomes very difficult; as the various coils of the receiving circuit are brought into resonance one is apt to get nothing but a series of clicks when the resonance curve of the reactance coil is too sharp. It is interesting to make the experiment in a practical way; first, try the single layer coil and then a multilayer coil, you will soon be convinced that a certain amount of capacity is necessary.

Incidentally, there is no question of coupling; the reactance coil should not couple to anything, and it is quite hard to prevent such stray coupling. The coil should be placed well away from the tuning circuits, as if stray coupling does take place you never know which way round it is going to act; if there should be any reverse coupling you will be in trouble on short waves! The coil I have shown there in the rejector circuit is not a coupling of any description, the coupling is the capacity, and the rejector circuit is merely a circuit which permits of the very maximum of potential being built up from one end to the other—that is to say, the combination of coil and condenser becomes an infinitely high resistance for currents of the frequency of the wavelength you are trying to receive and therefore potentials from one end to the other are at a maximum.

As regards the earthing of the cores of low-frequency transformers. This certainly does get rid of a lot of noise in some cases, but I do not attribute such noise to eddy currents; it is rather due to leakage of H.T. and possibly to the accumulation of a charge on the core. As a general rule, I usually earth a single transformer unless so doing causes any noise, but when using two or three transformers in the same amplifier, I find that earthing the frames is sometimes enough to cause a certain amount of coupling between them, and thus render the generation of low-frequency oscillations probable. I do not think that a metallic connection to the core would have the slightest effect on eddy currents.

**Mr. P. R. Coursey.**

I think we ought to thank Mr. Phillips for his excellent account of a means of simplifying the problems of high frequency amplification. There is one little point that I should like to make with regard to his remarks about the grid leak of a detector valve. I certainly agree with him that connecting the leak either to the positive or to the negative of the valve filament will not make much difference to the grid potential, but it may also be of interest to show how one can find what actual the potential is. If one can plot out the grid characteristic of the valve, *i.e.*, the grid current against the grid volts, it may be somewhat as shown at XYZ in the accompanying figure. Well, now, if the total difference of potential that can be impressed on the grid leak is, say, 4 volts, we should mark off 4 volts on the axis of grid voltage as at A, and set out a straight line AB to represent the resistance line of the grid.




That is to say, the slope of this line should equal the resistance of the grid leak. For example, suppose, as described by Mr. Phillips, the grid leak resistance = 2 megohms, and the potential difference across the filament = 4 volts, we should set off OA = 4 volts and OC = the current passed by 2 megohms on 4 volts—

$$= 4/2 \times 10^6$$
$$= 2 \text{ microamperes.}$$

This straight line will intersect the grid characteristic at some point such as Y, then the potential which the grid will assume will be given by the distance OZ′ measured along the axis of grid voltage.

**Mr. C. F. Phillips.**

I think that is a pretty way of getting at grid potential but he is not telling you how to get that curve. The only difficulty is that I cannot personally plot out the grid characteristic owing to the lack of sufficiently sensitive instruments.

**Mr. P. R. Coursey.**

If Mr. Phillips does not mind my criticising his remarks, there is one point which I would rather like to mention. He referred to the "resistance" of the condensers for various frequencies, and in giving these resistances he mentioned such figures as 15,000 ohms. I should be sorry to have to use a condenser having that resistance. I take it that he really meant "impedance."

I think there is one other little point raised by another speaker about the self-capacity of multilayer coils when using them for coupling the H.F. valve to the detector. I do not think it is perhaps realised as generally as it should be that the increase of high frequency resistance due to the self-capacity of the coil is due to the current which flows through the capacity. If we have a coy and connect a condenser across it, the self-capacitil and the coil is added to the external capacity, so that for the frequency to which the circuit is tuned if the coil has inductance $L$ and with total capacity $C$ its effective resistance is given by $L/CR$ where $R$ is the true high frequency resistance of the coil itself. Hence, for this purpose, it does not matter much where the capacity is located, *i.e.*, whether it is in the coil itself or outside. In any case also the plate capacity of the valve is added also on to the total effective capacity.

**Mr. M. Child.**

There are one or two little points which I would like to ask Mr. Phillips about. I notice, first of all, that there has been a slight discussion between the merits of the transformer coupling and the reactance capacity method, which Mr. Phillips advocated. I do not think that the latter circuit shows very much advantage over the transformers if these are of values properly chosen. I quite agree with Mr. Phillips that there is self-capacity between the primary and secondary high frequency transformer, and as a rule that capacity may be transmitted from the plate circuit to the grid circuit of the next valve, but I am not quite sure whether we are justified in assuming that that is all the transformer does. In his diagram (Fig. 1), Mr. Phillips shows a grid leak of 2 MΩ. That grid leak is for keeping the grid of the valve at a constant potential until the signals arrive Now, if we take the next diagram (Fig. 2) showing the transformer coupling, we dispense with the grid leak, and we substitute a winding of a relatively low resistance but of a high impedance. Mr. Phillips, will you kindly put in a condenser and a grid leak ? I had in my mind that it was possible to use a valve, what we might call a special detecting valve in that second position where it is not necessary to control the grid with condenser and grid leak, and in that case we may use, if necessary, a potentiometer and then the transformer of the secondary comes direct to the grid without the condenser and the leak. Now, what I should like to know definitely (if anybody can tell me), is whether that secondary now is not producing a potential difference between it. Under these conditions would the magnetic field in the primary of the transformer, be electronic ? I think it is. We have more the true transformer than we ordinarily get with the condenser and grid leak in its place. Another little point I noticed was that Mr. Phillips referred to that circuit marked X in Figure 1 as the rejector circuit. I understand that a rejector circuit is not a proper rejector circuit unless the resistance of the inductance is made extremely small. Now this is rather important, more so when you take into consideration that in practice if we want to get a long wavelength the capacity must be large. If those inductances which Mr. Phillips has actually shown us in practice are tuned, I do not think their resistance is by any means small enough for the circuit to be compared to a rejector circuit, but I daresay the advantage is explained in using those coils, and that you do get sharp tuning. If, however, you make the circuit very selective, and keep down the resistance, then the resonance is so difficult to obtain that it is almost impossible to work it in that way. I think it is a good thing to have some resistance. I would like to ask Mr. Phillips whether he always recommends joining the secondary of the low tension transformer to the negative side of the battery. We already have at this point resistance. There are circumstances where I find it very desirable to do so, such as for the reception of ordinary Morse signals, but I do not find it always an advantage to do that when one requires to receive telephony; it depends to a certain extent on the type of valve used, and its characteristic curve. I think Mr. Phillips will agree with me that that little point ought to be followed up. One ought to have a switch to switch that connection on to different places when one is receiving spark or telephony. I think we all ought to thank Mr. Phillips for opening this interesting discussion; the making of the low frequency grid positive is a very good scheme, and will assist a great many of us to keep our circuits steady on short-wave work.

**Mr. C. F. Phillips.**

I quite agree that transformer coupling has one advantage over reactance capacity, and that is the ability to use a potentiometer. Some people find it difficult to secure efficient rectification by potentiometer control of the grid, and I do not think that the average valve on the market gives such good rectification by potentiometer control as it does by grid current control as exercised by a grid condenser. In certain circuits the use of a grid condenser is absolutely barred : I allude to circuits used in front of high speed printing apparatus. A grid condenser may lead to temporary paralysis of the grid by an atmospheric, and before the grid has discharged through the leak, portions of a high speed signal might be missed.

With regard to the true rejector circuit, Mr. Child is quite right; it has large circulating currents in it, but currents of the frequency to which it is tuned will not pass through it. To ensure its behaviour in complete accord with this theory, it must be of very low resistance, and is consequently usually of low inductance and high capacity.

Touching low frequency amplification, it is certainly as well to be careful not to make the operative point such that the valve is working near the bend of its characteristic curve, as that would cause the low frequency signals to be re-rectified. Such re-rectification would occasion serious distortion of speech or music. In short, one should keep the grid of a L.F. valve as negative as is possible without producing re-rectification.

**Mr. H. H. Burbury.**

There is one question I should like to ask. I have for a long time used transformer coupled high frequency amplification, but I find I rather agree with Mr. Phillips that they do not altogether transform, and this can be shown if anybody will try connecting the filament connection to the secondary when they get signals almost as strong. That appears to me to cut out the theory that they really do transform.

At the same time I think one gets quite as good results from a transformer as you do from Mr. Phillips's circuit in point of magnification.

**Mr. M. Child.**

Might I suggest that if that circuit is possible the valve is one in which you get a very low velocity, you must have the connections controlled to the grid on the grid circuit of your battery to keep the grid normally straight, otherwise a charge accumulates and pops off through the valve.

**Mr. C. F. Phillips.**

Oh no, Mr. Child, it leaks through your faulty high frequency transformer and gets off that way.

**Mr. M. Child.**

That is due to bad insulation.

**The President.**

Gentlemen I think you will join in thanking Mr. Phillips and the other speakers for an interesting paper and discussion. As regards the last point, I have had a broken wire in my transformer without the signals stopping and I am inclined to agree with Mr. Phillips in that respect.

All the members for ballot have been duly elected.

I should like to say that if any of you feel inclined to give us lectures we shall be very glad if you will send in your names. We have no particular lecture arranged for next month and volunteers will be very gratefully accepted, not only for our own Society here but for the affiliated societies around London and in the Provinces.

That, I think, closes the Meeting.

**Mr. C. S. Dunham** (*communicated*).

I think Mr. Phillips rather misunderstood me; possibly I did not make my meaning quite clear. Experience seems to show that the tighter the coupling between the primary and secondary windings of a high frequency transformer the better, and it was to this coupling that I referred in my remarks, not to the coupling between anode coil in a reactance-capacity coupled amplifier, and other parts of the circuit. Hence my remarks that one could obtain better coupling on the shorter waves by using a basket coil, in preference to any system of multi-layer winding, which latter gives a comparatively small coupling surface except for wavelengths of say 4,000 metres upwards.

It is true that the basket coil, owing to its low self-capacity would give rather a peaked curve, but as Mr. Phillips suggested the coil could be well soaked in wax. Other methods of reducing such a wave will suggest themselves, such as, for instance, winding part of the transformer coil with resistance wire, coupling the primary and secondary with a small condenser, etc.

These methods were not, however, intended to be used in the reactance capacity coupled amplifier, where there is, of course, no necessity to have a large coil. The smaller the better in fact, so as to be free from the possibility of interlinkage of external fields which might create very undesirable results. The self capacity of this coil forming the damping element, it seems that any multilayer coil forms the ideal system of winding, and the much abused "slab" winding comes into its own.

**Mr. C. F. Phillips** (*reply to Mr. Dunham—communicated*).

I am sorry I misunderstood Mr. Dunham's earlier remarks. I agree that the tighter the coupling between primary and secondary of *commercial* high frequency transformers the better. That seems to prove my contention that they do *not* transform, as the tighter the coupling the higher the capacity between windings and the more nearly do you approach the system of reactance-capacity coupling.

**Mr. P. G. A. H. Voigt** (*communicated*).

I disagree with Mr. Phillips in making the first grid 6 volts positive. If you change your grid voltage from zero to 6 volts positive three things occur.

Firstly you change the point of the characteristic on which you work, but according to the commonly accepted theory, you might effect this change equally well by an increase of about 30 v. of H.T.

Secondly, there is a considerable grid current, which acts in every way as if the insulation of the aerial was bad. According to Mr. Phillips this loss can be replaced by a little more reaction. If this is true, then why do we insulate our aerials very carefully? It is well known that with bad insulation, the results are bad, in spite of any amount of reaction.

Thirdly, you get stability. In order to get stability in my own set I use capacity reaction in a suitable way, and can stabilise the set at any time without that loss of efficiency which is produced by a positive grid voltage.

Mr. Phillips mentioned early in his lecture that it was desirable to use a tuning condenser of extremely low self capacity in the "rejector" or tuned plate circuit. Later he said that the coils used in this circuit should have a high self capacity.

I fail to see why you should go to great expense getting special condensers with a low maximum capacity when you afterwards sometimes dip your coils in wax to bring that capacity up again.

I find that with ordinary wavelengths if the minimum capacity is small the coils become very aperiodic when no condenser is used. For example, one of my coils tunes from 2,000 metres up to 3,000 with a 0·002 condenser, but the minimum is very badly defined, and even 600 metres comes through very well, indeed. If, however, the least additional capacity is put in parallel, the 600 metre signals vanish. With regard to the condenser in parallel with H.T. Once I connected up a new set with a new H.T. and found by careful test that the addition of a large condenser in parallel with the H.T. did not make the least difference. Six months later when the H.T. was much colder I repeated the experiment, and this time it made an immense difference to the high frequency side of the set, but no appreciable difference to the low frequency side. This shows that the impedance of the H.T. is negligible for L.F., and a few hundred ohms more or less will make little difference to the low frequency side. For H.F., however, this is not the case, and the condenser provides a low impedance path for the oscillations.

Lastly, one of the speakers asked "if connecting the transformer stampings together in order to earth them did not produce eddy currents?" The answer is no. The eddy currents cannot flow unless the circuit is complete, and this requires at least two such connections.

**Mr. C. F. Phillips** (*reply to Mr. Voigt—communicated.*)

If Mr. Voigt will examine Figs. 1 and 6 he will see that the grid is about 4, not 6, volts positive. As regards his three points:—

1.—I want to change the point on the characteristic from the bottom bend to some way up, in order to prevent distortion; why bother to increase H.T. voltage to do so?

2 and 3.—With a grid current of 100 microamps. the grid filament resistance of the valve is reduced to 40,000 ohms, not a very serious loss of insulation: the results are *not* bad, and what is lost on insulation is more than made up by perfect control over regeneration, and thus maximum signal strength. The proof is easy; try both methods and judge for yourselves.

Mr. Voigt assumes that external capacity in shunt with an inductance has the same effect as distributed capacity. This is not so, as high distributed capacity flattens out a resonance peak far more than does the same value of external shunt capacity. I do not understand Mr. Voigt's remarks about his coils.

# Notes on the Design of Radio Frequency Intervalve Amplifier Transformers using Iron Cores

By A. S. BLATTERMAN, B.Sc., E.E.

(*Continued from page* 51.)

**Coefficient of Coupling.**

Let $M$ = mutual inductance between primary and secondary
$L_1$ = self inductance of primary
$L_2$ = self inductance of secondary
$K = \dfrac{M}{(L_1L_2)^{1/2}}$ = coefficient of coupling
$\Phi$ = total flux linking both primary and secondary
$\phi$ = leakage flux between primary and secondary
$N_1$ = number of turns on primary
$N_2$ = number of turns on secondary
$I_1$ = primary current
$I_2$ = secondary current

The mutual inductance $M$ is defined as

$$M = \frac{N_2\Phi}{I_1 \times 10^8} = \frac{N_1\Phi}{I_2 \times 10^8}$$

and the self-inductances $L_1$ and $L_2$ as

$$L_1 = \frac{N_1(\Phi + \phi)}{I_1 \times 10^8}$$

$$L_2 = \frac{N_2(\Phi + \phi)}{I_2 \times 10^8}$$

Hence

$$K = \frac{M}{\sqrt{L_1L_2}} = \frac{\Phi}{\Phi + \phi} \quad \ldots\ldots\ldots\ldots \quad (12)$$

The leakage flux $\phi$ is calculated with the help of equation (11) and is found to be

$$\phi = \frac{4\pi N_1 I_1}{10} \times \frac{4\pi t}{3} \times \frac{1}{\log \dfrac{2R}{b + 2R - \sqrt{b^2 + 4bR}}} \quad \ldots\ldots \quad (13)$$

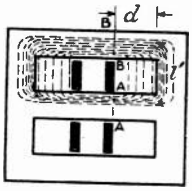


*Fig.* 9.

The mutual flux $\Phi$ may be considered as produced by the primary, passing through the central core leg and returning partly through the end core sections and in part also across the air path between the secondary and these end core sections as shown in Fig. 9.

The reluctance of the composite magnetic path outside the coils from section AA to section BB is, for the air part, approximately

$$\Re_a = \frac{3}{4\pi d} \log \frac{2R}{b + 2R - \sqrt{b^2 + 4bR}} + \frac{d}{\mu A}$$

and for the iron

$$\Re_i = \frac{l' + 2d}{\mu A}$$

The ratio of these two is therefore

$$\frac{\Re_i}{\Re_a} = \frac{l' + 2d}{\mu A} \times \frac{1}{\dfrac{3}{4\pi d} \log \dfrac{2R}{b + 2R - \sqrt{b^2 + 4bR}} + \dfrac{d}{\mu A}}$$

In many cases this ratio is very small and in such cases the flux $\Phi$ may be taken as that following the iron circuit alone. The calculations are thereby simplified considerably. As an example may be taken a transformer core used in a certain line of transformers built at these laboratories in which

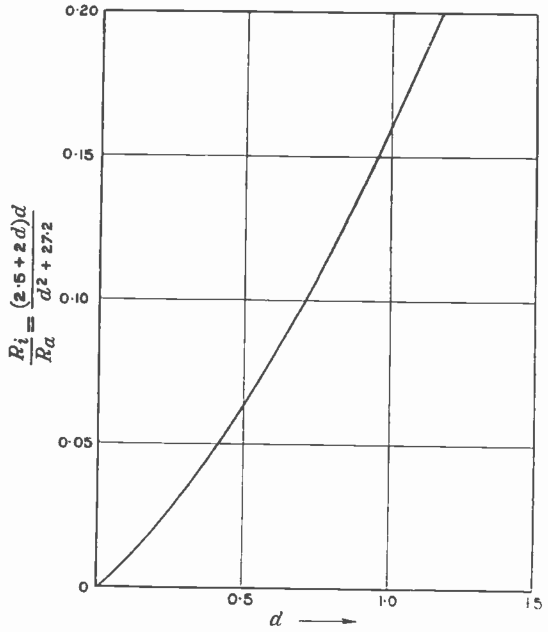



*Fig.* 10.

$$A = 0\cdot87 \text{ sq. cm}$$

$$\frac{b}{R} \doteqdot 2$$

$$\mu \doteqdot 100$$

$$l' = 2\cdot5 \text{ cm}$$

This gives

$$\frac{\Re_i}{\Re_a} = \frac{(2\cdot5 + 2d)\,d}{d^2 + 27\cdot2}$$

Fig. 10 shows values of this ratio for different values of $d$ and it is there seen that at least 90 per cent. of the flux will follow the iron for values of $d$ up to nearly 1 cm. Therefore, in this case and particularly when it is remembered that the flux paths under consideration form only a part of the entire magnetic circuit, the error is not great if the flux $\Phi$ is calculated on the basis of the iron path alone with length $l$ cm and cross-section $A$ sq. cm. If desired, the air paths may be approximately accounted for by mathematically increasing the iron section $A$ slightly (from about 3 to 8 per cent.).

We have then for the mutual flux $\Phi$

$$\Phi = \frac{4\pi N_1 I_1}{10} \times \frac{1}{\dfrac{l}{\mu A} + \dfrac{\delta l}{A}} \qquad \ldots\ldots\ldots\ldots\ldots \quad (14)$$

giving for the coefficient of coupling

$$K = \frac{\Phi}{\Phi + \phi} = \frac{1}{1 + \phi/\Phi} = \frac{1}{1 + a} \qquad \ldots\ldots\ldots\ldots \quad (15)$$

where

$$a = \frac{4\pi t}{3} \times \frac{\dfrac{l}{\mu A} + \dfrac{\delta l}{A}}{\log \dfrac{2R}{b + 2R - \sqrt{b^2 + 4bR}}}$$

or letting $\frac{b}{R} = \sigma$

$$a = \frac{4\pi t}{3} \times \frac{\dfrac{l}{\mu A} + \dfrac{\delta l}{A}}{\log \dfrac{2}{2 + \sigma - \sqrt{\sigma^2 + 4\sigma}}} \qquad \ldots\ldots\ldots\ldots \quad (16)$$

**Primary and Secondary Inductances.**

The primary inductance is

$$L_1 = \frac{(\Phi + \phi)\,N_1}{I_1 \times 10^8}$$

$$= \frac{4\pi N_1^2 I_1}{I_1 \times 10^9}\left(\frac{1}{\dfrac{l}{\mu A} + \dfrac{\delta l}{A}} + \frac{4\pi t}{3 \log \dfrac{2}{2 + \sigma - \sqrt{\sigma^2 + 4\sigma}}}\right)$$

$$= \frac{4\pi N_1^2}{10^9} \cdot \left\{\frac{1}{\dfrac{l}{\mu A} + \dfrac{\delta l}{A}}\right\} \cdot \left\{1 + a\right\} \qquad \ldots\ldots\ldots\ldots \quad (17)$$

The secondary inductance is similarly

$$L_2 = \frac{4\pi N_2^2}{10^9} \left\{ \frac{1}{\frac{l}{\mu A} + \frac{\delta l}{A}} \right\} \left\{ 1 + a \right\} \quad \ldots \ldots \quad (18)$$

It is to be noted that these inductances both comprise a portion due to leakage flux $\phi$ and calculable by the formula

$$L = \frac{4\pi N^2}{10^9} \cdot \frac{a}{\frac{l}{\mu A} + \frac{\delta l}{A}} \quad \ldots \ldots \quad (19)$$

and a second portion due to the mutual flux $\Phi$ calculable similarly by

$$L_0 = \frac{4\pi N^2}{10^9} \cdot \frac{1}{\frac{l}{\mu A} + \frac{\delta l}{A}} \quad \ldots \ldots \quad (20)$$

**The Circuit Problem.**

The circuit to be considered has already been shown in Fig. 3 except that in that figure the capacity $C_t$ is to be ignored as being negligibly small on account of the pancake winding construction used. The resistance due to core loss in the transformer as well as the secondary resistance $r_2$ of the input circuit of the tube will also be omitted from immediate consideration. The general effect of these resistances is to slightly change the actual values of the coupled resonance frequencies, and to reduce the maximum values of the humps in the resonance curves. They also cause the latter to flatten out considerably. It seems quite unnecessary to attempt to take these resistances into account in an accurate circuit solution for the location of the range of wavelength operation of an amplifier, particularly in view of the fact that they are both functions of frequency as are also $C_2$, $L_1$ and $L_2$. In addition all of the quantities $r_0$, $r_2$, $L_1$, $L_2$ and the coefficient of coupling depend to a certain extent upon the strength of the signal involved. The principal effect is the dulling or flattening out of the resonance curve and in this respect the core loss plays an important rôle. In certain transformers that have been built by the author, this resistance is of the order of 1,000 ohms at 200,000 cycles under working conditions.

The circuit then to be treated is that of Fig. 11. The matter to be investigated is the variation of secondary voltage $v''$, or what is the same thing the secondary current $i_3$, with frequency under the influence of the constant voltage $re_g = v$. Indicating the currents conventionally as shown, we get the Kirchoff equations (where $p = j\omega$)

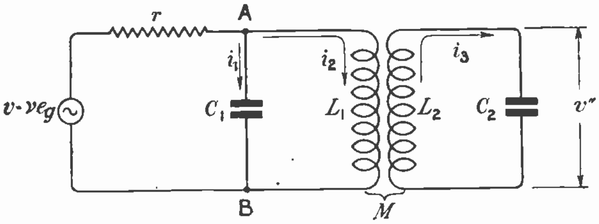



*Fig.* 11.

$$v = i_1 \left(r + \frac{1}{pC_1}\right) + i_2 r \quad \ldots \ldots \quad (21)$$

$$0 = -\frac{i_1}{pC_1} + pL_1 i_2 - pM i_3 \quad \ldots \ldots \quad (22)$$

$$0 = -pMi_2 + \left(pL_2 + \frac{1}{pC_2}\right) i_3 \quad \ldots \ldots \quad (23)$$

From these we get by routine methods

$$I_3 = \frac{V}{\sqrt{\left\{\frac{L_1 C_2 L_2 (1-K^2)\omega^2 - L_1}{\omega K \sqrt{L_1 L_2} C_2}\right\}^2 + \frac{r^2}{\omega^4 C_2^2 K^2 L_1 L_2} \left\{1 - \omega^2 (L_1 C_1 + L_2 C_2) + \omega^4 L_1 C_1 L_2 C_2 (1-K^2)\right\}^2}} \quad (24)$$

$$= \frac{V}{Z} \quad \ldots \ldots \quad (25)$$

The desired conditions are those giving maximum values of this expression. Such conditions obviously obtain when the denominator has minimum values and can be determined by equating

$$\frac{d(Z)^2}{d\omega} = 0$$

Such procedure gives

$$0 = 2\omega^8 \left[L_1^2 L_2^2 C_1^2 C_2^2 (1-K^2)^2 r^2\right] + \omega^6 \left[L_1^2 L_2^2 C_2^2 (1-K^2)^2 - 2L_1 L_2 C_1 C_2 r^2 (1-K^2)(L_1 C_1 + L_2 C_2)\right] +$$

$$+ \omega^2 \left[2(L_1 C_1 + L_2 C_2) r^2 - L_1^2\right] - 2r^2 \quad \ldots \ldots \quad (26)$$

The solution of this equation for $\omega$ and the selection of the proper roots is quite a formidable task mechanically. It can be most simply accomplished by graphics, but is cumbersome at best and since the coefficients themselves are functions of $\omega$ the tedium of the work is still further increased. The solution of the problem from (24) is in fact so complex and the accuracy of the results so doubtful on account of the difficulty of accurately formulating the coefficients in terms of $\omega$, that to the practical designer the procedure would be most uninviting. It seems very important to make simplifying approximations.

Consideration of (24) shows a way out of the difficulty. It will first be observed that the denominator of this expression comprises two terms. The second term involves $r$ as a factor and its influence on the value of $I_3$ therefore increases when $r$ is large and becomes negligible when $r$ is very small. In the latter case the impedance $Z$ is given practically by the first term of the denominator and is equal to zero, giving maximum current and secondary voltage when

$$L_1L_2C_2\,(1-K^2)\,\omega^2 - L_1 = 0$$

or when

$$\omega^2 = \frac{1}{L_2C_2(1-K^2)} \qquad \ldots \qquad (27)$$

that is at only one frequency. On the other hand, if $r$ is so large that the first term can be ignored then the impedance $Z$ becomes zero when

$$\omega^4L_1C_1L_2C_2(1-K^2) - \omega^2(L_1C_1 + L_2C_2) + 1 = 0$$

or when

$$\omega^2 = \frac{L_1C_1 + L_2C_2 \pm \sqrt{(L_1C_1 - L_2C_2)^2 + 4K^2L_1C_1L_2C_2}}{2(1-K^2)L_1C_1L_2C_2} \qquad \ldots \qquad (28)$$

which is the familiar expression giving the oscillation frequencies of a pair of inductively coupled circuits. Practically, neither one of these two extreme conditions exists, but both terms of (24) are effective thus giving two minima whose location just now is rather obscure.

Inspection, however, shows the following facts. The first term of the denominator varies with the frequency somewhat according to the curve A, Fig. 12. The second term varies according to curve B. If the first term (curve A) were not effective the two frequencies giving maximum amplification would be determined by the usual coupled circuit equation (28) and would be located at $f_0'$ and $f_0''$ (Fig. 12) where the B curve touches $f$ axis. The presence of the first term (curve A) however makes the resultant impedance curve (curve A + curve B) take the form of curve C. *The two minima are brought closer together. Thus as far as the location of the minima are concerned the effect is the same as though*

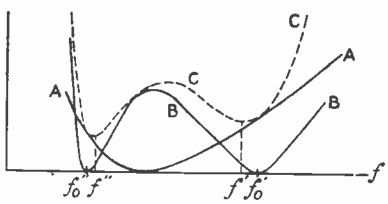



*Fig.* 12.

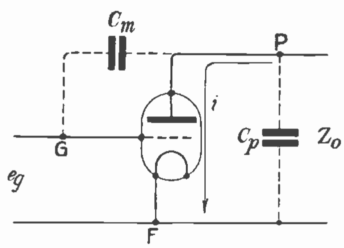



*Fig.* 13a.

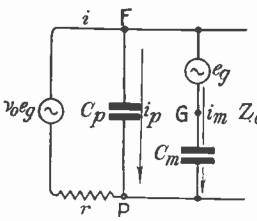



*Fig.* 13b.

*the coefficient of coupling in the second term had been decreased.* The suggestion immediately presents itself therefore that as an approximation the actual minima may be located by considering the second term alone using its condition for minima (28) but modified by considering the coefficient of coupling reduced so that $K^2$ can be neglected in comparison with unity. The conditions for maximum amplification would then become more simply

$$\omega^2 = \frac{\dfrac{1}{L_1C_1} + \dfrac{1}{L_2C_2} \pm \sqrt{\left(\dfrac{1}{L_1C_1} - \dfrac{1}{L_2C_2}\right)^2 + \dfrac{4K^2}{L_1C_1L_2C_2}}}{2} \qquad \ldots \qquad (29)$$

There are several further features, however, which must be considered before the form of (29) can be accepted for practical calculations. In the first place $C_1$ is a most uncertain quantity and is one of the factors which makes the rigorous solution of (24) so difficult. Secondly, since $K$ has been considered as reduced below its actual value in the formulation of (29) the question arises as to what value should be used for it in that equation.

As regards the stated variation of $C_1$, this may be readily understood from the following elementary analysis. The No. 1 or input tube is shown in Fig. 13. The actual circuit is shown at (a), and its analytical equivalent at (b). Across the load $Z_0$ appears the alternating voltage $ve_g (v \neq v_0)$. This voltage is associated with the current $i_p$ in the relation

$$i_p = ve_g \omega C_p$$

The current $i_m$ is also identified with this voltage $ve_g$ but in addition there is the grid voltage $e_g$ acting serially additive to $ve_g$ giving

$$i_m = (v + 1)\, e_g C \omega_m$$

The total capacity current is therefore

$$i_p + i_m = ve_g \omega \left[ C_p + \left(1 + \frac{1}{v}\right) C_m \right]$$

The effective capacity $C_1$ is seen to be

$$C_1 = C_p + C_m \left(1 + \frac{1}{v}\right)$$

This value will, of course, be somewhat modified by the nature and magnitude of the impedance supplying $e_g$ and the exact phase of $e_g$ with respect to $ve_g$. The general nature of the effects determining $C_1$ is well indicated, however, and explains the statement just made regarding the variation of this quantity. It will be obvious that an approximation to $C_1$ is highly desirable if not, in fact, essential. The one which we shall make is $C_1 = C_p + C_m$.

Now, referring to (28), it will be seen that using $C_1 = C_p + C_m$, which is smaller than its actual value, operates on the separation of the two resonant frequencies in a contrary manner to reduction of $K$. What is desired, according to the indications of Fig. 12, is to somewhat raise the lower resonant frequency $f''_c$ as determined from (28) and lower the higher resonant frequency $f_0'$ (generally a somewhat greater amount).

It is noted that the quantity $(1-K^2)$ in the denominator increases for the higher frequencies tending toward unity as $K$ falls off. It may also be noted that the two resonant frequencies $f'$ and $f''$ will be expected somewhere in the neighbourhood of the natural frequencies of oscillation of the individual circuits. This suggests the determination of these natural frequencies. Now, $L_1$ and $L_2$ are larger for low frequencies than for high ones, so that if their inductance values as identified with the separate natural oscillations of the two circuits are used in (28) it will be evident that in the neighbourhood of the lower coupled circuit frequency $(f'')$, $L_1$ will be considerably lower than its actual value, which would have had to be used in the solution of the complete equation (24), and $L_2$ will likewise be somewhat lower than its actual value, though the difference will not be so great as with $L_1$, since $f''$ and $f_2$ will probably not be widely different. Similarly, in the neighbourhood of the higher coupled circuit frequency $(f')$ $L_1$ will be nearly correct or a little high, and $L_2$ will be considerably higher than its actual value.

Under these conditions and when using the minus sign for the radical it will be seen that the lower frequency $f''$ of (28), wherein actual values of all the quantities would be used, will move upward somewhat by the use of (29) wherein

$L_1$ = value of $L_1$ for independent primary circuit resonance.

$L_2$ = value of $L_2$ for independent secondary circuit resonance.

$K$ = actual values of $K$.

$C_1$ = $C_p + C_m$ (lower than actual value).

Likewise the higher frequency $f'$ of (28) will be reduced by the use of (29) with its approximations. These conclusions are, of course, quite general in nature. They indicate, however, that the approximations stated are operative in the right direction and result in comparatively simple calculations for the practical designer. Equation (28) cannot be used *per se*, and the complete expression (24) is prohibitively cumbersome even after assuming some average value of $C_1$.

According to the contemplated method we are to calculate the location of the peaks of the amplification characteristic from (28) which is now to be written thus—

$$f' = \sqrt{\frac{f_1^2 + f_2^2 + \sqrt{(f_1^2 - f_2^2)^2 + 4K^2 f_1^2 f_2^2}}{2}} \quad \ldots \ldots \quad (30)$$

$$f'' = \sqrt{\frac{f_1^2 + f_2^2 - \sqrt{(f_1^2 - f_2^2)^2 + 4K^2 f_1^2 f_2^2}}{2}} \quad \ldots \ldots \quad (31)$$

$$f_1 = \frac{1}{2\pi\sqrt{L_1 C_1}}$$

$$f_2 = \frac{1}{2\pi\sqrt{L_2 C_2}}$$

$$K = \frac{M}{\sqrt{L_1 L_2}} = \frac{1}{1 + a}$$

**Determination of Free Frequencies $f_1$ and $f_2$ and proper Correlation of $K$.**

The formulæ previously developed for the inductances and coefficient of coupling involve the permeability $\mu$ of the iron core. The permeability is not constant but varies with the frequency. For the kind of iron used at these laboratories (Alexanderson 1°w carbon steel $1\frac{1}{2}$ mils thick), it has been found that the relation between permeability and frequency for small flux densities can be very closely expressed as follows :—

$$\mu = \frac{3 \cdot 02 \times 10^5}{f^{0 \cdot 6}} \text{ from 200,000 to 1,500,000 cycles} \quad (32)$$

$$\mu = \frac{2 \cdot 6 \times 10^4}{f^{0 \cdot 4}} \text{ from 200,000 to 75,000 cycles} \quad (33)$$

In determining the location of the peaks of the resonance curve of the transformer, that is, the frequencies $f'$ and $f''$ of (30) and (31) the natural frequencies $f_1$ and $f_2$ of the primary and secondary circuits must be known. At first sight these seem to be somewhat ambiguous because the inductances $L_1$ and $L_2$ are themselves functions of frequency depending upon the core permeability. The problem is presented, therefore, of determining the natural frequency of oscillation of a circuit comprising an iron core inductance. It can be solved most simply by a graphical method as follows.

Let $L = \phi(f)$, as determined from the dimensions of the coil and core, and permeability of the latter. Also let $L = \psi(f)$ be the functional relation between the frequency, the inductance of the coil and the capacity with which the latter is associated. Obviously

$$L = \psi(f) = \left(\frac{1}{4\pi^2 C}\right) \times \frac{1}{f^2}$$

while $L = \phi(f)$ is calculated from the formulæ previously given as (17) and (18). If the two functions $\psi(f)$ and $\phi(f)$ are plotted on the same sheet they will be found to intersect as at P, Fig. 14a, and the frequency corresponding to this intersection point will be the frequency at which the circuit will stabilise in free oscillation. In any particular design the natural frequencies $f_1$ and $f_2$ are thus determined.

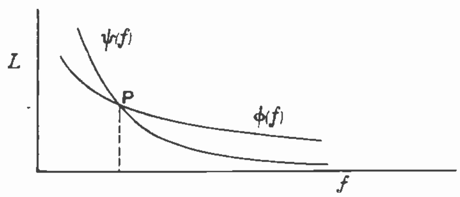



*Fig.* 14a.

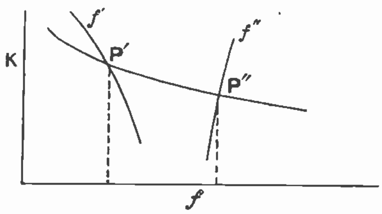



*Fig.* 14b.

A further ambiguity arises in the calculation of $f'$ and $f''$ owing to the variation of $K$ with frequency, but this is also satisfactorily solved by a graphical method. Having determined $f_1$ and $f_2$, as just described, $f'$ and $f''$ are plotted as functions of $K$ according to (30) and (31). The functional relation between $K$ and frequency as determined from the geometry of the transformer, etc., by formulæ (15), (32) and (33), is also plotted on the same sheet (see Fig. 14b). The intersections of this curve with the two curves of $f'$ and $f''$ as at $P'$ and $P''$ (Fig. 14b) determine the values of $f'$ and $f''$ at which the resonant humps occur.

In many cases it will be found that this second graphical step is not strictly necessary, as a very fair approximation may be had by using a value of $K$ corresponding to a frequency about midway between $f_1$ and $f_2$, and calculating $f'$ and $f''$ directly from (30) and (31) using this average value.

**The Tube Capacities.**

The capacities $C_1$ and $C_2$ of Fig. 3 are required in order to predict the operational characteristic. Denoting—

$C_g$ = capacity between grid and filament.

$C_m$ = capacity between grid and plate.

$C_p$ = capacity between plate and filament.

We have, according to the approximation previously stated, $C_1 = C_p + C_m$

As regards $C_2$ there are two cases which must be differentiated, first, when the tube on the secondary of the transformer is used as detector with by-passing radio frequency condenser across its output, as is usual practice ; and, second, when the secondary tube is another radio frequency amplifier with transformer similar to the one under consideration in its plate circuit. In either case $C_2$ may be taken as $C_2 = C_g + (1 + \nu') C_m$ where $\nu'$ is the voltage amplification factor. In the case of the detector with radio frequency by-pass condenser in the plate circuit $\nu'$ is obviously zero because of the short-circuiting effect of such by-pass condenser on the plate. Therefore, in this case $C_2 = C_g + C_m$

In the other case where the tube is a unit in another stage of amplification $\nu'$ has a variable value with frequency depending upon the impedance of the transformer in its plate circuit. As a maximum value it will, of course, approach the amplification constant $\nu$ of the tube, but will generally be somewhat less than this because the impedance of its plate transformer will not be infinite. Experiment has shown, however, that except for very short wavelengths the effective resistance of the load (transformer) at its tuning points is of the order of 100,000 ohms so that the error in assuming $\nu' = \nu$ is not large. For wavelengths of the order of 400 metres experiment also has indicated that the effective resistance falls to about one-tenth the value just given for long waves (1,000 metres and over), and the value of $\nu'$ is therefore more nearly equal to $\nu/2$*. Such approximations as these are convenient and sufficiently accurate to formulate the design.

It is important to note, according to the formulæ just given, that in a cascade multi-stage amplifier-detector system using identical coupling transformers throughout, the wavelength range of the last stage of amplification will be different from the stages preceding because the last stage works into the detector tube. This condition will, in general, tend to flatten out and broaden the tuning characteristics of the system, making it more nearly uniform in its response to different frequencies over a certain range. If it is desired to avoid this effect as for sharp tuning to a single frequency the last transformer in the series should be arranged with a different secondary than those preceding according to the difference in the value of $C_2$ with which it operates.

For the American type VT-1 tube, which tube is most frequently used in Signal Corps receiving equipment, we have the average values—

$$C_g = 15$$
$$C_m = 13$$
$$C_p = 13$$
$$\nu = 6{\cdot}5$$

*(To be concluded.)*

# Notes

**Maritime Wireless News.**

News circulated to ships at sea which has been radiated by the Marconi Company for the last twenty years from Poldhu will from May 1st, be transferred to Clifden, thereby increasing the radius by 1,000 miles, making the distance over 2,500 miles.

The news will be transmitted on a wavelength of 5,750 metres, spark.

**The Postmaster-General on Telephony Broadcasting.**

In the House of Commons on April 3rd, the Postmaster-General, in reply to a question put by Sir Douglas Newton, said that the whole question of the broadcasting of wireless telephone messages was being referred to the Imperial Communications Committee. The Postmaster-General expressed his sympathy with the idea.

**The Genoa Conference.**

It is understood that the wireless station at Spezia (**ICS**) will be used for the transmission of press news relative to the Genoa Conference. The station at Spezia consists of a Marconi 15 kW valve set. The transmissions will, it is understood, be made on a wavelength of 3,400 metres C.W. at 1,500 G.M.T.

**Marriage of Wireless Interest.**

The marriage took place on Monday, the 13th March, of Lieut. Duncan Sinclair, of the Department of Civil Aviation, Air Ministry, to Doris Elsie, only daughter of the late G. W. Brind, Esq. Lt. Duncan Sinclair, it will be remembered, was the author of a paper entitled "The Wireless Stations of the British Commercial Airways," read before the Wireless Society of London.

**Mr. A. E. Hay,** of "Glendale," Abernant, Aberdare, S. Wales, **would be glad to hear from** anyone prepared to listen for telephony, tonic train, and spark signals from his station. The following stations are received well by him:— **2 IV, 2 MM, 2 OM, 2 KQ, 2 DX, 2 TV, 2 HM,** or **2 HW** (presumed to be a Bristol station), **2 PZ, 2 IQ.** Mr. Hay states he is heard regularly up to distances of 150 miles. His call is **2 KG.**

# Correspondence

*To the Editor of* THE WIRELESS WORLD AND RADIO REVIEW.

SIR,—On opening the March issue of *The Radio Review* this morning and reading over my review of Leggett's "Wireless Telegraphy," I see that I have done the author an injustice, due to misunderstanding a sentence in the book. I refer to lines 10 to 14 in my review, where I expressed surprise at the author's suggestion that the well-known books by Fleming, Hawkhead, and Eccles were not written by actual wireless engineers but contained matter largely obtained second-hand from other books. On reading over the quotation again, however, I see that it bears quite a different construction to that which I placed upon it, and that the author intended no such suggestion, but rather referred to the three authorities named as the sources from which other writers obtained their second-hand matter. It is also obvious that, in making the statement that, with very few exceptions books dealing with wireless telegraphy are not

*For resistance load $R$, and tube resistance $R_0$, $\nu' = \dfrac{R}{R + R_0}\nu$

written by actual wireless engineers, Mr. Leggett regarded the three authors named as among the exceptions.

Having criticised several features of the book, I am the more anxious to correct at once what is obviously an injustice to the author.

G. W. O. H.

*April 5th,* 1922.

*To the Editor of* THE WIRELESS WORLD AND RADIO REVIEW.

SIR,—The following appeared on page 571 of "Tit-Bits" (issue dated February 25th) :—

HORSE-POWER BY WIRELESS.

> " . . . and now a big *wireless power station* is working in Germany. Great towers, more than a hundred feet high, transmit current across the River Elbe to distant factories."

I should be very much obliged for any information available regarding the system and wavelength used.

This is not idle curiosity—far from it—as I listen in at night I scarcely dare vary my A.T.C. for fear I should touch a harmonic of the wave-length of this new station. To those building their own tuners I would point out the awful consequences resulting from a miscalculation of inductance or the presence of a rusty iron nail in the coil.

I cannot sleep at night for thinking of the dangers that beset my brave colleagues—what if a strong gust of wind should for one brief second deflect the beam on to a resonant aerial ?

At the same time the possibilities of this invention are boundless.

We may expect to see things like this in our newspapers in the near future :—

ORIGINAL SUICIDE AT PECKHAM !

" A verdict of ' suicide during temporary insanity ' was recorded at the inquest on the charred remains of R. Adiobug.

" It appears the lad, still in his teens, had just had the misfortune to ' burn out ' one of his precious wireless valves. This seems to have turned his mind, for a witness of the tragedy states that the poor lad feverishly fitted up a crystal receiver, placed the 'phones on his head, and taking a deep breath, unhesitatingly turned the A.T.I. switch of his tuner on to the thirteenth and last stud. The coroner expressed his deepest sympathy with the parents of the young lad, but pointed out the dangers of his hobby."

We may even expect to see something like this in our *trade* papers :—

INGENIOUS INVENTION.

" Messrs. A.B.C. have just put on the market their new ' Radio Rat-trap ' (Patent 706941). This should be a good selling line, absolute and unfailing reliability combined with its extreme simplicity.

" The weight of the rat on a board automatically closed the secondary circuit of a radio receiver tuned to the ' National Wireless Power Station,' at the same time making electrical contact with the rat and assuring its sudden, painless and odourless demise."

The advertisement pages of *The Wireless World* may be filled with the announcements of enterprising undertakers, setting forth the advantages of the new system of radio cremation to careless amateurs.

To those possessing a good aerial there will doubtless be facilities for home cremation in the shape of portable crematoriums.

It is even possible that the principal firms of wireless apparatus makers will offer special free life insurance policies to those purchasing their "Harmonicless" tuners.

I feel sure you will agree with me that, after all, there really is a future in wireless.

"MILLY AMPERE."*

## Books Received.

THE STRUCTURE OF THE ATOM. By Stephen Miall. (London : *Benn Brothers, Limited.* Pp. 26. $8\frac{1}{2}'' \times 5\frac{1}{2}''$. Price 1/6 net.)

LA T.S.F. DES AMATEURS. By Franck Duroquier. (Paris : *Masson & Cie.* Pp. 305. 315 figs. $7'' \times 4\frac{1}{2}''$. Price 10 fr.)

## Calendar of Current Events

**Tuesday, April 11th.**

Transmission of Telephony at 7 *to* 7.25 *p.m.* on 700 metres followed by C.W. Calibration Signals on 1,000 metres, by 2MT at Writtle, near Chelmsford.

**Wednesday, April 19th.**

NORTH MIDDLESEX WIRELESS CLUB.

8 *p.m.*—At Shaftesbury Hall, Bowes Park, "Electro-Chemistry," by Mr. R. Maxwell Savage, B.A.

COWES AND DISTRICT RADIO SOCIETY.

"Independent and Self Heterodyne Methods."

**Friday, April 21st.**

WIRELESS SOCIETY OF HIGHGATE.

7 *p.m.*—Lecture and demonstration by Lieut. Walker.

BRADFORD WIRELESS SOCIETY.

7.45 *p.m.*—At 5, Randallwell Street, Bradford. Meeting.

**Wednesday, April 26th.**

RADIO SCIENTIFIC SOCIETY, MANCHESTER.

Smoker and Exhibition.

WIRELESS SOCIETY OF LONDON.

6 *p.m.* (Tea 5.30 *p.m.*). At the Institution of Electrical Engineers, Victoria Embankment, W.C.2. "The Four Electrode Valve," by Captain H. de A. Donisthorpe.

**Thursday, April 27th.**

LIVERPOOL AMATEUR WIRELESS SOCIETY.

"A System of Recording and Demonstration," by Mr. L. Haggard.

**Friday, April 28th.**

LEEDS AND DISTRICT AMATEUR WIRELESS SOCIETY.

*Selected.* Mr. A. F. Carter, A.M.I.E.E.

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* Our correspondent should not be taken too seriously.—ED.

Its application to practical working was described and followed by practical experiments, such as lighting a lamp, ringing a bell and starting a motor by means of a beam of light. A full description of this lecture was given in a recent report of the Manchester Wireless Society.

At the conclusion of the lecture several questions were asked and Mr. McKernan cleared up many little points regarding the nature and application of selenium, after which a further discussion on high-frequency current took place, several members having formulated a few ideas on H.F. work since Mr. McKernan's previous lecture. A vote of thanks, proposed by Mr. Parkinson, was heartily accorded by the meeting.

A Special General Meeting was held on March 28th for the purpose of passing new rules, which had been drawn up by the Committee. This business over, the Hon. Treasurer (Mr. J. Waller) presented the whist drive balance sheet, which showed a profit of £5 4s. This account was approved and a vote of thanks was proposed by Mr. Rawsthorne to all who had helped to make the whist drive a success.

Mr. Parkinson then gave a lecture on the "Manufacture of Wireless Telegraphic Apparatus," many useful hints being given on making inductances, condensers and the use of solder. The meeting closed with a vote of thanks to Mr. Parkinson, which was given with acclamation.

### Southampton and District Wireless Society.

Hon. Secretary, Mr. T. H. Cutler, 24, Floating Bridge Road, Southampton.

The fourth meeting of the Southampton and District Wireless Society was held at the Kingsland Assembly Room on Wednesday last, March 29th; a good attendance was recorded. It is satisfactory to state that for the first month's work of this society fourteen new members have been enrolled, the club aerial erected, and rule cards, etc., issued. The first four weeks have been devoted to experimental work with various member's sets, and good results have been obtained. It is the intention of the society to get first-class lecturers, and the month of April has been given over for lecturing, with the usual thirty minutes' buzzer practice. Demonstrations will shortly be given, and very interesting evenings are anticipated. The society hold their meetings every Wednesday at 7.30 p.m., and anyone interested will be cordially welcomed. The annual fee for membership is 12s.

### St. Austell Wireless Club.

Hon. Secretary, Mr. H. Whetter, 26, Fore Street, St. Austell.

The second Annual Meeting of the above Club was held in the Queen's Head Hotel on Monday, March 20th. The attendance was very good. Mr. W. H. Graham, of Tywardreath (Cornwall's first amateur), took the chair, and proved himself a most capable chairman, especially when it came to giving some helpful advice on the management of club affairs. He was unanimously elected President for 1922.

It is hoped to have several field days during the summer months.

### Grimsby and District Radio Society.

Hon. Secretary, Mr. J. H. Perkins, 35, Hare Street, Grimsby.

A meeting of the above Society was held in the Club-room, Welldigate, on Tuesday, March 28th. The Marconi Concert was received quite loud on Mr. Wood's (Vice-President) 3-valve H.F. amplifier.

Meetings are held each Tuesday from 7 p.m. to 10.30 p.m., and anyone interested will be cordially welcomed.

### Wolverhampton and District Wireless Society.

A well-attended meeting of the above Society was held on Wednesday, March 29th, at headquarters, 26, King Street, Wolverhampton. Mr. H. Taylor gave a very interesting discourse on high-frequency amplifiers. With the aid of diagrams drawn on a blackboard he was able to illustrate his remarks, so that even the uninitiated could grasp the subject. The discourse lasted over an hour and was much appreciated.

Membership cards are now being issued; all local radioists should have one. Apply to the Hon. Secretary, Mr. Geo. W. Jones, 8, Rosebery Street, or 26, King Street, Wolverhampton.

### Brighton Radio Society.*

At the meeting of the above Society, held at its headquarters in Buckingham Road, on March 23rd, a most interesting paper was read by Mr. James Cowie, A.M.I.E.E., entitled "Recent Developments in Experimental Psychology." The lecturer outlined most clearly how beneficial the application of this fascinating subject would be to the wireless experimenter in the pursuance of entirely new ideas somewhat off the beaten track. The large number of members present indicates the keen interest which is being taken by Brightonians in the development of wireless telegraphy, and there is no doubt that valuable assistance will be rendered to the local experimenters who were fortunate enough to hear the lecture.

The Society continues to swell its membership daily, and now that the Postmaster-General has granted the necessary licence for the installation of a transmitting set, a large number of intensely interesting experiments in wireless telephony, etc., will be carried out during the current year.

Any gentlemen interested are invited to communicate with the Hon. Secretary, Mr. D. F. Underwood, 68, Southdown Avenue, Brighton, who will be pleased to furnish full details as to membership, etc.

### The Wallasey Wireless and Experimental Society.

At the meeting of the Society held at 106, Albion Street, New Brighton, on Thursday, March 16th, Mr. W. F. Mills treated the members to a most interesting discourse on "Wireless for Beginners." Owing to the fact that the Society is a new one, and at least half of its membership are beginners, the lecture could not have been more valuable.

### CORRECTION.

The stations referred to in Mr. Yardley's lecture before the Leeds and District Wireless Society, reported in the March 18th issue, should have been **2 LA** and **2 LB** and not **2 NA** and **2 NB**, the latter being the stations of Mr. J. Barnaby, Sylvan House, Broad Road, Manchester.

# Questions and Answers

*NOTE.—This section of the magazine is placed at the disposal of all readers who wish to receive advice and information on matters pertaining to both the technical and non-technical sides of wireless work. Readers should comply with the following rules.—(1) Each question should be numbered and written on a separate sheet on one side of the paper only. (2) Queries should be clear and concise. (3) Before sending in their questions readers are advised to search recent numbers to see whether the same queries have not been dealt with before.* **(4) The Editor cannot undertake to reply to queries by post.** *(5) All queries must be accompanied by the full name and address of the sender, which is for reference, not for publication. Queries will be answered under the initials and town of the correspondent, or, if so desired, under a " nom de plume."* **(6) Readers desirous of knowing the conditions of service, etc., for wireless operators will save time by writing direct to the various firms employing operators.** *(7) Four questions is the maximum which will be accepted at a time.*

**"H.J." (Harrow)** *is having severe trouble with a motor on the premises, and asks for advice.*

We are not quite clear from your letter whether the supply for the motor is also used for the set. The symptoms point to a small armature fault on the motor. The most likely cure we can suggest is to put a large capacity between each brush of the motor and earth. We do not think a screen to the motor will be very useful, but you might try it if it can be easily done. If the same supply is used for the receiver, put chokes in each lead near the receiver and also a large condenser across the leads.

**"R.C." (Liverpool)** *asks questions about a coupler.*

Your sample wire did not come to hand.

(1) Wind primary with No. 22, and secondary with No. 26.

(2) Two or three tappings will be sufficient.

(3) About 2,500 metres.

(4) Wavelength can be increased by adding coils in both circuits. It is useless to add coils to one circuit only.

**"RIVERESCO" (Dumfries)** *asks (1) For dates of issues describing a crystal set with the price. (2) What is the meaning of C.W. (3) Names and prices of Textbooks on practical work.*

(1) and (3) "The Elementary Principles of Wireless Telegraph." Part I deals with crystal receiving apparatus. There is no recent article on the subject in *The Wireless World*, as most beginners prefer to start right away with a valve receiver, owing to its ease of manipulation.

(2) C.W., or Continuous Wave, is the name applied to systems of wireless telegraphy transmission in which the amplitude of the ether strains remains constant. Continuous wave stations usually employ valves, high frequency alternators, or arcs for the production of the sustained oscillations. The use of this method, which is described more fully in textbooks, possesses many advantages, but necessitates the use of special methods and apparatus for reception.

**"BEGINNER" (Halifax)** *asks (1) If there is any limit to the number of valves permitted for a receiving set by the P.M.G. (2) If so, what the limit is.*

We do not think so unless stated on license, but in practice it is seldom of much use to employ more than about six for ordinary reception with telephone receivers.

**"S.O.S." (Swansea)** *asks (1) If a plate 18″ × 12″ buried 2 ft. deep will do for an earth. (2) For criticism of a circuit. (3) If a filament resistance is necessary. (4) Where to obtain a list of call letters and what station has the call letters* **PCGG.**

(1) Plate should be considerably bigger in area and buried deep enough to lay in damp soil.

(2) The circuit is quite all right as shown except that it is liable to give re-radiation as it has only one circuit with reaction.

(3) A filament resistance is very desirable with all valves.

(4) **PCGG** is a station at the Hague sending out telephony. A full list of call stations is given in "The Wireless Year-Book," but many calls will be found in a supplement published with the January 7th issue.

**"W.F." (West Hartlepool)** *asks (1) If it is possible as an ex-service man to get assistance in taking a course of wireless. (2) What address to apply for this help.*

(1) We do not know of anything being done in this way, but should advise you to apply to the Ministry of Pensions.

**"F.W.F.L." (Chichester)** *asks (1) If a stage of H.F. will be better than a stage of L.F. for getting* **PCGG.** *(2) If the tuner described on page 439, October 15th, will be suitable for the reception of concerts. (3) If a condenser "C" in his diagram is necessary. (4) If a 1/1 ratio will be all right for a transformer in the circuit.*

(1) The H.F. will be distinctly the better. For circuit, see Fig. 1, January 7th issue.

(2) Yes, if proportions of coil are suitable.

(3) "C" is necessary and capacity should be about 0·001 mfd.

(4) "T" may be of ratio between 1/1 and 1/3.

**"S.G.S." (Langley Mill)** *asks (1) If a crystal set sketched is suitable for* **PCGG.** *(2) For size of a frame aerial for it. (3) If not suitable, for advice for improvement.*

(1) A crystal set is quite useless for this station at such a distance.

(2) A frame aerial is quite useless for use with a crystal set.

(3) To get this station you would require at least three valves with an outside aerial. For good results with a frame aerial on any stations not in the immediate neighbourhood you would require still more valves.

**"RENRUT" (Cambridge)** *asks (1) For a simple crystal circuit with valve magnification. (2) Whether Poldhu transmits on 2,800 metres C.W.*

(1) The most efficient way to use a valve and crystal is with the valve as H.F. Amplifier followed by the crystal as Detector. For circuit see diagram (Fig. 1).

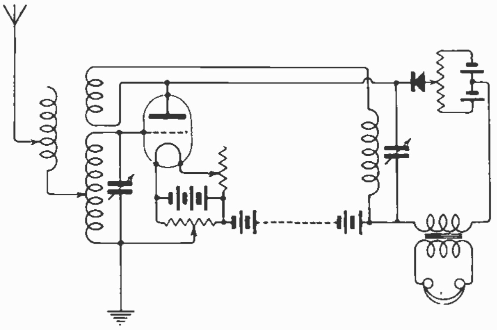

*Fig. 1.*

(2) We believe the bulk of Poldhu work is still done on the spark set, but the station possesses a C.W. transmitter which is probably used at times on this wavelength.

**"G.M." (Birmingham)** *asks for information for a simple set, preferably crystal, which he can use with a very small aerial.*

A frame will be useless to you without several valves, even a crystal will be very poor on so small an aerial as you suggest. One of the best sets you could try would be "A School Receiving Set" described in the issues of September 17th and October 29th last.

**"HIGH FREQUENCY" (Birmingham)** *asks (1) If it would be possible to add a stage of H.F. for his detecting valve panel. (2) If so, for connections. (3) If a Weston relay is suitable for wireless recording.*

(1) and (2) Yes, this can be done. See diagram (Fig. 2.)

(3) Yes, for fairly light duty at slow speeds.

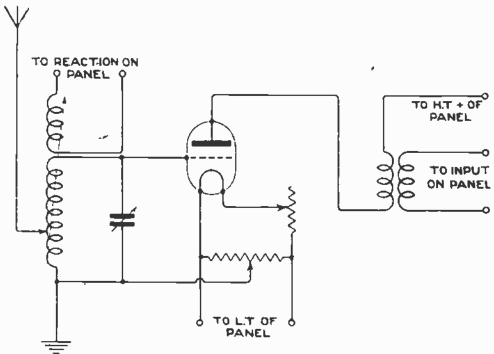


*Fig. 2.*

**"R.L." (Dulwich)** *sends a circuit for criticism and asks (2) If a variable condenser of 0·0002 mfd. would be suitable for it. (3) For dimensions of reaction coil. (4) How to tap the A.T.I. without unwinding it.*

(1) and (4) You will not be able to tap the A.T.I. without unwinding it, but you might fit a slider to it. This would improve the set by allowing you to connect the slider to the aerial, putting the condenser and also the filament and grid across the whole coil. This would greatly reduce the re-radiation and give better tuning.

(2) Yes.

(3) 5″ × 5″ of No. 28.

**"H.J." (Tunstall)** *asks (1) How to stop a 6-valve set from oscillating. (2) If he can receive 180 metres on the set. (3) If not, why not. (4) If there is anything wrong with the loud speaker which only gives a few signals weakly.*

(1) Try weakening the reaction and all couplings in the circuit; also keep the input and output leads of the valves as far from each other as possible.

(2) and (3) You should do so if the sizes of the coils, about which you say nothing, are suitable.

(4) Without more detailed information we cannot suggest the cause of the trouble.

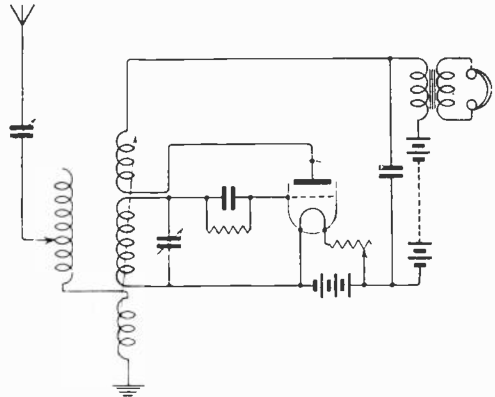

*Fig. 3.*

**"V.D.B." (Reading)** *asks various questions on the circuit on page 396, September 17th issue.*

The best way of coupling the receiving coils is to line them up on one axis as shown in your second sketch: the closed circuit coil being in the middle, reaction at one end and A.T.I. at the other. If this is done, it is generally best for the A.T.I. not to come right over the closed circuit coil. Alternatively, the A.T.I. may be taken further away from the closed circuit coil and coupling between the two circuits obtained by a small coupling coil connected in series with the A.T.I. and sliding inside the closed circuit coil.

**"F.M." (Sydenham)** *has a coil 4″ × 3″ wound with No. 18, and asks (1) If it can be used as a secondary of a loose coupler. (2) For suitable dimensions of a primary for use with it. (3) What gauge wire for the primary. (4) Range of wavelengths the loose coupler would have.*

The coil suggested would be quite good for short wavelengths, but would not give above about 750 metres. A suitable primary to use with it would be 5″ × 4″ wound with the same size wire.

**"——" (Acton)** *hears Croydon telephony but cannot hear local short wave concerts. He asks why.*

This is probably because your circuits were not tuned to a short enough wavelength, without the use of so little inductance that you obtained too little coupling. Try a series condenser in the aerial and a smaller closed circuit condenser.

**"H.H.R." (Bristol)** *asks for a circuit with dimensions of parts for best single valve receiver.*

See diagram (Fig. 3) for a very good circuit. Dimensions can be:—A.T.I., 8″× 6″ of No. 24; aerial coupling coil, 4″× 3″ of No. 24; closed circuit inductance, 7″× 5″ of No. 26; reaction coil, 5″× 3″ of No. 30; A.T.C., 0·002 mfd.; closed circuit capacity, 0·0005 mfd.; blocking condenser, 0·0015 mfd.; grid condenser, 0·0005 mfd.; leak, 3 megohms.

**"TRIUMPH" (Heckmondwike)** *sends diagram of set and asks* (1) *If the wiring can be improved.* (2) *If he should get good telephony.* (3) *Where to put a vernier condenser.* (4) *Why he can only get signals on 5 out of 8 slab coils in his set.*

(2) Almost immaterial. If you use transformer H.F. we should use transformer L.F., and similar for resistance coupling.

(3) Presence of black colour does not necessarily prove great hardness, but it is generally found in hard valves.

(4) Depends very largely on the type of circuit used. A current amplification of five times is very fair.

**"DORPITE" (Transvaal)** *refers to a condenser given on page 524, and asks* (1) *How the capacity is calculated.* (2) *For the capacity of another condenser.*

(1) The formula used is $C = \dfrac{N K A}{4 \pi d \times 900{,}000}$

where $N$ equals number of spaces between foils, in this case three, $K$ is the specific inductive capacity (mica = 6 approx.), $A$ is the area of the overlap of the

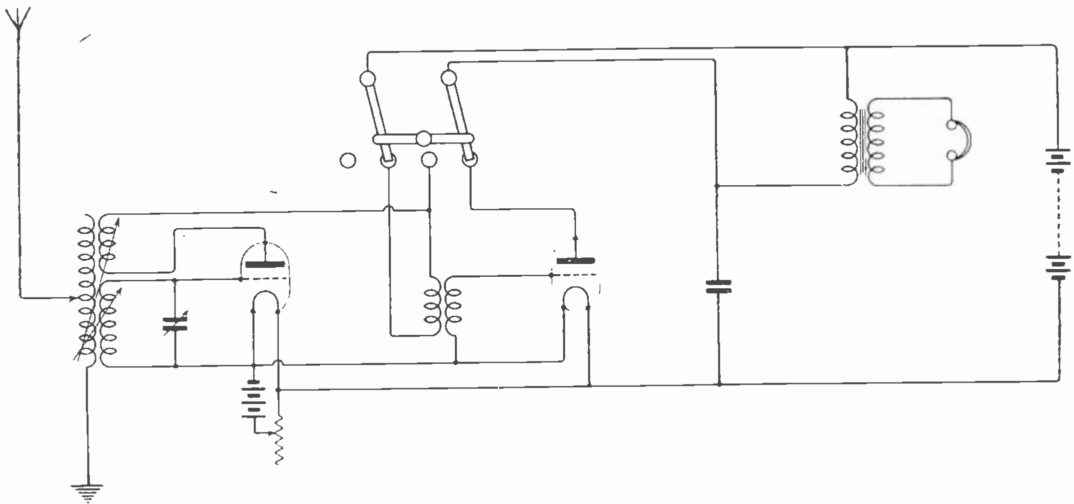

*Fig.* 4.

(1) Wiring is correct.

(2) Fair; but it would be better to have more H.F. and less L.F.

(3) In parallel with A.T.C. You should also have a condenser across primary of the first L.F. transformer.

(4) Coils are obviously defective, but we cannot say exactly how without examination. They may have a break in them, or more likely have a few turns shorted. The presence of shorted turns can be immediately detected if tuning is very flat on buzzer or similar signals.

**"R.J.S." (Catford)** *asks* (1) *For a diagram of a 2-valve set with a switch to cut out the H.F. amplifying valve.* (2) *If an L.F. magnifier is added, should it be transformer or resistance coupled.* (3) *If valves having a black appearance are hard or soft.* (4) *Approximate amount of amplication for one stage of H.F.*

(1) The circuit of the diagram (Fig. 4) complies with your requirements, but we do not particularly recommend any switching method.

plates, *i.e.*, 9 sq. centimetres, and $d$ = the thickness of the dielectric in centimetres, which is 0·004 × 2·54. This gives

$$C = \frac{3 \times 6 \times 9}{4 \times 3{\cdot}14 \times 004 \times 254 \times 900{,}000} = \begin{matrix}0{\cdot}0015\\ \text{approx.}\end{matrix}$$

(2) Using exactly the same formula the capacity of this condenser is 0·0037 mfd.

**"E.P." (Sanderstead)** *refers to Fig. 2, page 584, of December 10th, and asks* (1) *If a single slide tuner could be used.* (2) *Which is the reaction condenser.* (3) *If a sample of wire sent is suitable for a lead-in.* (4) *If set is suitable for* **PCGG.**

(1) A single slide coil may be used for the A.T.I. if a reaction coil to slide inside the A.T.I. is provided.

(2) Strictly speaking no condenser in this set is a reaction condenser. Reaction is obtained by the coil across Condenser 3, which is better omitted. The coil need not have a slider.

(3) Yes.

(4) Just possible with very careful handling.

**"C.M." (Worthing)** *has three valves, a single layer inductance, two condensers and H.R. telephones, and asks for advice how to use them.*

You have not enough apparatus for a 3-valve set, and you will find Telefunken valves, unless of the cylindrical plate type, very poor. We should advise you to try a circuit similar to Fig. 8, page 778, March 4th issue. We cannot give size of anode coil as you do not state dimensions of your present coil. 0·001 mfd. condenser should be across the telephones and 0·0005 mfd. condenser used for the grid. A 6-volt L.T. and a 30-volt H.T. battery will be required. The circuit will only just give **PCGG.**

(2) Either resistance or transformer coupled amplifiers may be used for telephony, but the resistance type are somewhat simpler to handle.

**"R.H." (Lewisham)** *asks* (1) *If the set given on page 156, May 28th issue, is suitable for C.W., spark or telephony.* (2) *What weights of wire will be required.* (3) *Gauge and suitability of sample of wire.*

(1) Yes.

(2) For A.T.I., 12 ozs. of No. 24, and for reaction coil, 3 ozs. of No. 28.

(3) No. 30 wire, which may be used for the reaction coil if desired.

If this is done, it will probably be best to rewind the coupling coil with finer wire.

(2) Yes.

(3) Method "B" is correct.

**"Q.T.C." (Dovercourt)** *asks* (1) *How long an "R" valve should last.* (2) *If it is normal to receive* **BGL** *on* 1,000 *metres.* (3) *Wavelength range of a certain set of basket coils.* (4) *Why signals are only received on a single valve set when it is howling.*

(1) Valve filaments more often break than wear out. They are particularly liable to break if roughly handled immediately after switching off. With careful handling a valve should burn 1,000 hours at least.

(2) This station can be received on a number of wavelengths owing to harmonics which it emits.

(3) We have no information about these coils. The makers should be able to give you the information.

(4) We are unable to say without detailed examination of the set. The result may be due to a too large reaction coil; to a faulty grid condenser or to the absence of a condenser across the telephones.

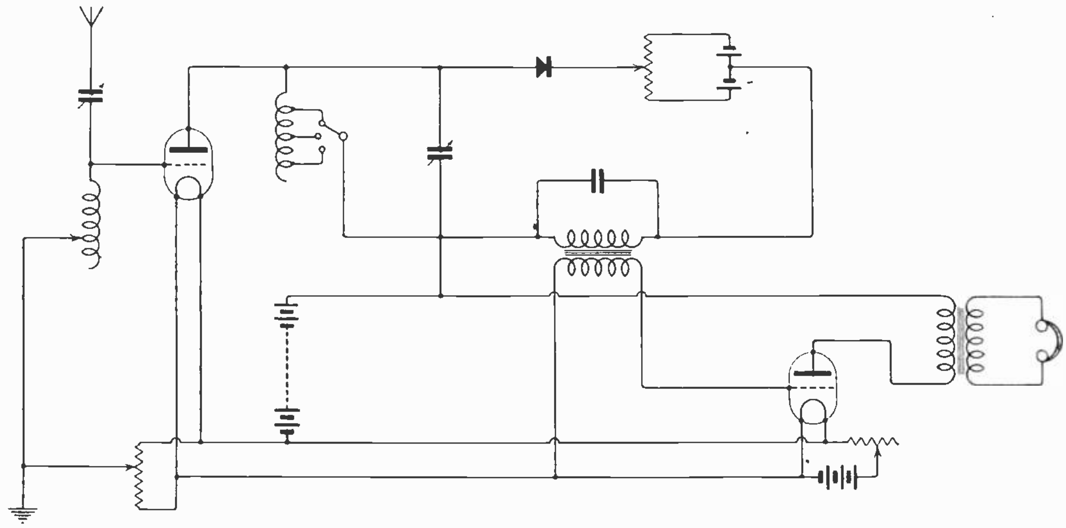

*Fig. 5.*

**"J.D." (London)** *wishes to add a note magnifier to the valve and crystal set described in April, 1920, using common L.T. and H.T. batteries.*

See diagram (Fig. 5). We regret we are unable to give you the exact differences between various of the Mark III and Mark IV amplifiers, but any of them should be suitable for use with this set.

**"H.H." (Morfa-Mevin)** *is adding a valve to a Marconi Type 16 receiver, and asks* (1) *If the coupling coil is sufficient inductance for a reaction coil.* (2) *If crystal potentiometer is suitable as grid potentiometer.* (3) *Which of two ways of connecting the aerial is the better.*

(1) This winding will be satisfactory, but owing to the smallness of the P.M.G. aerial it will be desirable to add a loading coil to the A.T.I. to get up to the maximum range of the closed circuit.

**"E.R." (Wimbledon)** *asks questions about a crystal set.*

(1) The crystal shown is wrongly connected. It should be between the condenser, as at present connected, and the potentiometer slider.

(2) For the reception of C.W. on crystal sets, see an article in the January 21st issue, but none of the methods of attacking this problem are very satisfactory.

(3) You will not get **PCGG** on this or any other crystal set.

**"K.B.S." (Campbeltown)** *asks* (1) *For size of formers for 3,000 metres.* (2) *If the reaction coil should slide in and out of the A.T.I.* (3) *For a suitable filament battery, other than accumulators ;* (4) *For criticism of circuit.*

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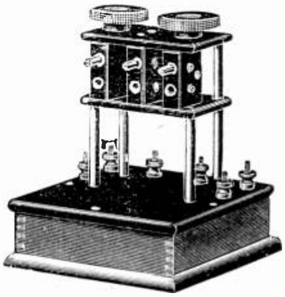

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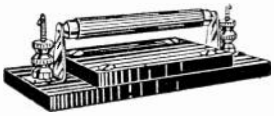

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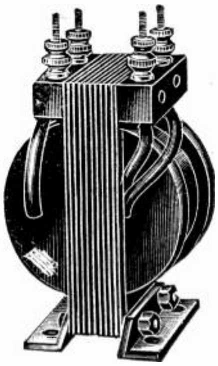

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(1) With 0·0005 mfd. in parallel with the A.T.I., this should be 5″× 8″ of No. 24. The reaction coil 4″× 4″ of No. 32.

(2) Yes; or the reaction coil may be wound on a spherical former revolving inside the A.T.I.

(3) The only alternative to accumulators is dry cells, which, if used, should be of very large size, say the Siemens' "M" size, which will give enough current for one valve for short periods. The use of dry cells would be very expensive.

(4) The circuit is all right. There is no simple switch of the type you desire. Such switches are made, but are very expensive. It might be possible to link your two switches together, but we think it hardly worth while as it is quite simple to interchange coils when required without any switching.

**"P.T.W." (Crofton Park).**—The connections of your set are incorrect. Rearrange as Fig. 3, page 585, December 10th issue. Do not use iron wire in the aerial. Unless you increase the A.T.I. the maximum wavelength will be about 1,500 metres. An indoor aerial is useless for a crystal set.

**"HOPEFUL" (Blackheath)** *asks how to add a valve to a Mark III tuner.*

An article on the conversion of this tuner for valve work was published in the June 25th issue, which can be obtained from the Publishers.

**"J.A." (Derby)** *refers to answer to* **C.C.W. (Woolwich),** *January 7th, issue and asks* (1) *Weight of wire for coils.* (2) *If A.T.I. has slider or tappings.* (3) *Ditto for secondary coil.* (4) *Wavelength range.*

(1) 8 ozs. of No. 22 and 4 ozs. of No. 26.

(2) A slider would be best.

(3) Three tappings will be sufficient.

(4) Aerial circuit 2,500 metres, closed circuit 4,000 metres.

**"J.N." (Barnet)** *asks for construction of details of H.F. transformers.*

These transformers are wound to suit the wavelength required. For information see issues of October 15th and 29th, and November 12th, 1920. Adjustment of the windings to best value should be done experimentally as it is difficult to predict them at all accurately.

**"M.E.T." (Reading).**—If No. 26 wire were used an A.T.I. about 9″ in diameter would be required with a reaction coil of about half this size, but we strongly advise the use of honeycomb coils. The dead-end switch arrangement you suggest while looking well on paper is quite useless in practice owing to the great difficulty found in making all segments make good contact at once. It is much better to use entirely different coils for different parts of the range.

**"C.H." (Sudbury Hill)** *asks for the relative advantages of grid potentiometers and grid leaks.*

These are not alternative pieces of apparatus. Theoretically, when a grid condenser is used a grid potentiometer is almost useless, but a leak essential. In practice a leak is not always found to be essential owing to accidental leaks already existing. If a grid condenser is not used a leak is of no use, and then a potentiometer becomes very desirable, especially in sets of few valves in order to adjust the valves to the best working points in their characteristics. We should advise you to consult a book on valve theory, such as Bangay's.

**"A.S.W." (Sparkhill)** *refers to Valve Panel, September 17th issue, and Panel Tuner, September 3rd issue, and asks if they will go well together.*

There is no object in mounting these two panels side by side in a box as one is simply an experimental panel, while the other is a complete coupled tuner with a valve detector. If desired an additional valve may be added to the panel tuner to give high or low frequency amplification.

**"G.D.H." (Yeovil)** *has trouble with a single valve set in which signals periodically fade away.*

You do not give a diagram of your circuit, but it would appear that you have a broken grid circuit which causes the grid to become negatively charged stopping signals until sufficient negative potential is obtained for the grid to discharge itself, after which the process is repeated. If you are using a grid condenser the resistance of the leak may be too high. For 3-valve diagram, see Fig. 5, page 706, February 4th issue. For 2-valve 2-note magnifier, see May 28th and June 25th, 1920 issues.

——— **(Harringay)** (1) *Sends crystal set for criticism.* (2) *Asks how to safeguard against lightning.*

(1) Set is wrongly connected. See Fig. 5, page 642, January 7th issue, omitting the condenser C.1. Maximum wavelength, 1,500 metres. You should get ships and **2 MT** telephony on 700 metres. Tinned iron sheets are very bad for condenser vanes.

(2) Best protection against lightning is obtained by joining the earth and aerial leads when the set is not in use. More detailed information is required before we can reply to your final question.

**"HONEYSLAB" (Coventry)** *asks* (1) *Windings for 12 basket coils for 120 to 25,000 metres.* (2) *Capacity of condenser.* (3) *If basket coils wound in and out of slots cut regularly in a piece of cardboard are as good as coils wound on a spider which can be removed when the coil is finished.*

(1) Beyond the scope of these columns. The smallest coil might have about 30 turns with a mean diameter of 2″, and the maximum, say, 1,000 turns on a number of coils each of mean diameter of 4″. With a reasonably good condenser not more than six coils intermediate between these should be required.

(2) 0·0003 mfds.

(3) This method is satisfactory if the cardboard is well impregnated with wax or shellac, but not if it is allowed to get damp.

**"D.G.L." (Southborough)** *refers to Fig. 3, page 674, January 21st issue, and asks* (1) *If suitable for spark, C.W. and telephony.* (2) *Suitable windings for 5,000 metres.* (3) *Capacity of A.T.C.* (4) *Capacity of 0·0005 and 0·0001 mfd. condensers.*

(1) Yes.

(2) A.T.I., 6″× 14″ wound with No. 26. Reaction coil, 5″× 8″ of No. 30.

(3) 0·0003 to 0·0005 mfds.

(4) For 0·0005 mfds. four foils, two each side with overlap 2″× 1″. if waxed paper is 0·005″ thick. For 0·001 mfds. four foils one side and three the other.

**"J.D.J." (Erith)** *asks if his three valve set will receive telephony if it has a reaction coil.*

It will probably receive it without a reaction coil but better still with one. We cannot give best size as you do not describe your windings.

**"T. F." (Hull)** *referring to page 533, November 26th, asks for information about the impedance amplifier there described.* (2) *Asks for windings for A.T.I. and reaction coil suitable for 160 to 1,200 metres.* (3) *Asks for a design of an H.F. amplifying panel to be added to a detecting panel, if possible to be used with a simple throw-over switch.*

(1) We have no additional information about this set, but think it probable that it is similar to a resistance capacity amplifier with iron core chokes instead of the anode circuit resistances.

(2) A.T.I. 7″ × 5″ of No. 20, no condenser being necessary. Reaction coil 4″ × 4″ of No. 26.

(3) Without a diagram of your panel we cannot be certain that this can be done. If it is possible, the connections would be on the lines of the diagram (Fig. 6) which will show you how your panel should be rearranged if necessary. Switching in of the additional stage would need a complicated and expensive switch liable to give trouble in various ways, and is not recommended.

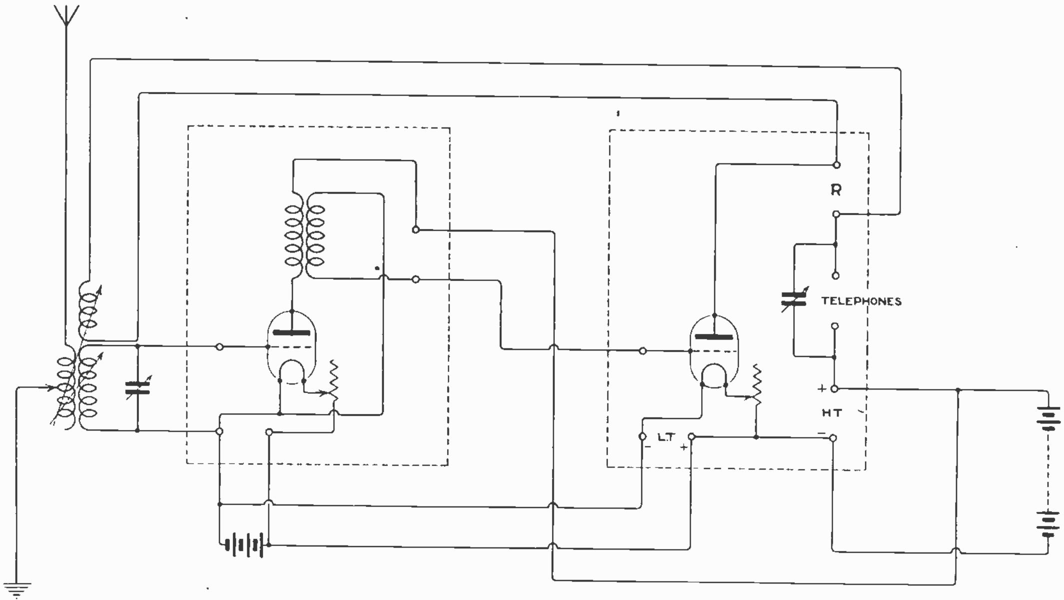


*Fig. 6*

**"AUDION" (Abercynon)** *asks* (1) *If a circuit sketched is satisfactory.* (2) *If 120 ohms telephones would be satisfactory with a telephone transformer.* (3) *What make of valve we recommend.*

(1) Yes, except that a condenser is required across the H.T. battery and telephones. (2) Yes.

(3) Any of the advertised makes are quite satisfactory. One of the type known as "French" would be satisfactory.

**"T.A.T." (East Acton)** *wishes to make an electrostatic receiver on the lines of that described in July and August issues. He asks* (1) *The best material to use.* (2) *Suitable polarising voltage.* (3) *If a gramophone motor would be suitable for the drive.*

(1) Many different forms of this apparatus have been tried, none of which are very satisfactory. The Rahbek form will give good results with a polished agate cylinder. This will be difficult to obtain and very expensive. On the whole, the oil dielectric form will probably suit your purpose best.

(2) For the Rahbek form the polarising E.M.F. should be about 200 volts; for the oil form it is not necessary.

(3) This spring would only be useful for experimenting on a small scale, as considerable force is required to drive these instruments.

**"P.S." (Ramsgate)** *sends a two-valve circuit with a resistance coupling and asks* (1) *For the value of the resistances.* (2) *Particulars for making them.* (3) *Whether the grid leak is necessary.*

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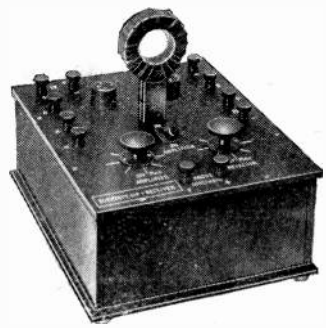

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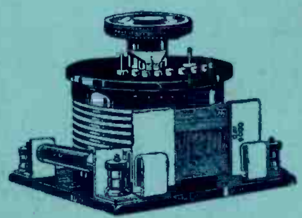

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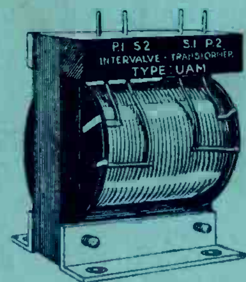


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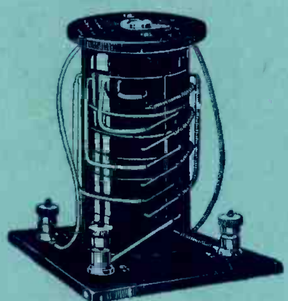

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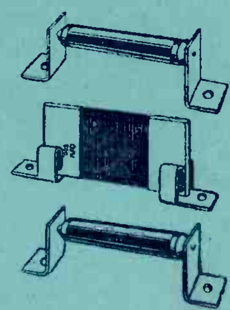

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# THE WIRELESS WORLD
## AND RADIO REVIEW

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A MAGAZINE DEVOTED TO WIRELESS TELEGRAPHY AND TELEPHONY

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THE
# WIRELESS WORLD
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THE OFFICIAL ORGAN OF THE WIRELESS SOCIETY OF LONDON

VOL. X. No. 4. APRIL 22ND, 1922. WEEKLY

# Faults in Valve Circuits: Diagnosis and Cure

By G. P. KENDALL, B.Sc.

IT is probable that the characteristic which most clearly distinguishes the seasoned wireless man from the novice is the former's power of quick location of the faults which occur from time to time on amateur-made sets; it often seems quite miraculous to the beginner to see how an experienced friend will don the telephones, switch on, say "something wrong," and put his hand on the trouble in a few seconds. This kind of thing, of course, is not really done by means of second sight, but by the use of two things, the first and most important being a systematic method of testing the set circuit by circuit, and the second a wide experience which enables one to recognise the indications given in the telephones by particular types of faults.

I hope, in the lines which follow, to show how a suitable series of tests may be worked out for any simple type of set. I say *simple*, because it is usually the owner of such a set who needs assistance; the man who runs a six-valve set has generally become fairly expert at locating faults. There is, it is true, another type who buys or makes, say, a three-valve H.F. amplifier, sticks it on to a loose-coupled tuner, and expects to get the Dutch concert without previously finding out the subtle difference between inductance and capacity, and whether the latter is best measured in litres or pints. This type of amateur, however, does not command my sympathy, and is really too difficult a person to cater for within the limits of a W.W. article.

The following examples show typical series of tests for locating faults in various common receiving circuits, and I think the reader will have little difficulty in adapting them to his own particular set.

Since the method of testing to be described is based almost entirely upon indications in the telephones, the first thing to do is obviously to make certain that they are sound. (With a pair of reliable make, in daily use, it is fairly safe, however, to assume that they are O.K., and proceed with the next test.) Place the tags across *one* small dry cell. A loud click should be heard on making and breaking the circuit. No click in either earpiece indicates a disconnection in either windings or cords. Short circuit first one and then the other earpiece and test again. If the disconnection (hereinafter called a "dis.") is in one earpiece it will be located by this method, but if the tests still give no result it means a fault in either the cords or *both* telephones. Settle the point by replacing the cords with sound wires and test again. A click in one earpiece only when testing across a cell indicates a short-circuit in the *other*; or in the cords leading to it. Replace cords with temporary leads, as before.

Assuming that the telephones have been proved to be in order, we will now proceed to consider the testing of the actual receiver circuits.

### 1.—SINGLE VALVE AUTODYNE CIRCUIT.

(1) Switch on L.T. If the valve does not light, the fault is in the circuit shown with a full line in Fig. 1. Examine valve filament. If apparently

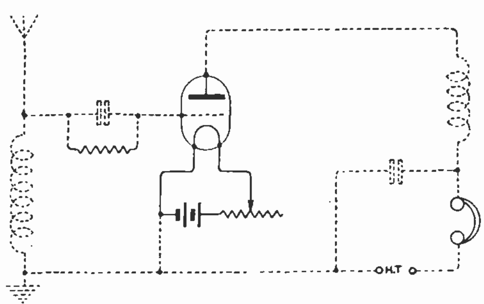



*Fig.* 1.

sound, pull the valve from its socket and open out the split pins carefully with a knife, to ensure their making contact in the socket. Replace valve and try again. If it still fails to light, replace it with another. If there is again no result, examine connections of L.T. circuit, especially the soldered ones on the valve socket.

(2) Switch on H.T. (with L.T. off). A good loud click should be heard in the telephones, as a result of a charge passing into the by-pass condenser C. No click indicates a dis. in the circuit shown with a full line in Fig. 2. A likely spot is the by-pass

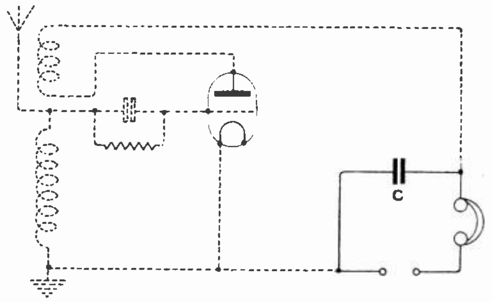



*Fig. 2.*

condenser itself. A very loud click followed by rushing and rattling noises indicates a short circuit, also very probably in the blocking condenser.

(3) With H.T. on switch L.T. on and off. A click at " on " and another louder one at " off " should be heard. No result means a dis. in the circuit shown with a full line in Fig. 3. Examine connections of reaction coil and open plate pin of valve. If this does not clear the fault change the valve.

(4) Switch on L.T. and H.T. and tighten reaction coupling until the set oscillates (or doesn't, as the case may be). If no oscillation results, reverse the connections of the plate coil (unless you are certain they are correct), and try again. No response indicates a fault in the circuits shown with a full line in Fig. 4.

(*a*) Variable condenser may be short circuiting (not very likely with one in ordinary continual use). Take it out of circuit and test by placing in series with telephones and a cell. With the capacity at minimum a *faint* click should be heard at make and break.

(*b*) A dis. between X and Y. This is best recognised by noting what sort of sound is audible in the telephones. If any interference from power or lighting mains is normally heard it will probably come in much louder when such a fault occurs. (Try it and see, because this is a most useful indication.) Check connections carefully, and if necessary test tuning coils for continuity with cell and telephones.

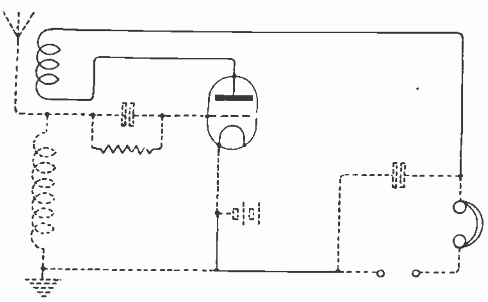


*Fig. 3.*

(*c*) Short circuit from X to Y. Unlikely and rather difficult to locate, there being no simple and universally applicable test.

(*d*) Dis. between X and grid of valve. This, again, produces much increased humming from A.C. mains, if any is usually heard. Likely places are pin of valve, soldered connection on the socket, and grid condenser.

Finally, if the set will receive spark signals but refuses to oscillate, although none of the above-mentioned faults appear to be present, it means in all probability that the filament accumulator is run down.

This completes the list of actual faults (the commoner ones, at least), but there remain three troubles which can hardly be classed as faults, since they do not cut out signals entirely, but nevertheless are capable of causing a great deal of wear and tear of the experimenter's temper. They are commonly known as " Overlap," " Howling," and " Artificial Thunderstorms."

*Overlap.*

This condition prevents many novices from getting satisfactory results, because they fail to recognise that anything is amiss with their sets. A circuit is said to be suffering from overlap when it is very difficult to adjust to the point required for the proper reception of telephony, that is, to a point just short of the beginning of self-oscillation. As the reaction coupling is tightened the set quite

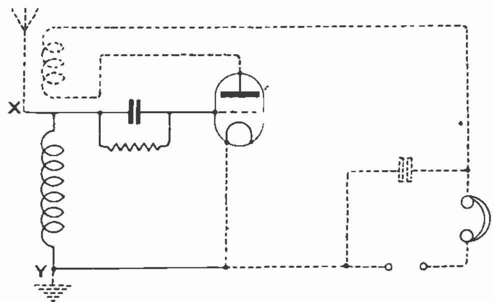



*Fig. 4.*

suddenly starts to oscillate, generally with a loud click. Then, to stop it, one has to weaken the coupling much beyond the point at which oscillation began, so that when it finally ceases the set is far from its most sensitive adjustment, and little can be heard. Even if, by patience and luck, one succeeds in getting the right coupling adjustment one's troubles are not over, for the set is then in a very unstable condition, and any strong signal or atmospheric will start it off oscillating. The usual causes are too much or too little plate voltage or filament current, or too low resistance in the grid leak.

*Howling.*

May be due to an unsuitable grid leak, too much plate voltage, too much wire on the reaction coil, etc. Results in shrieks and howls when the reaction coupling is tightened beyond a certain point. Not a very serious trouble, being chiefly trying to the nerves of the operator. Indeed, a certain tendency to howl when the reaction is too strong is rather desirable from one point of view; it would stop many amateurs from making a nuisance of themselves in their misguided efforts to receive telephony.

*Artificial Thunderstorms.*

The name indicates sufficiently clearly what the symptoms of this trouble are like. It is often very puzzling to the novice, because the possible causes are so numerous. These are some of the likeliest :—

(*a*) Bad or run-down cells in the H.T. battery. If the battery is composed of $4\frac{1}{2}$ volt refills, test through with a flash-lamp bulb and cut out any cells which do not give a light. In the case of 15 volt units try cutting out each unit in turn until you find the one which is making the noise. The same tests will locate another possible cause, namely, a bad connection in the battery.

(*b*) A loose contact almost anywhere, but generally in the plate circuit. Test by striking the instrument table. If this results in a particularly heavy peal, look for loose wires, tighten terminals, see that switch contacts are clean, and so on. This test, by the way, is quite a useful one, and can be applied so as to locate loose contacts in various parts of the set. It is so popular with some experimenters that I am told that not merely do they wear their tables into holes, but that this is the true source of the emphatic style of some wireless lecturers !

(*c*) Defective grid leak. Cut it out and see if the noise stops.

(*d*) Charged rain falling on the aerial. This is by no means so rare as was thought in crystal days. Disconnect the aerial and note whether the noise continues.

II.—MULTI-VALVE CIRCUITS.

It will be seen from the foregoing that it is a fairly simple matter to work out a series of tests for any single-valve circuit. When a series is required for a receiver employing more than one valve, however, it is not quite so easy. The guiding principle in such a case should be to test each valve and its circuits separately, beginning with the valve whose plate circuit contains the telephones and finishing with the one which is connected to the tuned circuits. Testing by this method is greatly facilitated by the provision of separate H.T. and L.T. switches for each valve. The following examples are intended more as illustrations of the method than as an attempt to cover all the possible varieties of simple circuit :—

*A.—Rectifier and one note magnifier.*

(1) Test note magnifier filament circuit as before.

(2) Switch on H.T. Strong click should be heard in the telephones, as in the case of the rectifier circuit. (*Note.*—This test does not work without the condenser C, whose presence is desirable for this reason and because it often clarifies telephony considerably.) No click means a dis. in the part of Fig. 5 shown with a full line.

(3) With H.T. on, switch L.T. of the note magnifier on and off. Clicks indicate that the plate circuit is O.K.

On the completion of these tests it is generally safe to assume that the note magnifier is working satisfactorily, since faults in the grid circuit are somewhat unusual. If it is suspected that one is present, test for it by connecting a cell to the intervalve transformer primary. Loud clicks should be heard at make and break if the L.F. amplifying circuit is free from faults. The rectifier and its associated circuits can now be tested exactly as before.

*B.—One H.F. Amplifier, Rectifier.*

(1) Test rectifier circuits as given previously. (Nos. 1-3. Note also (4) *d.*)

(2) Test filament circuit of H.F. valve.

(3) With H.T. to both valves on and filament of rectifier alight, switch the H.F. valve filament on and off. Clicks indicate absence of faults in H.F. amplifier plate circuit.

(4) Test the tuned circuits and grid circuit of the H.F. valve as in Test (4) of the single valve series.

*C.—One H.F. Amplifier, Rectifier, one L.F. Amplifier.*

(1) Test the circuits of the L.F. valve as in *A*.

(2) With H.T. and L.T. switched on to the L.F. valve test the rectifier circuits as in *B* (1).

(3) With H.T. and L.T. switched on to both note magnifier and rectifier test the H.F. circuits as in *B* (3) and (4).

This completes the set of examples, since circuits employing more than three valves can hardly be classed as simple, while the other possible simple types of one, two, or three valve circuits may be tested in a very similar way to those dealt with ; I think the reader will have little difficulty in making the necessary modifications, and once they are made he will be in possession of a set of tests which will go far towards removing the feeling of helplessness which is apt to seize the novice as he sits and looks at a set which appears to be O.K., but which refuses to yield a sound in response to his efforts.

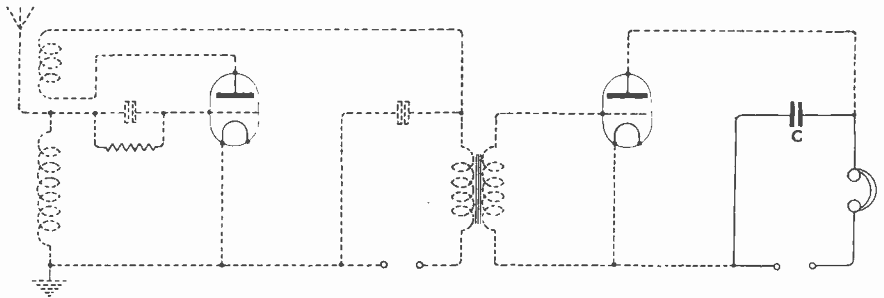



*Fig. 5.*

# The Modern View of Electricity and the Three-Electrode Valve

By G. G. Blake, A.M.I.E.E., A.Inst.P.

(*Concluded from page 73.*)

WE will now see what practical use can be made of the information we have just gained, and at the same time try and picture what actually happens to the electrons in the valve, as the grid voltage is varied.

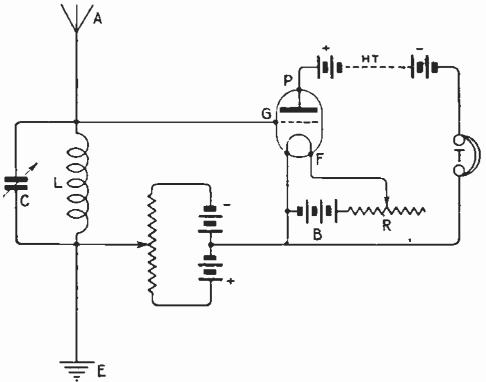



*Fig.* 6.

Fig. 6 shows a valve coupled up to an aerial circuit. For each spark at the distant transmitting station a train of waves reaches the receiving aerial, causing a high-frequency alternating current in the aerial tuning inductance, so that if our potentiometer is set at zero, the grid of the valve changes from positive to negative, say some 9 or 10 times with diminishing amplitude. If we have arranged for the valve to function at the centre of the straight portion of its curve, these fluctuations of grid voltage will produce exactly similar fluctuations in the plate current, having the same frequency but much greater amplitude, and the valve will be functioning as a high frequency amplifier. We shall, however, hear nothing in the telephones, as the amplified currents are at a frequency above audition (that is at radio frequency).

In order to hear the signals in a telephone, we should have to pass them through either a crystal, or other form of detector, working either at the top or bottom end of its curve, in order to rectify them.

Of course, if instead of connecting our grid to a circuit alternating at radio frequency, we connect it to a circuit alternating at audible frequency, we should obtain audio-frequency amplification or note magnification.

Fig. 7 indicates diagrammatically a mechanical illustration which I have devised to show the action of incoming oscillations upon the grid and plate current of a valve. These oscillations are represented by the movement of a cotton thread held in position by a frame (*see* fig. 7) which can be made to oscillate. The cotton rubs against a small disc representing the grid of valve, causing a spring, which represents the plate current, to oscillate also.

If the disc is on zero line, it will oscillate equally above and below it, see characteristic curve of valve at top of slide. If we render the grid more negative by a small weight, at every downward oscillation, obviously our plate current spring cannot move far ; but at every upward or positive half oscillation it is free to move.

Note the characteristic curve on the right of Fig. 7.

Our valve is now functioning at the lower end of its characteristic curve.

If we imagine the top of the spring to represent the filament, and its bottom, the plate, and movements above zero to be negative, and below positive, the effects will be reversed and the device serves to illustrate a valve functioning at its upper bend, and a decrease in grid potential will make a decrease in the plate current, while an increase produces only very slight increase.

Let us once more consider the conditions in the bulb of our valve. When we are working at the lower end of its characteristic curve, the filament is emitting more electrons than the positive potential of the plate is able to neutralise, and a cloud of electrons congregate round the filament, forming a space charge, which for any particular filament heat, and plate voltage, remains constant. The plate continually draws off all the electrons it requires, which are being continually replenished at the same rate from the filament. If we impress an alternating current on the grid, during the positive half of each oscillation, the grid attracts, and is able to neutralise a fairly large number of electrons in the space charge, and so for the moment a larger quantity are able to leave the filament.

At the negative phase of its alternation, the negative space charge repels the electrons on the grid, and very little alternation in the plate current occurs.

If we arrange the valve to function at its upper bend, we have these effects exactly reversed.

The space charge is now almost removed by the positive plate voltage, and if we make our grid more positive, very little effect occurs, as there is practically no space charge to remove. If, however, we make the grid negative, it creates an artificial space charge, and shuts off a large part of the plate current.

It is obviously better to employ the lower end of the curve for reception, so that each oscillation gives an increase of plate current, than it is to use the upper bend where a large current is passing through the plate circuit and telephones all the while, except during the reception of signals. In the latter case, as the grid has to be positive, a wasteful grid current is likely to be flowing which has a damping effect on the oscillations.

When the valve is functioning at the lower end of its curve each train of oscillations will cause a slight pulse of increase in the plate current, through the telephones, and this rise and fall of current occurs once during each complete wave train, at an audible frequency, which can be heard.

On the left of Fig. 8 is a diagram of probably the most popular single valve circuit at present employed. On the right are the connections necessary in order to add one stage of note-magnification, working from the same high tension, and low tension batteries. We will at present confine our attention to the single valve receiver. The various parts of the apparatus are so well known, that I need not describe them.

oscillation, until the wave train dies out, so that a steady negative charge gradually builds up on the grid, which, as already explained, repels the electrons emitted from the filament, and so reduces the plate current. At the termination of each group of incoming oscillations, the charge in the grid leaks off through the grid leak, and the grid and plate current return to their normal potentials. This comparatively slow decrease and rise of current produces an audible note in the telephones.

It should be noted that in addition to this comparatively slow building up of a negative grid potential, the grid potential also fluctuates at radio-frequency, which causes a radio-frequency rise and fall of the plate current through the phones; this current is, however, inaudible. Its amplitude is increased if we place a condenser across the telephones and H.T. battery, to make a path of low impedance.

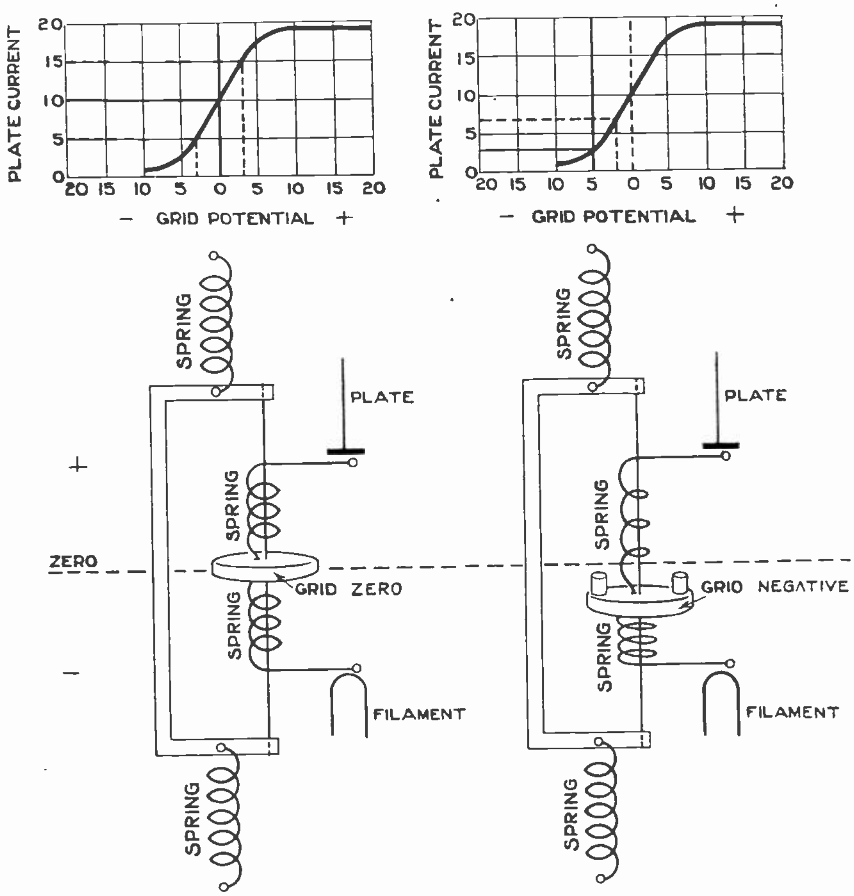



*Fig. 7.*

We will first examine the function of the grid condenser, and whilst so doing let us imagine that the reaction coil is removed so far from the aerial tuning inductance that it does not react.

The action of the grid condenser is somewhat as follows :—When the incoming oscillations tend to charge the grid negatively, no current flows from the filament to the grid ; but when the positive half of each oscillation passes into the grid, some of the electrons from the space charge pass into that plate of the condenser connected to the grid. This happens during the positive half of each

Again, referring to the Fig. 8, let us imagine that the reactance coil has been brought within range of the aerial tuning coil. It will now be seen that the received oscillations cause high

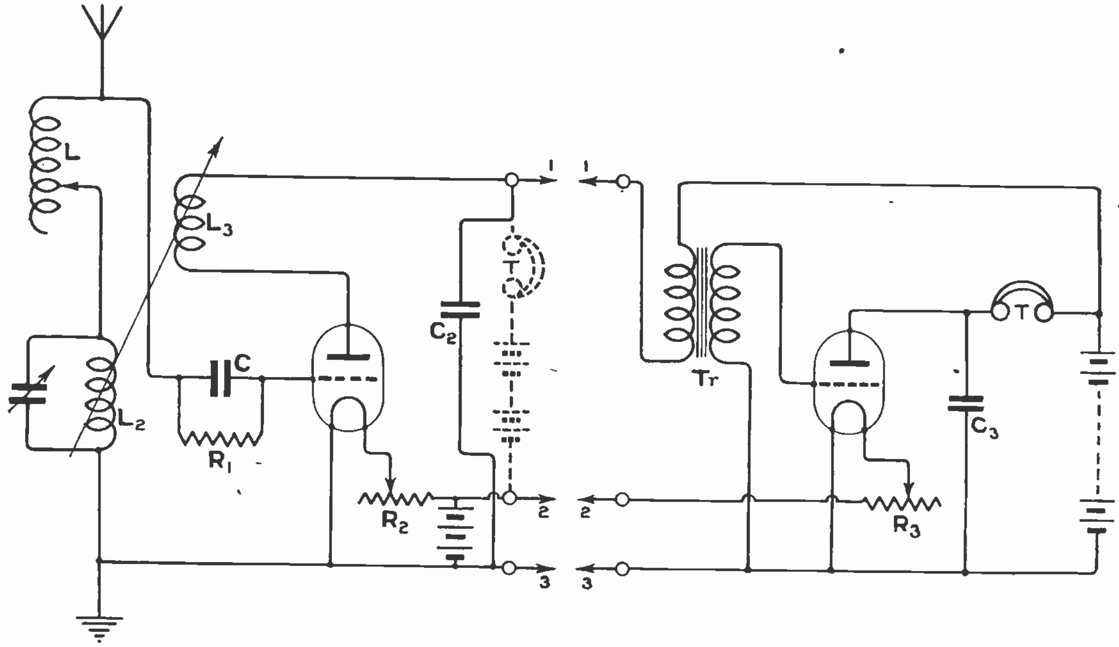



*Fig.* 8.

frequency fluctuations of grid potential (while the grid condenser is building up its negative charge). These are repeated in the plate circuit, and consequently they pass through the reactance, which by simple transformer action induces similar H.F. currents in the aerial tuning inductance, which amplify the oscillations already induced therein by the ether waves. (It should here be mentioned that it is absolutely essential to place the reactance the right way round, or it will wipe out the aerial circuit oscillations instead of amplifying them. Owing to the increase of the amplitude of the oscillations they will obviously persist longer in the receiving aerial; that is to say there will be more oscillations per wave train. Fig. 9 may make this clear.

If the coupling between the reactance and the aerial inductance is made very tight, the valve

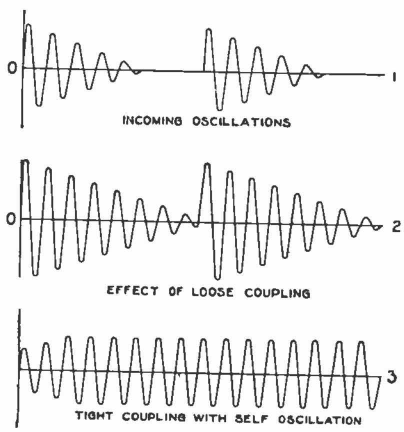



*Fig.* 9.

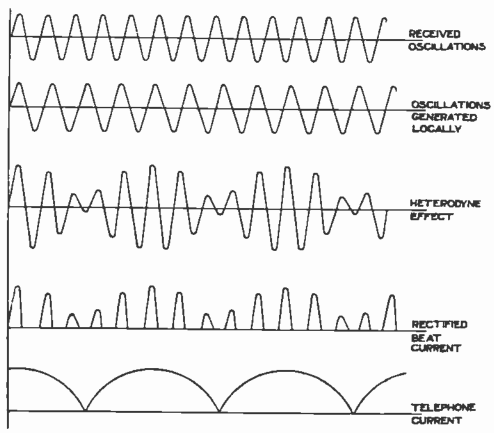



*Fig.* 10.

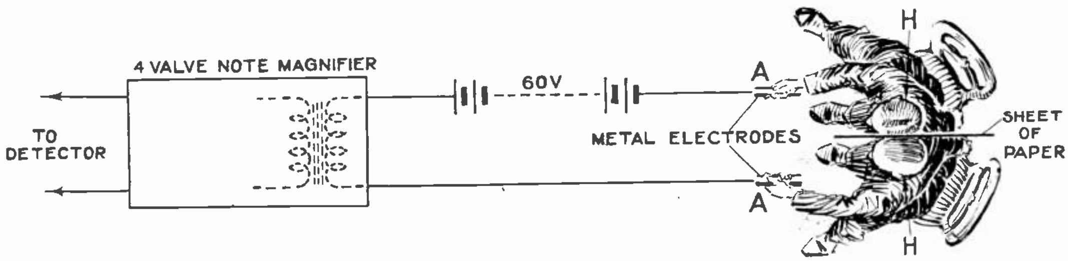



*Fig.* 11*a*.

oscillations never die out, and the valve is in a state of self-oscillation.

If we listen in a telephone while we vary the coupling between reactance and aerial inductance from zero to tight, we shall note an increase in the strength of signals as the reactance is increased; but at a certain point the signals lose their original note, and though they become much louder, their note becomes very harsh. This is because the valve

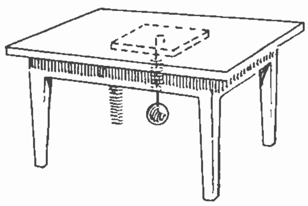


*Fig.* 11b.

has commenced to oscillate and is now generating oscillations. The harsh note is caused by beat effects between the two sets of oscillations, those rom the incoming waves, and those generated by he valve. This effect is known as heterodyning, and is made use of in receiving C.W. signals.

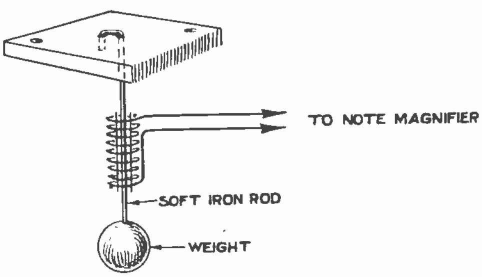



*Fig* 11c.

A valve is most sensitive in the reception of telephony when it is just on the point of generating oscillations.

For the reception of C.W. signals heterodyning affords the best method of reception. The waves themselves arrive at an inaudible frequency, and if we tune our receiving circuit so as to be just slightly out of tune with them, the beats produced by the two sets of oscillations will occur at an audible frequency.

(A mechanical lantern slide was shown at the meeting to illustrate the form of the wave motions illustrated in Fig. 9.)

In Fig. 10 are a number of graphs showing :—

(1) The received oscillations.

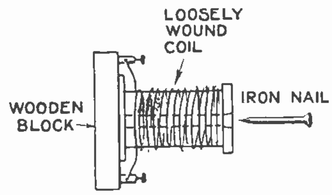



*Fig.* 11d.

(2) Local oscillations set up by valve.

(3) Heterodyne effect, and how, where the oscillations come into step, a greater amplitude is reached, due to reinforcement, and when out of phase, a reduction of amplitude occurs, due to interference. This graph is not quite correct as it does not show the change of phase which occurs.

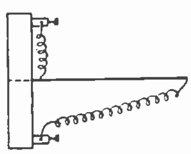


*Fig.* 11e.

(4) Shows the rectified unidirectional current.

(5) The rise and fall in plate current, which operates the telephones.

I will now give a brief description of the note-magnifier shown in the diagram, on the right-hand side of Fig. 8.

We must imagine the H.T. battery and telephones shown by dotted lines removed to the plate circuit of the second valve, and the three terminals, 1, 2 and 3 connected together.

Every rectified pulse from valve No. 1 now alters the potential of the grid of valve No. 2, which faithfully reproduces every current change with increased amplitude in the plate circuit of the second valve.

This really concludes my lecture, but I have fitted up one or two telephone curiosities, which I have adapted to wireless uses, and which I thought would probably be of interest.

Figs. 11a to 11e show several rather novel methods of hearing wireless telephony and signals.

(1) If two persons hold a handle each, and are connected in series with the secondary of the output transformer of a 4-valve note-magnifier and a small H.T. battery, and place a sheet of thin paper between their heads as shown, they can both of them quite easily hear signals or speech. I have received music by this method at my station.

(2) If a person holds his hand on one side of a sheet of paper placed against the ear of another, the speech is heard by the listener. This effect is undoubtedly electrostatic.

(3) The paper can be dispensed with if the hand wears a thin leather glove.

(4) The voltage used is sufficient to overcome the resistance of a circuit consisting of several persons holding hands interposed between the two listeners and each of the handles, with very little diminution of signal strength.

(5) Another variation is for, say, three people to listen at once, connected up in cascade as follows:—No. 1 holds one handle from the note magnifier and places his free hand against a sheet of paper over No. 2's ear; No. 2 places one hand against a paper over the ear of No. 3, who holds the other handle from the note magnifier.

(These experiments were shown at the meeting.)

I have arranged another experiment based on Ader's telephone. Below the top of this table there is a light weight, suspended by a thin soft iron rod. A small bobbin wound with fine wire to the same resistance as the secondary of the transformer of the note magnifier, fits loosely round this rod, and is connected to the output transformer from the note-magnifier. The signals cause slight changes in the length of the iron, due to magnetisation, and any number of people who place one ear against the table are able to hear the signals. Ader's telephone, which led me to think of this experiment, is shown on the diagram, also two other very crude forms of telephone, which may be of interest.

(1) Very weak reproduction can be obtained with a loosely wound bobbin, in which is placed an iron core. (2) A straight length of soft iron wire, fastened at one end in a block of wood, will just allow sounds to be extremely weakly detected when connected as shown.

In conclusion, I wish to thank Mr. Pickering, my assistant, for the great help he has rendered me in the preparation of this lecture, also Mr. Hope-Jones, who very kindly prepared the two mechanical slides in a great hurry at the last moment.

## DISCUSSION.

**The President.**

This very interesting lecture is now open for discussion.

**Mr. P. R. Coursey.**

I am sure all present this evening must have been very interested to hear Mr. Blake's description on the action of the valve. When we use valve circuits every day we do so, perhaps, without thinking what happens in the valve itself. It is therefore very enlightening to spend a moment to reconsider where we are and to consider what is happening inside the instruments we are using.

The mechanical analogy of the valve using a frame and the threads and springs which he described is extremely interesting, and I think perhaps some day he ought to be persuaded to rig up the apparatus in this Lecture Hall and give a demonstration to the Society. I am sure we should all be interested to see it, and feel that it could be used to show up many of the phenomena which occur in the valve, with very slight modifications made in it.

He referred in his lecture to the voltage amplification factor of the valve. He asked me, before the lecture, to give a description of a little instrument which I had made up the other day for measuring in a simple way that voltage factor without any complicated apparatus. If I may just describe it on the blackboard it will perhaps be clearer. As Mr. Blake has already told us this evening, the voltage amplification factor of the valve is the ratio of the change which must be made in the high tension battery in order to keep the anode current constant to the corresponding change which is made in the grid voltage. Hence, if we rig up a potentiometer across some suitable source of A.C. and arrange it so that we can supply by it a small fraction of the total voltage on to the grid circuit of the valve, and the remainder of the applied A.C. to the plate circuit of the valve, it will be found possible, by moving that slider along, to discover a position on the potentiometer where there will be no sounds in the telephones in the plate circuit, due to this source of audible frequency A.C. This means that at any given instant we are applying, say, a negative voltage to the grid and in opposite phase we are supplying a positive voltage to the plate. When there is no sound in the telephones there must be no change in plate current, and therefore the ratio of the voltages applied to the two circuits must be the voltage amplification of the valve. The ratio of these two voltages is the ratio of the resistance $r_a$ in the plate circuit to the resistance $r_g$ in the grid. Hence, $r_a r_g$ is the voltage amplification factor of the valve. That is a very simple experiment to carry out and it is one, moreover, that can be carried out with simple apparatus which does not require the use of an expensive moving coil galvanometer, but merely a buzzer with transformer for the A.C. source, a potentiometer and a pair of telephones. When using an ordinary potentiometer, the readings are a bit rough, but are probably good enough for many practical purposes. I have had such an instrument made up but it was not possible to bring it here to-night, but perhaps on some other occasion it may be possible to show it in action.

Simple measurements of that sort may be very useful in enlightening us as to what is happening in our valves when we use them under various conditions, and they are such as can be recommended to every experimenter as they require no complicated apparatus. I am sure all of us will wish to express our greatest thanks to Mr. Blake for giving us such an excellent lecture this evening and for showing so many interesting experiments.

**Mr. Maurice Child.**

I endorse Mr. Coursey's remarks on the very interesting exhibitions that we have had to-night, and also the subject matter of the lecture. One experiment which interests me very much is that in which the lecturer showed the electroscope and the lantern. It struck me as possible, in future, to introduce this into ordinary wireless methods and that possibly this scheme may be worked on a larger scale over short distances for signalling purposes.

I am afraid I cannot add anything of interest to what Mr. Coursey has said. We ought to be very grateful, indeed, to Mr. Blake that at such short notice he has given us such excellent demonstrations and experiments.

**The President.**

Mr. Blake is ready to show the ultra-violet experiment now, and I am sure he will reply later to the remarks that have been made.

**Mr. G. G. Blake.**

I think, Mr. President, there is practically nothing to reply to but with regard to this, with reference to the ultra-violet rays, I should like to show it now. This experiment is, perhaps, rather away from the point of the lecture so it is just as well not to show it until now.

(A demonstration showing some of the properties of ultra-violet light was then given.)

**The President.**

Mr. Blake has covered a very large field this evening in theory of atoms and structure of matter in its relation to wireless telegraphy, and I think we ought to give him our thanks for filling up the gap at such short notice. What he would have done if he had had a month's notice I do not know. I think it was an interesting and most instructive evening, and any of those interested in valves and their characteristics will appreciate the practical way he has explained it. I think I have nothing I can add of interest, but I will ask you to give a hearty vote of thanks for his very excellent and interesting lecture.

# Air Ministry Receiving Station

*Photo.]* *[Press Exclusives.*

*The above is a photograph of a receiving station at the Air Ministry. Here weather reports are received and from the data thus collected meteorological forecasts are prepared. Such weather forecasts are available to farmers and others in this country who subscribe to the service.*

# Notes on the Design of Radio Frequency Intervalve Amplifier Transformers using Iron Cores

By A. S. Blatterman, B.Sc., E.E.

(*Concluded from p.* 84.)

**Example of Design and Experimental Checking of Theory.**

As an example of application of the formulæ that have been arrived at will now be given the calculations on a transformer constructed by the author. The theoretical results were checked experimentally with good agreement as is shown below.

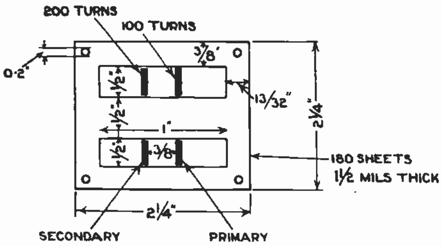



*Fig.* 15.

The core plates of the transformer in question are 1½ mils thick and have the other dimensions shown in Fig. 15. This particular transformer had no air gap $\delta l$.

The primary and secondary coils were made up in pancake units, 100 turns per unit, one unit for primary and two for the secondary. The primary and secondary are spaced ⅜ in. apart.

For the calculation of leakage flux it will be assumed that the central and side core legs are of equal size and round instead of square. The radius $R$ is taken at ¼ in. The cross section of the iron $A$ is 0·87 sq. cm. The mean length of magnetic circuit $l$ is 11·42 cm. Therefore

$$\sigma = \frac{b}{R} = 2$$
$$l = 11\cdot42 \text{ cm.}$$
$$A = 0\cdot87 \text{ sq. cm.}$$
$$\delta l = 0$$
$$\frac{l}{A} = 13\cdot14$$

from (16)

$$a = \frac{4\pi t}{3} \times \frac{\dfrac{l}{\mu A} + \dfrac{\delta l}{A}}{\log \dfrac{2}{2 + \sigma - \sqrt{b^2 + 4\sigma}}} = \left\{ \frac{42}{\mu} + 3\cdot68\ \delta l \right\} t$$

This is a general expression for "$a$" for all transformers using the core stamping shown in Fig. 15, both with and without air gap and for different spacing "$t$" between primary and secondary. The permeability $\mu$ depends upon frequency, as has already been pointed out. The last equation can therefore be more conveniently put into the following form where (32) and (33) are used for $\mu$.

$$a = \left\{ \frac{13\cdot9}{10^5} f^{0\cdot6} + 3\cdot68\ \delta l \right\} t \quad \text{for } f \text{ above 200,000 cycles} \quad . \quad . \quad (34)$$

$$a = \left\{ \frac{16\cdot2}{10^4} f^{0\cdot4} + 3\cdot68\ \delta l \right\} t \quad \text{for } f \text{ below 200,000 cycles} \quad . \quad . \quad (35)$$

In Fig. 16 are shown values of $a$ for different frequencies and different air gaps calculated from formulæ (34) and (35) with $t$ equal to 1 cm. For values other than 1 cm the ordinates of the curves of Fig. 16 are to be multiplied directly by $t$.

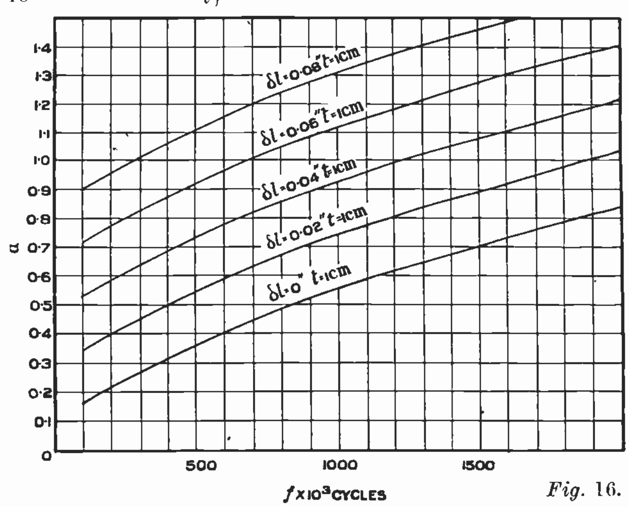



*Fig.* 16.

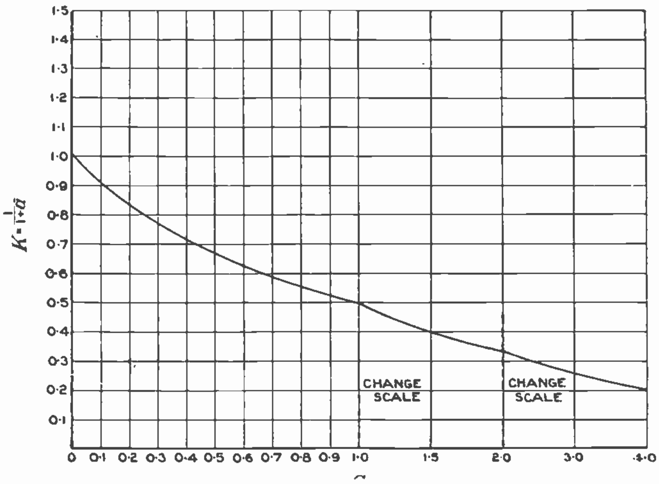



*Fig.* 17.

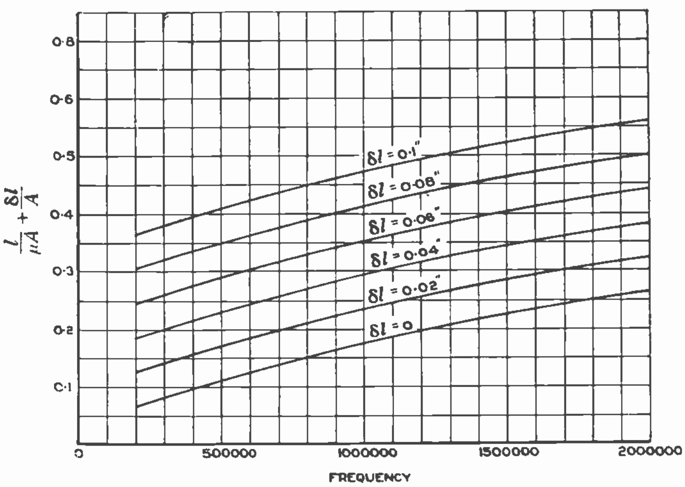



*Fig.* 18.

Similarly in Fig. 17 are shown curves of the coefficient of coupling, $K = 1/(1 + a)$, for different values of $a$; and for further convenience in design the quantity

$$\frac{l}{\mu A} + \frac{\delta l}{A}$$

found in the expressions (17) and (18) for inductance is plotted in Fig. 18 for different frequencies and values of air gap $\delta l$. With the help of these charts the inductance of a winding may be readily computed for any set of conditions relative to air gap, turns, and frequency from the formula

$$L = \frac{4\pi^2 N^2}{10^9} \cdot \frac{1}{JU} \quad \ldots \ldots \ldots \ldots \quad (36)$$

wherein

$$J = \frac{l}{\mu A} + \frac{\delta l}{A} \quad \text{reading from Fig. 18}$$

$$U = \frac{1}{1 + a} = K \quad \text{reading from Fig. 17}$$

In the present case, where $\delta l = 0$ and $t = \frac{3}{8}'' = 0{\cdot}953$ cm, the calculation gives the results shown in Figs. 19 and 20, $L_1$ depending upon the frequency according to curve A (Fig. 19) and $L_2$ according to curve A (Fig. 20).

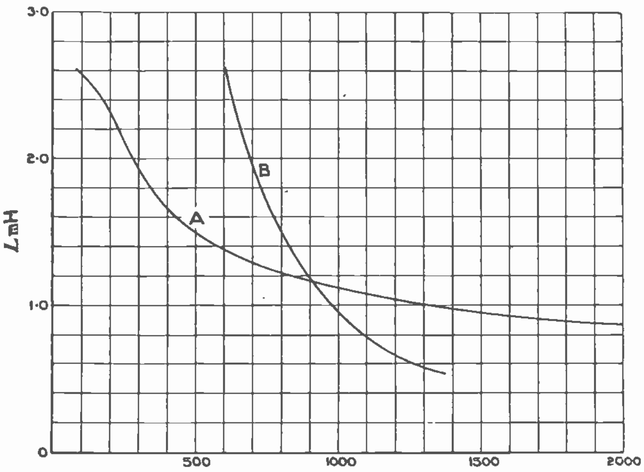



*Fig.* 19.

Proceeding now upon the supposition that the load on the transformer is a detector tube of the VT-1 type, we have for the secondary capacity $C_2$, as previously stated,

$$C_2 = C_g + C_m$$
$$= 15 + 13 = 28\ \mu\mu F$$

The primary capacity $C_1$ is

$$C_1 = C_p + C_m$$
$$= 13 + 13 = 26\ \mu\mu F$$

Curves B in Figs. 19 and 20 show the inductances required for different frequencies with the above capacities, and as is elsewhere explained the intersections of curves A and B in these figures determine the natural oscillation frequencies $f_1$ and $f_2$ of the primary and secondary circuits. Thus, the natural frequency of the primary is seen to be $f_1 = 900{,}000$ and the secondary is $f_2 = 360{,}000$.

From Figs. 16 and 17 we get the variation of $K$ with frequency set out in Table I. :—

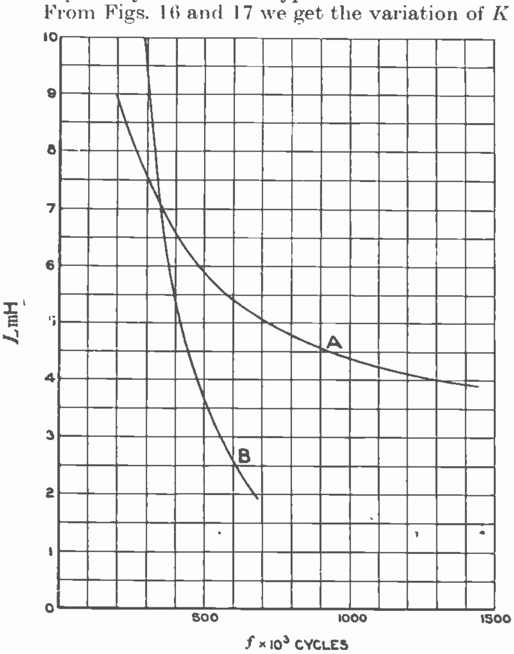



*Fig.* 20.

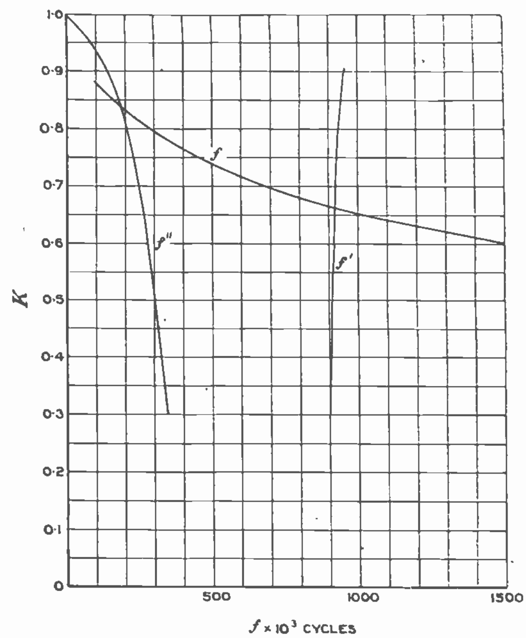



*Fig.* 21.

These values are plotted in curve $f$ of Fig. 21.

Formulæ (30) and (31) give the two curves of $f'$ and $f''$ (Fig. 21) showing the interdependence of coupling frequencies and $K$. The intersection of these curves with curve $f$ give the two resonant humps

TABLE I.

| $f$ | $K$ |
|---|---|
| 200,000 | 0·833 |
| 400,000 | 0·77 |
| 700,000 | 0·70 |
| 1,100,000 | 0·64 |
| 1,500,000 | 0·60 |

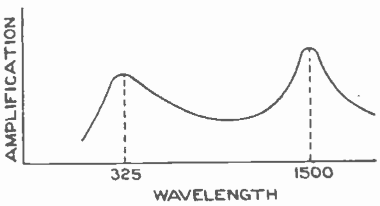


*Fig. 22.*

at which maximum amplification may be expected to occur as has been explained. These are seen to be 200,000 cycles and 925,000 cycles corresponding to 1,500 metres and 325 metres respectively. This Transformer might be expected, therefore, to work satisfactorily into a tube detector of the VT-1 type from perhaps 300 metres to 2,000 metres the amplification characteristic having peaks in the neighbourhood of 325m and 1,500m, and a depression between these values somewhat according to the rough curve of Fig. 22.

## Experimental Checking.

The theoretical results arrived at were checked, firstly, by measuring the inductance of the primary of the transformer at different wavelengths and comparing these measured values with those calculated; and, secondly, by measuring the voltage amplification at different wavelengths with a single stage of amplification and the transformer working into a VT-1 detector tube by means of the standard circuit used for such measurements at these laboratories.

Comparison of the inductance values is made in Table II.

TABLE II.

| Frequency. | $L$ mH measured. | $L$ mH calculated. |
|---|---|---|
| 100,000 | 2·7 | 2·6 |
| 150,000 | 2·65 | 2·49 |
| 200,000 | 2·6 | 2·35 |
| 300,000 | 2·15 | 1·94 |
| 400,000 | 1·9 | 1·68 |
| 500,000 | 1·55 | 1·48 |
| 750,000 | — | 1·25 |
| 1,000,000 | — | 1·12 |
| 2,000,000 | — | 0·87 |

This table shows that the calculated values do not differ from those measured by more than 5 per cent.

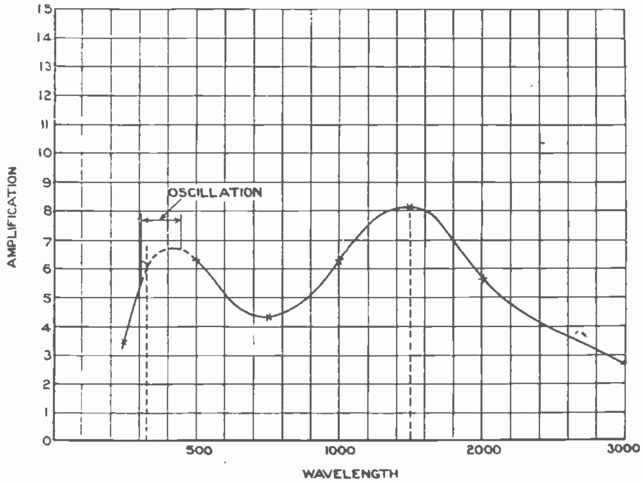


*Fig. 23.*

In Fig. 23 is shown the measured voltage amplification at different wavelengths. It is seen that one of the peaks comes at 1,500 metres, which agrees exactly with the calculations. With the apparatus used for making this measurement self-oscillations were produced between 450 and 300 metres, so that within this range it was not possible to trace the curve. Points were obtained, however, as shown, at 500 metres and 250 metres and the indications are that the other peak of the curve lies sufficiently near the calculated value of 325 metres for this latter figure to be accepted with confidence as locating, at least very closely, the position of the lower peak of the curve.

In conclusion the writer desires to mention that a very large number of experimental transformers and tests were made by his associate, Mr. Max C. Batsel, during the early part of the Signal Corps development, and much of the data thus obtained has proved invaluable in the practical construction of amplifiers.

# RECOMMENDATIONS OF THE COMMITTEE of the WIRELESS SOCIETY OF LONDON

## Regarding the Regulations Governing Amateur Transmission

**Preamble.**

At the third Annual Conference of Affiliated Wireless Societies held on January 25th, 1922, a resolution was passed, arising out of item 5 of the Agenda, requesting the Wireless Society of London to open negotiations with the Post Office regarding the regulations now governing amateur transmission licences and also in regard to the substitution of some medium wavelength other than the present 1,000 metre wave for general amateur use—the object being to avoid interference by amateurs with aircraft traffic of which official complaint had been made. Speaking on the resolution, Captain Loring, R.N. (Radio Dept., G.P.O.), stated that the Post Office would be prepared to receive recommendations from the Wireless Society of London, and to give them every consideration.

The considered opinion of the Committee of the Wireless Society of London (hereafter referred to as "the Committee") is contained in the following recommendations :—

**1.** It is a condition of most amateur licences that transmission is permitted to a maximum of five other stations only. The Post Office is willing to make alterations from time to time in the particular five correspondents selected by any transmitting station, but frequent alterations must of necessity occasion considerable clerical work.

The regulation is irksome in the extreme, as amateurs are not always able to carry out their experiments with any of the five stations allotted to them, whereas they hear other suitable stations working, with whom they may not communicate, although such stations may be ready and willing to test with them.

The Committee is of the opinion that the present regulation serves no very useful purpose, and tends to limit research in the direction of obtaining maximum transmission distances with the power permitted—research as regards the design of transmitting and receiving apparatus.

The Committee therefore recommends:—

(*a*) That no restriction be imposed on amateur transmitting stations communicating with any other amateur station—provided always that no amateur transmitting station may, in any circumstances, make a "CQ", or any other general call.

Should it be considered impracticable to act on recommendation (*a*), the following alternative recommendation is put forward :—

(*b*) That amateur transmitting stations be permitted to communicate with any other amateur station within a defined area or radius. As to what the radius should be, the Committee, after careful practical investigation, is prepared to state that amateurs possessing good receiving apparatus have no difficulty in receiving transmissions from carefully designed transmitting stations using an input power of 10 watts at distances up to 60 or 70 miles in the case of telephony, and 150 miles and more for C.W. telegraphy. In the circumstances, it is hoped that, should a radius be imposed, it will not be too circumscribed.

Finally, the Committee, in the interests of research, desire to urge the Post Office to adopt recommendation (*a*) should it be in any way possible to do so.

**2.** The present regulations as regards hours of working provide that no station may transmit for more than two hours a day. Upon obtaining a licence the holder is permitted to select his own times, but once selected, he must adhere to them unless he gets them altered by the Post Office. In practice most amateurs have selected the same two evening hours, which makes it difficult to make proper experimental transmissions without experiencing jamming. From time to time most amateurs make alterations in their apparatus, involving adjustments and careful testing; in such circumstances it would be reasonable for them to seize an opportunity when others were not working and such a moment might well occur outside their allotted hours; it is not always practicable to make special application to the Post Office for an extension of hours on the occasion of each individual test. In fact, were continual applications of the sort to be made, considerable unnecessary clerical work and consequent expense would be occasioned to the Post Office. Considering the matter in all its aspects, the Committee is of the opinion that no very useful object is served by defining the exact hours between which stations are permitted to operate, and ventures to point out that, according to the wording of many of the licences, no contravention would take place were stations to transmit for an unbroken period of two hours at a stretch!—a most undesirable state of affairs. The Committee considers that a restriction should be imposed, governing the maximum period of *uninterrupted* transmission.

The Committee therefore recommends :—

(*a*) That amateur stations be authorised to transmit for an aggregate maximum time of two hours in each twenty-four, without mention of any specially defined two hours.

(*b*) That no uninterrupted transmission shall last more than, say, 10 minutes, followed by a period of not less than three minutes listening-in on the same wavelength as that used for transmission.

(*c*) That no transmission be commenced without previous listening in to ascertain whether the proposed transmission is likely to interfere with any other station (including amateur stations) which may be working.

**3.** In principle, bearing in mind the complaints made by the Air Ministry that aircraft traffic has been seriously interfered with by amateurs who have been allotted the general wavelength of 1,000 metres for transmission, the Committee is of the opinion that it would be highly desirable for amateurs to be allotted some other medium wave in lieu of 1,000 metres. From information received it appears that aircraft land stations are obliged to use high amplification and very non-selective circuits in order that calls may not be missed from aircraft, all of which are not tuned sharply to 900 metres for transmission. In such circumstances, which it is recognised are unavoidable, it is not surprising that amateurs using 10 watts on 1,000 metres interfere occasionally with the reception of signals from aircraft. If such interference exists now, when most amateur work is done in the evenings, it may be expected to become worse when night and evening flying become more general. Should it be considered desirable to retain an amateur wave of the order of 1,000 metres, the Committee suggest that an alteration to 1,025 or 1,050 metres might minimise any danger of interference with aircraft.

However, it would be far preferable to give up the 1,000 metre wave altogether, and to substitute some wave of the order of 300 or 400 metres, preferably the latter. The following advantages of such a wavelength are cited, some of which are advantages from the point of view of the authorities, and nearly all from the point of view of the amateur.

(i) All danger of interference with aircraft entirely ceases, as also does the risk of interfering with Admiralty reception on 1,005 metres.

(ii) Transmission of telephony on 400 metres, using 10 watts, is so sharp that it can safely be stated that it will be absolutely inaudible, except on circuits tuned from 390 to 410 metres, and that it will be exceedingly weak except on sharply tuned receiving circuits.

(iii) From reports received from members of the Committee deputed to listen in, it would appear that no appreciable Government or commercial work is done on 400, 325, 375 or 425 metres.

(iv) The 400 metre wave is much better suited to the standard G.P.O. amateur aerial than 1,000 metres; such aerials will be found to be much better radiators on the shorter wave. This fact has been conclusively proved by experiment, and as it will enable the amateur to cover reasonable distances with the permitted 10 watts input, he will not have the temptation that is undoubtedly present on the 1,000 metre wave, to use excessive power in order to radiate a reasonable amount of energy so that he may be heard through the volume of spark jamming present on 1,000 metres.

(v) The design of transmitting apparatus is quite as simple on 400 as on 1,000 metres, and there should be little difficulty in altering existing apparatus to the proposed new wavelength.

(vi) The 400 metre wave is as easy to work on as 500 or 700 metres, and, on account of the vast amount of spark jamming on those wavelengths, they would be most undesirable.

As regards the short wave of 180 metres which is generally allotted to amateurs in addition to the 1,000 metre wave, it is not considered desirable to confine amateurs entirely to a short wave of that order, to the exclusion of an alternative longer wave. Topographical considerations do not permit all amateurs to erect an aerial of low inductance and capacity such as is necessary to secure efficiency of transmission and reception on waves of the order of 180 metres. Nevertheless, it is desirable that a short wave of this order should be available to amateurs in order to foster research and experiment in a direction which is certain to prove useful, bearing in mind that telephony on such waves can be carried out by a large number of stations within quite a narrow band of wavelengths without mutual interference. On account of this last cited fact, the Committee considers that the present 180 metre wave might well be extended and converted into permission to use the whole band of wavelengths from, say, 180 to 200 or 220 metres.

The Committee have accepted as a broad principle that the bulk of amateur stations will be licensed for two waves, one short and one medium. The Committee assumes that, as heretofore, the Post Office will always consider applications for other special wavelengths in those cases where really good and sufficient reasons can be shown.

The recommendations of the Committee, as regards wavelength, are therefore as follows :—

(*a*) That general use by amateurs of 1,000 metres should cease, and that a wavelength of 400 metres for C.W. and Telephony should be allocated in lieu. Should 400 metres not be practicable, that wavelengths of 375, 425 or 325 would, in the order named, be very nearly as suitable.

(*b*) That, in lieu of the present 180 metre wave allocated to amateurs, they be permitted to use at will the band of wavelengths from 180 to 200 or 220 metres for C.W., Telephony or Spark.

**Conclusion.**

The Committee is of the opinion that, should their recommendations be accepted, two great ends will be attained. The first is that the Services will have no further occasion to complain of amateur interference, and the second, that the amateur will be satisfied with the power permitted to him and will not have the great temptation that now presents itself to ignore sometimes the terms of his licence as regards excessive power, unauthorised wavelengths, times of working, and stations communicated with.

The Committee would remind the Post Office that they have been requested to assist in "maintaining reasonable discipline." They are prepared to do so whole-heartedly, but they would point out that their task will be lightened considerably if amateurs appreciate that the authorities desire to impose only such restrictions as may be really necessary, and show a willingness to withdraw others that may perhaps seem merely irksome.

Finally, the Committee believe that, through their Control Committee for the London area, and through sixty odd affiliated societies in the Provinces, they will really be able to assist the Post Office in seeing that the terms of licences are observed by their members, and in making these recommendations they undertake formally so to do.

(*Signed*) H. B. JACKSON,
Admiral of the Fleet,
*President.*

(*Signed*) H. LESLIE MCMICHAEL,
*Hon. Secretary.*

# Russian Time Signals

## TRANSMISSIONS FROM PETROGRAD AND MOSCOW

DETAILS of the Wireless Time Signals sent by the stations of Petrograd and Moscow have been received from M. N. Dnieprovsky, Chief of the Time Service of the Pulkovo Observatory. As this information may be of service to astronomers and others interested in Wireless Time Signals, the substance of M. Dnieprovsky's communication and a few observations taken at Greenwich are embodied in this note.

In the first place it appears that Standard Time has been adopted in Russia, the time being two hours in advance of Greenwich. The time-determination is made at Pulkovo Observatory, which is connected by land-line with the wireless stations of Petrograd and Moscow. The programme of signals sent out is as follows, all times being expressed in Greenwich Mean Time (Civil), *i.e.*, reckoning from midnight :—

| Nature of Signal. | Time of Transmission (G.M.T.) From Petrograd. | From Moscow. |
|---|---|---|
| Series of V's . . . . | 1900 to 1902 | 2155 to 2157 |
| Series of T's . . . . | 1902.20 to 1902.50 | 2157.20 to 2157.50 |
| Time Signal, consisting of three dashes each of one second duration with one second space. | 1903 | 2158 |
| Series of M's . . . . | 1903.20 to 1903.50 | 2158.20 to 2158.50 |
| Series of Time Signal dashes, as above. | 1904 | 2159 |
| Series of O's . . . . | 1904.20 to 1904.50 | 2159.20 to 2159.50 |
| Series of Time Signal dashes, as above. | 1905 | 2200 |

The corrections to the Time Signals are given at 1905.10 (Petrograd) and 2200.20 (Moscow).

### RHYTHMIC SIGNALS.

PETROGRAD.

1906 to 1913.49. Sixteen series of 22 dots; two series every minute from 0 to 19 seconds and 30 to 49 seconds. The spacing of the dots is 66 in 60 seconds of time, or 11 in 10 seconds.

MOSCOW.

Six series of 31 signals, commencing at 2202.30 each set being separated by the omission of 9 signals. This is followed by a set of 121 signals. This is followed by six series of 31 signals similar to the previous set. The interval between contiguous signals is 48 to 49 of 1 second.

The time of the first rhythmic signal is not communicated by wireless. In order to use interpolated instead of extrapolated clock errors the times will be published at intervals.

The Moscow Time Signals have been observed on a few occasions at Greenwich, but it was not understood when they were first taken that the figure telegraphed after the signals gave a correction to the time signal. The correction is shown on January 7th and January 9th :—

| Date. | | Approx. Error of Signal. secs. |
|---|---|---|
| December | 16 | 0.02 fast. |
| ,, | 21 | 0.46 slow. |
| ,, | 23 | 0.77 ,, |
| ,, | 24 | 0.41 ,, |
| ,, | 28 | 0.45 ,, |
| ,, | 29 | 0.44 ,, |
| ,, | 30 | 0.67 ,, |
| ,, | 31 | 0.46 ,, |
| January | 2 | 0.57 ,, |
| ,, | 4 | 0.28 ,, |
| ,, | 5 | 0.42 ,, |
| ,, | 7 | 0.43 – 0.10 |
| ,, | 9 | 0.60 – 0.30 |

With reference to the correction given for the Time Signal, the wording used in the description is to the effect that the whole seconds and tenth at which the clock sends the time signal are telegraphed. Three figures are given. For example, on January 7th these were 001, which is read as meaning the signal was sent 0.1 sec. late and correction appears to be given in that sense.

*(Communicated by Mr. W. Witt Burnham, Member I.R.E., by kind permission of Sir Frank Dyson, Astronomer Royal.)*

# Some Notes on the Edison Accumulator

THE principle of the Edison Accumulator is very different from the usual lead-acid type of battery, neither lead nor sulphuric acid being used in its composition. This type of accumulator is therefore free from sulphation, corrosion of terminals, buckling of plates, and similar familiar troubles.

The positive plate consists of a number of nickel-plated spirally wound perforated steel strips, forming tubes mounted in a nickel-plated steel grid. Each tube contains over 300 alternate layers of nickel hydroxide and very fine flake nickel, the whole being highly compressed. The tubes are bound with eight solid steel bands placed equidistantly, and in order to avoid the remotest chance of plate distortion, adjacent tubes are wound oppositely, *i.e.*, the right-hand wound tube is placed next to the left-hand wound tube and so on.

The negative plates consist of nickel-plated steel

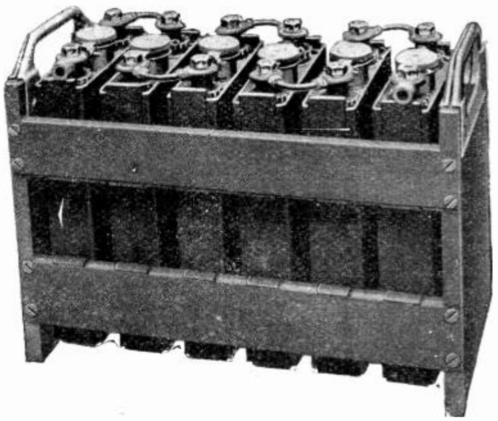


*Fig.* 1.

*A standard crate of Edison cells ready for use.*

grids which support a number of rectangular pockets made of perforated nickel steel ribbon. The pockets contain iron-oxide, and we may mention here that, practically speaking, the only chemical change which occurs with the Edison Accumulator is that on charge the oxygen leaves the negative element and joins with the positive element, while, on subsequent discharge most of the oxygen

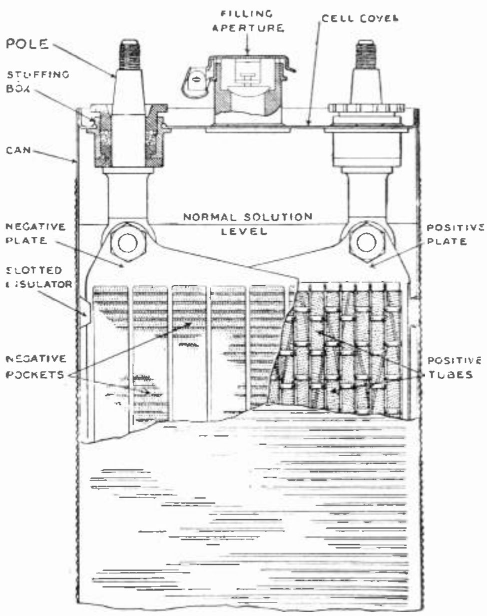



*Fig.* 2.

*Sectional view of an Edison cell.*

returns to the negative material. This chemical change is the nearest approach that has yet been reached (in accumulator construction) to being completely reversible. In other words the active material in the Edison cell is practically everlasting.

The negative plates are assembled in the manner indicated in Fig. 3, and the plates are separated from each other and the steel container by a special kind of hard rubber. As depicted in the illustration, the assembled elements of the Edison cell form a very neat and mechanically sound unit.

The container is constructed of sheet steel nickel plated. It is interesting to note that all steel used in the manufacture of the Edison Accumulator is nickel plated in an atmosphere of hydrogen, which process prevents the metal oxydising and therefore eliminates any possibility of the nickel peeling off the finished product.

An alkaline solution is used for the electrolyte, namely potassium hydrate which contains a small percentage of lithia.

Some advantages which are claimed for the Edison Accumulators are—

(1) Long life. They are guaranteed to give their full-rated capacity at the end of six years service. Their useful life is many times the guaranteed period.

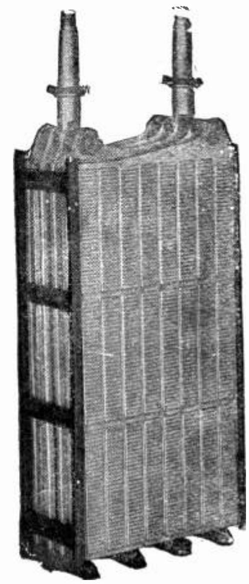


*Fig.* 3.

*An Edison cell assembled but removed from container.*

(2) Simple in operation. Only the addition of distilled water required to allow for evaporation.

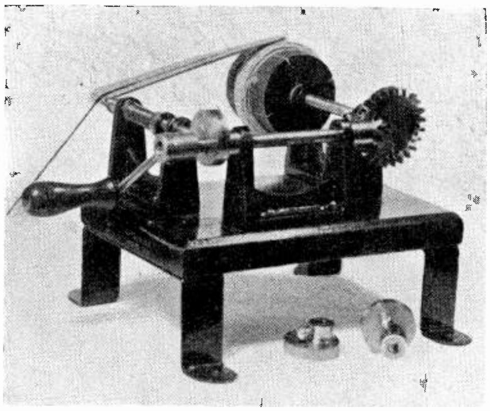
(3) The Edison Accumulator can remain idle indefinitely in a charged or discharged condition without the slightest fear of deterioration. It can also be short-circuited with impunity, and even charging in the wrong direction will do it no permanent harm.

(4) No acid fumes are given off by the Edison battery, and it can therefore be placed in close proximity to delicate instruments without fear of damaging them.

# A New Coil-Winding Machine

A MOST useful appliance in the equipment of the experimental station is an inductance winder capable of rapidly constructing flat tuning coils having reasonably low capacity between their turns and layers.

The machine shown has been designed for this purpose. It is supplied with interchangeable cams, making it suitable for winding coils of various widths and compensating for the difference in space taken by wires of different gauges and coverings. Skilfully handled, these cams are useful for spacing the turns when coils of specially low self-capacity are desired.



Although the manufacturer's instructions on the operation of the machine are a good guide and will lead one to the successful construction of very beautiful coils, the user is reminded that it is essential to keep a good pull on the wire while winding and to keep the oscillating rod pressed hard against the cam.

For uniformity, and in order to facilitate the collection of data, it is convenient to use only one gauge of wire. No. 26 D.S.C. wire wound with No. 1 cam will be found suitable for most purposes. Double silk and double cotton coverings are recommended on account of their elasticity, giving a little springiness between the layers. Intervalve oscillation transformers can be made by winding two wires simultaneously, taking care to keep a good tension and preventing the wires from crossing. No. 28 D.S.C. is best for this purpose and if green and white coverings are taken, the ends can be easily identified. Using cam No. 1, 130 turns of the handle produce a transformer suitable for wavelengths of 600 to 1,200 metres. A great advantage is that a number of transformers of identical value can be constructed for building a multi-valve high frequency amplifier. The outside ends are taken to the grids and plates.

For strength the coils can be impregnated with either wax or shellac, though if the latter is used care must be taken to bake the coils in order to dry out the interior. Of course, treatment of this kind increases the self-capacity.

## Experiments with "Loose Contact Telephone Receivers"

By MARIUS THOUVAIS.

WITH regard to Mr. Leslie Miller's paper, which was recently read before The Wireless Society of London and published in the December 24th issue of *The Wireless World*, I wish to point out experiments that were conducted in France before the war.

In 1914 a French amateur * had already discovered a curious phenomenon very similar to the one described in the paper referred to. The original apparatus with which experiments have been conducted differs very little from the one used by Mr. Leslie Miller. It consists simply of the usual telephone earpiece whose magnets and windings have been withdrawn; a small piece of galena is firmly soldered to a back-adjusting screw in order to be gently pressed against the usual metal diaphragm of the receiver. Of course, this adjusting screw is insulated from the metal case by an ebonite bush. A terminal is fixed to the metal ears and another one connected to the adjusting screw, as in Mr. Leslie Miller's receiver. Such an apparatus was simply used as an ordinary galena detector, without auxiliary current, and gave successful results. In experiments with a good amateur aerial about four miles away from Eiffel Tower spark signals were reproduced loud enough to be easily read several feet away from the set.

An article, entitled "Acoustical Reception on Crystal Detector without Telephone Receiver" (*Réception accoustique sur détecteur à cristaux sans écouteur téléphonique*) was published by Mr. Perret-Maisonneuve in the April 30th, 1914, issue of the French wireless review, "T.S.F. Revue mensuelle de Radiotélégraphie."

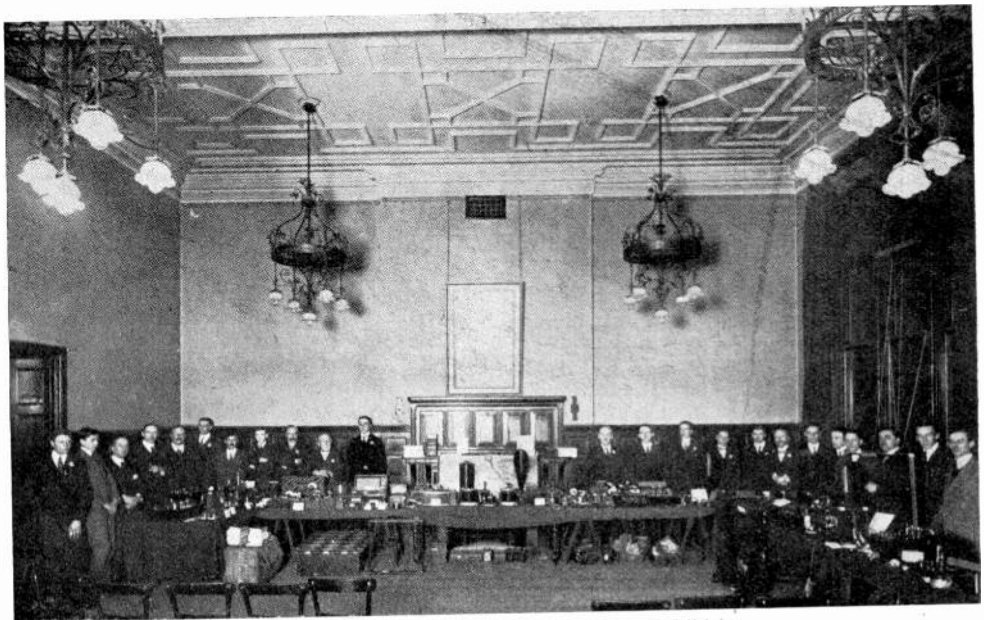
It may be quite interesting to point out that galena has been very successfully used without any auxiliary current.

## Exhibition at Hove, Brighton

UNDER the auspices of the Sussex Wireless Research and the Brighton Radio Societies a most successful exhibition of wireless apparatus lasting for three days—the first of its kind in the district—was held recently at the Hove Town Hall. Notable features of the proceedings were the lectures delivered by Capt. E. A. Hoghton, F.P.S.L., Associate I.R.E. (President Sussex Wireless Research Society), and the practical demonstrations on various types of apparatus by Capt. Hoghton, Messrs. E. Hughes, B.Sc., W. E. Dingle (President Brighton Radio Society), A. Blackburn and other gentlemen.

About 25 complete sets, dating from 1905 down to the latest types, were on view, together with loud speakers, a variety of wireless accessories and component parts, and an array of beautifully constructed bridges, galvanometers, milliamperemeters, and other measuring instruments. The amateur section included sets constructed by Messrs. Magnus Volk, W. E. Dingle, C. L. Fry, M. Foster and N. R. Phelp, the latter's pocket set attracting considerable attention. A complete set

* Mr. Perret-Maisonneuve.



*The Town Hall on the occasion of the Exhibition.*

of their Unit System, kindly loaned by the Marconi Scientific Instrument Co., was much admired. Exhibits, which embraced such interesting items as a battleship coherer set, a 3-valve ship set, and two 6 and one 7-valve sets, would occupy far too much space, and it must suffice to remark that the apparatus as a whole was of a highly educative character.

The proceedings included lectures by Capt. Hoghton each evening.

The joint committee wish to place on record their warm appreciation of the courtesy and assistance rendered by the Hove Town Hall authorities, and to the Marconi Scientific Co. for apparatus loaned; to the Wireless Press, Ltd. for a splendid assortment of technical literature; Messrs. Siemens Bros. for high tension and other batteries; the Brighton Municipal Technical College, Messrs. Isaacson and Brown, Messrs. Spicer and Co.; and the Zenith Manufacturing Co. for the loan of apparatus.

# Correspondence

*To the Editor of* The Wireless World and Radio Review.

Sir,—I will appreciate very much any information regarding a radiophone station in operation on March 28th at about (possibly before) 10.15 p.m. B.S.T.

During his conversation he called London, mentioned the name of a leading electrical engineering firm, his distance from London and his wavelength—360 metres.

The speech being very good, it may be of some interest to the gentleman operating the transmitter to learn that he was heard here.

Denmill Cottage, G. W. G. Benzie.
Peterculter, Aberdeenshire.
*March 29th*, 1922.

*To the Editor of* The Wireless World and Radio Review.

Sir,—Listening to the loud telephony transmitted from Paris last Tuesday, about 4 p.m. (single-valve), the speaker for a minute or more played fairly slowly up through three octaves of a piano, and then down again, putting in the semitones.

This afforded a very excellent means of adjusting the receiver to a maximum clarity of tone and loudness, the well-known steps of tones being brought to purity. This especially applies to the very high notes, say two to three octaves above C, which in a concert transmission are more difficult to hear, or to hear with purity.

The speech which followed was received with record audibility.

My object in writing is to bring this to your notice and consideration as to whether an adoption of this would assist amateurs in receiving other telephony, the "Hague," chiefly, which, though clear, does often become a task of adjustment, etc.

83, Argyle Street, Thomas Forster.
Hull.
*February 24th*, 1922.

*To the Editor of* The Wireless World and Radio Review.

Sir,—With reference to Mr. Burbury's letter in the current issue, I think perhaps it would not be out of place to give some particulars of some low power experiments carried out by Mr. Burbury and myself. The arrangement was follows :—I called him up on full power and warned him of the reduction in powers and probable slight change in wavelength ; the generator was then stopped and the town lighting mains connected to the transmitter—the voltage was down, I dare say owing to a heavy load somewhere, to 220 volts. On changing over, Mr. Burbury reported clear C.W. and asked for speech, which was given ; changing over again Mr. Burbury reported good clear speech.

The meter readings are of considerable interest. My transmitter is designed for a high voltage, consequently 220 does not put much in as will be seen.

H.T. volts, 220.
Plate current, 7 milliamperes.
Power input = 1·54 watts.
Aerial radiation, ·01 amperes.

Distance between 2 AW and 2 QK is just over 20 miles.

Mr. Burbury was using 2 H.F. and 2 L.F. valves.

I was rung up immediately afterwards by a gentleman at Headingly, near Leeds (distance 14 miles), who had received this quite well on two valves.

Another reports from Keighly (10 miles) "received here, three valves," and finally one from Bramley (8 miles) on three valves also.

All these gentlemen reported good clear speech.

I think this has "cooked the American goose to a frazzle." Also I am convinced that I can halve this input and get as good results with some improvements I am incorporating in a new transmitter.

Finally I might add that I have used tuned transformer high-frequency coupling for about 14 months now, and I shall not change for anything that is going at present as I consider that as an amplifier for all and in fact any wavelength it is without its equal.

J. Bever.

85, Emm Lane,
Bradford. *March 18th*, 1922.

*To the Editor of* The Wireless World and Radio Review.

Sir,—With reference to my letter of 18th inst. I find I made a mistake about Mr. Burbury's receiver, which was a three-valve, not five as stated. It should read as follows :—

"Mr. Burbury was using 1 H.F., 1 rectifier and 1 L.F."

Further tests carried out yesterday are as follows :—

Input 230 volts 6 milliamperes.
Watts = 1·38.
Aerial radiation, 10 milliamperes.

I was received quite well by Mr. Ward 2 IQ, in Sheffield, approximate distance 45 miles.

J. Bever.
2 QK.

*March 20th*, 1922.

*To the Editor of* The Wireless World and Radio Review.

Sir,—Referring to Mr. Miller's paper, reported in your issue of December 24th, I noticed a similar effect produced in Army telephones (Stevens or D III), *i.e.*, that it is usually possible to read buzzer signals from a distant station in one's own microphone. Here the effect is unusually striking, because of the step-down transformer as which the induction coil acts. At the time I asked Dr. Eccles, I think, but time did not allow of investigating further. I mentioned it, however, as a curious effect in a book written in 1917 ("Practical Elementary Electricity." Harrison & Sons. Page 98).

R. Raven-Hart.
*Divisional Telegraph Engineer, B.A.P. Rly. Co.*

Union Club,
Necochea y Peru,
Mendoza.
Argentine Republic.
*February 24th*, 1922.

# Notes.

**Cancellation of an Amateur Licence.**

The Wireless Society of London notifies us that at a Committee Meeting, held on the 15th of March, the cancellation of Post Office licence of the Altrincham Wireless Society, held in the name of its secretary, owing to contravention of its terms, was considered. The Society was offered the alternative of changing its Secretary or of abandoning its affiliation with The Wireless Society of London. The Altrincham Society have since chosen the latter course.

**5GH and 5CO.**

Can any reader say who are the telephony stations **5GH** and **5CO**, heard working in the afternoon ?

**Eiffel Tower Telephony.**

Mr. A. Woodhams, a new member of the Wireless Society of London, who was in Paris recently armed with a letter of introduction from the Chairman, received much courtesy at the Eiffel Tower, and was permitted to hail his brother and a party of friends who were waiting expectantly at his flat near Piccadilly. The reception of speech, both French and English, was excellent.

**New Wireless Service.**

In the Marconi Service opened on Wednesday, April 12th, between Berne and Ongar (in Essex) the wavelengths used and other particulars of the stations are as follows :—

Berne, call-sign **HBD**, wavelength 3,400 metres, 25 kW Marconi valve set.

Northweald (near Ongar, Essex), call-sign **GLA**, wavelength 3,800 metres, 15 kW Marconi valve set.

The Northweald station is one of a number of stations which are being erected on the same site.

**The P.M.G. and Broadcasting.**

An appeal has recently been made to the Postmaster-General by the Central Landowners' Association to consider the desirability of including weather forecasts in any broadcasting of information by wireless telephone which may be introduced. The broadcasting of such information, which is, of course, conducted on an extensive scale in the United States, must here be submitted for approval to the Imperial Communications Committee, and the views of several Government Departments have to be considered in order that interference with essential services may be avoided.

**Messrs. Burnham & Co.**, Deptford, S.E.8, desire to advise our readers that, owing to the growth of their business, their wireless department has been transferred to a company to be known as **Burndept Limited.** The new company will shortly open a factory, equipped for the production of their wireless apparatus, at "Aerial Works," Blackheath Village, S.E.3, three minutes from Blackheath Station, S.E. & C.R. New showrooms will also be opened very shortly at 228, Shaftesbury Avenue (New Oxford Street). All communications in the meantime should be addressed to Burndept Limited, St. Paul's Wharf, Deptford. The London retail depot will be at 19, Hand Court, until the new premises are ready.

**8AB.**

The station belonging to Mr. Léon Deloy, of 55, Boulevard Mont-Boron, Nice, has been heard on several occasions in this country. Mr. S. Hanley, of Kintbury, Berks, reports having heard **8AB** on the evenings of the 5th and 6th April, on 200 metres, on a single valve set. Mr. P. Smellie, of Edinburgh, using a four-valve H.F. tuned transformer amplifier, heard this station on the evening of the 8th March, on about 1,000 metres C.W.

**The Wireless Society of London.**

The next meeting of the Society will be held at the Institution of Electrical Engineers, at 6 p.m. on the 26th April, when Captain H. de A. Donisthorpe will open a discussion on "Four-Electrode Valves."

# Book Review.

Electrical Engineering Testing. By G. D. Aspinall Parr. (London: *Chapman & Hall.* Fourth Edition. Pp. 691 + viii. Figs. 296. 9″ × 5½″. Price 16s. net.)

This is a new edition of a well-known book by the former head of the electrical engineering department of Leeds University; it has been revised and enlarged and is now issued as one of the publishers' "Directly-Useful" Technical Series, which is intended to occupy a position midway between the purely theoretical and the ultra-practical books which can be obtained on almost every subject. The aim and scope of the book under review are indicated by its sub-title "A practical work on continuous and alternating currents for second and third year students and engineers."

Although this new edition contains much new material which will greatly increase its value as a laboratory text-book, we cannot but feel that in his attempt to bring the book "more thoroughly up to date" the author has not been altogether successful.

The illustrations given of oscillographs represent very ancient types which have long been superseded; two pages are devoted to instructions for making up the all-but-obsolete Clerk cell, whereas no such instructions are given for the Weston cell which has superseded it; not that we consider either a very promising experiment for a second or third year student of electrical engineering.

In many cases instruments which are mainly of historical interest are described at length without any hint to the student that they are now almost if not entirely obsolete. The reference to a parallel plate air condenser as an "Air Leyden" is very archaic and unusual.

It seems a great pity that better use was not made of the opportunity afforded by the preparation of this new edition of rewriting the obsolete sections and bringing the book entirely up to date. Some attempt has been made but in our opinion it has been too patchy and half-hearted.

The illustrations are very mixed, some very good and some very bad. There is a good index and an appendix containing a number of tables of useful data. G. W. O. H.

# Calendar of Current Events

**Saturday, April 22nd.**

Sunderland Wireless and Scientific Society.

"Aerial Design," by Mr. A. F. Stafford.

**Monday, April 24th.**

Wireless Society of Hull and District.

7.30 *p.m.*—At Signal Corps Headquarters, Park Street, "Winding Inductances by Machine," by Major Holman.

**Tuesday, April 25th.**

Wireless Society of London.

6 *p.m.* (Tea, 5.30 *p.m.*).—At the Institution of Electrical Engineers, Victoria Embankment, W.C.2, "Four Electrode Valves," by Captain H. de A. Donisthorpe.

**Wednesday, April 26th.**

Radio Scientific Society, Manchester.

Smoker and Exhibition.

Transmission of Telephony at 7 *to* 7.25 *p.m.* on 700 metres, followed by C.W. Calibration Signals on 1,000 metres, by **2MT** from Writtle, near Chelmsford.

**Thursday, April 27th.**

Liverpool Amateur Wireless Society.

"A System of Recording and Demonstration," by Mr. L. Haggard.

**Friday, April 28th.**

Leeds and District Amateur Wireless Society.

*Selected.*—Mr. A. F. Carter, A.M.I.E.E.

**Saturday, April 29th.**

Luton Wireless Society.

Public Exhibition.

Sunderland Wireless and Scientific Society.

At the Technical College, "Telephony," by Mr. T. Brown Thomson.

**Wednesday, May 3rd.**

Cowes and District Radio Society.

"The Application of Three Electrode Valves to Transmitting."

Institution of Electrical Engineers (Wireless Section).

6 *p.m.*—"Prevention of Interference in Wireless Telegraphy" (Provisional), by Mr. C. S. Franklin.

**Thursday, May 4th.**

West London Wireless and Experimental Association.

"Lantern Lecture and Demonstration," by Mr. Oswald Carpenter, Associate I.R.E.

**Friday, May 5th.**

Wireless Society of Highgate.

"Production of Low-Frequency Oscillations by the Valve," by Mr. L. Grinstead.

Institution of Electrical Engineers (London Students' Section).

7 *p.m.*—"Electrically Oscillatory Discharges," by Mr. R. P. Howgrave-Graham.

# Wireless Club Reports

*NOTE.—Under this heading the Editor will be pleased to give publication to reports of the meetings of Wireless Clubs and Societies. Such reports should be submitted without covering letter in the exact form in which they are to appear and as concise as possible, the Editor reserving the right to edit and curtail the reports if necessary.* **The Editor will be pleased to consider for publication papers read before Societies. An Asterisk denotes affiliation with the Wireless Society of London.**

### Liverpool Wireless Association.*

A meeting was held on Thursday, March 23rd, at the Royal Institution. After the reading of the minutes and the transaction of formal business, the members adjourned to the Liverpool School of Wireless Telegraphy, Colquitt Street, where they were received by the principal (Mr. Woodland). The fine equipment of the school was much admired by the visitors, and Mr. Woodland went to considerable trouble to explain fully the various instruments and apparatus. Mr. Clemmey had brought down a short wave receiving set, and a musical programme was received from a local transmitting station. Mr. Clemmey, who is well known as an expert in telephony, was most kind in giving full details as to the working of transmitting sets. At the conclusion of the proceedings a hearty vote of thanks was given to Mr. Woodland and Mr. Clemmey for the trouble they had taken to render the evening so enjoyable and instructive.

The Hon. Secretary (Mr. Wilkie) is due to lecture on Thursday, the 13th inst., but as he is paying a short visit to West Africa it will be necessary to postpone the lecture until his return, in a week or two. It is regretted that, in view of the next meeting being fixed for the day before Good Friday, it has proved impossible to secure another lecturer.

### North Middlesex Wireless Club.*

Hon. Secretary, Mr. E. M. Savage, "Nithsdale," Eversley Park Road, Winchmore Hill, N.21.

The eighty-eighth meeting of the Club was held on Wednesday, April 5th, and was well attended. The chair was taken by Mr. G. Evans, and after the minutes had been read he called on Mr. D. J. Stone to give his paper on "Electric Clocks."

Mr. Stone (by kind permission of the Synchronome Co.) had brought to the hall a master clock made by that firm and two wall dials, also the movement and hands of a large turret clock. These he had affixed in prominent positions, and they ticked off the half-minutes during the evening in the manner which is well known to most wireless workers. In addition, there were a number of diagrams, drawn to a large scale, which enabled the audience to follow the lecture with ease.

The lecturer started by giving a brief history of electric clock-making, saying that the idea of driving clocks by electricity existed very early in the days of electricity, but owing to practical difficulties it was found impossible to make these early types keep good time and at the same time be economical in current consumption. Mr. Stone described the different types of electric clocks, and pointed out the advantages and disadvantages of each. He then dealt in detail with the "Synchronome" system, which, he told his audience, was in his opinion and in that of many others, the best system so far invented. He explained the movement by means of various parts which were on the table, and laid particular stress on the extremely low current consumption, which amounted to only 3½ ampere hours per annum. Another special feature of this type is the very short duration of contact, and, further, the impulse given to the pendulum is independent of the state of the battery. Mr. Stone explained the ingenious method used when correcting these clocks by wireless. Some of the members present gave their experience of these clocks, and of other makes, and Mr. Stone answered many questions.

The meeting closed with a vote of thanks to the lecturer for the trouble he had taken and the pleasure he had given.

### Wireless and Experimental Association.*

A meeting was held on April 9th and was devoted to a discussion on the construction of high-tension condensers. The use of washed glass negatives and tinfoil was suggested, but it was pointed out that by this method condensers would be of inconveniently large dimensions.

Hon. Secretary, Mr. Geo. Sutton, A.M.I.E.E., 18, Melford Road, S.E.22.

### The West London Wireless and Experimental Association.*

Meeting held March 30th.—Listening-in on Association's apparatus gave exceptional strong signals, and all were able to hear the results by aid of the loud speaker. Informal discussion then followed, and many interesting points were raised, amongst which was data for frame aerials, the short wave tuner, the construction of condensers, etc. The Vice-President (Mr. F. E. Studt) in most instances replying to the satisfaction of the querists. The club's library is now possessed of "The Year-Book of Wireless Telegraphy and Telephony for 1922," so members will have up-to-date information respecting all the new large-power and amateur transmitting stations.

The Committee hope to arrange a summer half-day field day, including a visit to some not far-distant station.

Members are requested to make a special note of the demonstration by the Marconi Scientific Instrument Co., to be held on May 4th next. Also it is hoped that Messrs. H. D. Butler & Co. will demonstrate before the Association the following week.

The Secretary (Mr. Horace Cotton), 19, Bushey Road, Harlington, Middlesex) will be pleased to hear from any gentleman who desires particulars of qualifications for membership.

### Plymouth Wireless and Scientific Society.*

Wednesday, April 5th, was an open night so far as lectures were concerned. The meeting began with half-an-hour's buzzer practice. The business of the evening was "Complaints and Suggestions." members being invited to make any complaints or grievances and also to put forward suggestions for the improvement of the Society. The Committee were fully prepared to hear a long list of grievances against the management of the Society's affairs, and were gratified as well as surprised when none were forthcoming. Among the complaints of a general nature was the ever-recurring one of the impossibility of obtaining a transmitting licence in this neighbourhood. Stowed away as we are in a corner of the old country, with no amateur transmitting station within sixty or eighty miles, we have very little chance of experimenting in short wave reception. As far as telephony is concerned also we are in an unfavourable position for experiment. The amateur concerts are inaudible here, the Chelmsford weekly concert is an impossibility, due to interference from ships; the Dutch Concert is also too distant for us, shielded as we are by the heights of Dartmoor, so that before the commencement of the Paris telephony we were in a bad position. Fortunately, the French Concerts come in quite well, and prove a veritable blessing. Long may they continue, especially if they could only give us a little English now and then.

A suggestion was made that the Society hold a social and dance at a near date, and take that opportunity of giving a public demonstration of wireless telegraphy and, if the fates are propitious, telephony. The suggestion met with unanimous approval, and a sub-committee was at once elected to deal with the matter.

Full particulars of the Society may be obtained from the Hon. Secretary (Mr. C. H. Lock), 9, Ryder Road, Stoke, Devonport.

**Newcastle and District Amateur Wireless Association.***

On Monday, April 3rd, Mr. W. D. Owen, A.M.I.E.E., delivered an interesting lecture on the "Electronic Theory." This was very much appreciated by the members present, as this subject had never been dealt with at any previous meeting of the Society. We are looking forward to a further lecture promised by Mr. Owen.

Hon. Secretary, Mr. Colin Bain, 51, Grainger Street, Newcastle-on-Tyne.

**The Wireless Society of Hull and District.***

Mr. G. H. Strong presided over an excellent attendance of members at the fortnightly meeting held on the 3rd. After the routine business had been disposed of and members' individual difficulties discussed, the rest of the evening was profitably spent in building up a complete receiving set, various members having brought down different pieces of apparatus. The set was duly assembled by Mr. W. J. Featherstone, and signals soon obtained. A topic which is being constantly discussed by members is the question as to whether this Society should purchase some apparatus with a view of erecting a permanent receiving station. Although the Committee have only recently decided, after much discussion, that the present is not an opportune time for this development, and the matter will be kept before them for future consideration.

Meetings of the Society are held fortnightly, on Monday evenings, at the Signal Corps Headquarters in Park Street, at 7.30 p.m., buzzer practice 7 to 7.30 p.m. Next meeting April 24th, when Major Holman will give an exhibition of winding inductance coils by machine. This gentleman has kindly offered to wind coils (duolateral) for any member if they will supply the wire. Wireless operators who happen to be in port will be welcomed as visitors at any meetings of the Society.

**Newark-on-Trent and District Wireless Society.**

With the idea of stimulating the interest, a public lecture was held at the Magnus Grammar School, on March 15th, and to add to the interest the Society was honoured by a visit from Mr. W. R. Burne, the Transatlantic Tests winner.

The lecturer was Mr. T. Brown-Thomson, of Leeds, who gave an excellent lecture on Wireless Telephony. He fully explained, in as interesting a manner as possible, the propagation and reception of ether waves, illustrating by blackboard diagrams. The demonstrations of reception were accomplished by means of an Ultra IV. and two-valve note magnifier, and made audible to the whole audience by a Brown loud speaker. Several continental stations were tuned-in and the C.W. signals shrieked out loudly. An amateur telephony station was also picked up during the demonstration.

Mr. W. R. Burne then followed with a brief description of his reception from the American amateurs, which proved very interesting.

Six new members were enrolled, and it is hoped that anyone interested will communicate with the Hon. Secretary, 6, Beech Avenue, Hawtonville, Newark-on-Trent.

**Dick Kerr Wireless Society.**

The Society was formed on February 28th and held its First General Meeting on Saturday, 25th ult., Mr. H. A. Cox in the chair. The rooms of the Society are situated at Ashton Park, Ashton, Preston, and membership is restricted to members of the Dick Kerr United Club. The apparatus consists of a multi-valve receiver with long, medium and short wave tuners, and loud speaker. Additional apparatus is available for experimental purposes. An inverted "L" aerial is used, conforming to the P.M.G. licence, and an internal frame aerial 7 ft square is being erected for D.F. purposes.

The Officers and Committee are as follows:—*President*, Mr. R. Livingstone; *Vice-Presidents*, Mr. H. B. Player; Colonel C. Hardie, Mr. J. Conner; *Chairman*, Mr. H. A. Cox; *Vice-Chairman*, Mr. W. Paddock; *Hon. Secretary*, Mr. A. H. Topham; *Hon. Treasurer*, Mr. G. Masters; *Committee*, Messrs. A. Aldington, G. Davies, J. Isherwood, H. Simpson, L. H. Short and W. Swindlehurst.

The first message received on the Society's apparatus was a special message sent from Eiffel Tower through the courtesy of General Ferrié, of the French Army Wireless. An international ladies' football match in aid of the Rheims Cathedral Restoration Fund took place in the grounds of the Dick Kerr United Club at 5-45 p.m., and the following message was received at 6 p.m. on 2,500 metres:—

*Preston de FL. With our sincere gratitude to those who give their valuable help for the Rheims Cathedral Restoration Fund, we are expressing our heartiest sympathy to the Wireless Section of the Dick Kerr United Club. We wish all success to the members of this section, as well as to the organisers of the Football Match which is to be* *held to-day between the British and French Ladies' Teams.*

A special wireless concert sent from the Eiffel Tower an hour previously was received and made clearly audible. The articulation and modulation were faultless.

A series of lectures has been arranged comprising a complete course in the principles of Electro-Magnetic Wave Propagation and these will be given on alternate Friday evenings. The membership now stands at over 70.

The Society has received every support from the English Electric Co., Ltd., who have made a financial grant towards the initial cost of the apparatus.

It is hoped to install a telephony transmitter at an early date.

Hon. Secretary, Mr. A. H. Topham, Ashton Park, Ashton-on-Ribble, Preston, Lancs.

### Southampton and District Wireless Society.

A General Meeting was held at the Kingsland Assembly Rooms on Wednesday last, April 5th: a good attendance was recorded. It had been decided to hold a series of lectures for members, and the first of these was held on Wednesday last. The Chairman (Mr. Freeman) opened the meeting at 8 o'clock, and demonstrated on dry cells, after which Mr. Edwin Bateman gave a lecture on "Accumulators, Ohm's Law, Galvanometers," and finally the Wheatstone Bridge. Mr. Bateman, in a very lucid manner, dealt ably with all the above subjects, and at question time was subjected to a bombardment of questions, which, needless to say, he emerged from successfully. At the conclusion of the lecture a hearty vote of thanks was proposed, seconded, and carried unanimously, and an enjoyable evening was brought to a close at 10.15 p.m.

Hon. Secretary, Mr. T. H. Cutler, 24, Floating Bridge Road, Southampton.

### The Wallasey Wireless and Experimental Society.

On Thursday, March 23rd, the Society had the pleasure of listening to Mr. J. C. Mason's lecture on "Tuning." The lecturer opened by explaining the theory of self-heterodyne circuits; he dealt with this most important branch very fully, and then gave several valve circuits, giving the reasons for each one as he drew them. He also explained the theory and practice of spark and C.W. reception.

On the 20th inst., Mr. A. Lea read before the Society a most interesting paper on "Telephony." Mr. Lea has a good grip of his subject, and during his lecture illustrated difficult points with clear and concise diagrams. The paper was partly historical, partly theoretical and wholly interesting. Mr. Lea explained before he began that he did not call himself a lecturer, but was doing his best to be an example to the rest of the Society's members: he hoped that others would prepare and read papers for the Society's benefit. The meeting closed with a vote of thanks to Mr. Lea.

The Hon. Secretary (Mr. C. D. M. Hamilton), 24, Vaughan Road, will be pleased to send particulars of the Society to any prospective members.

### Sunderland Wireless and Scientific Association.

A General Meeting of the Association was held on Saturday, March 4th, in the Examination Hall of the Technical College. There were about 180 persons present. A paper on "A Wireless Set for £5" was read by the Secretary. Mr. MacColl outlined very briefly the action of a simple valve receiving set, and then proceeded to explain how one could be constructed at small cost. Signals were received on a loud speaker kindly lent by Messrs. Thos. Hudsons.

A General Meeting was held on Saturday, March 18th, when Mr. W. Guthrie Dixon, of the Newcastle and District Amateur Wireless Association, gave a most interesting lecture on the "Thermionic Valve." Mr. Dixon illustrated his point by a demonstration on a 7-valve set of his own construction.

On Friday, March 31st, under the auspices of the Association, a lecture on "Einstein's Theory of Relativity" was given by Mr. Robert Lunnon, M.A., B.Sc. (of the University of Durham), in the Subscription Library Hall, and was attended by over 200 persons.

On Saturday, April 1st, a General Meeting of the Association was held at the Technical College. The constitution and bye-laws which had been drawn up by the Committee were adopted. The President (Mr. G. Nelson, B.Sc., A.R.C.S., A.Inst.P.) gave an interesting lecture on "Electrons," which was illustrated by slides and some excellent demonstrations with vacuum tubes.

The Association's receiving set is now under construction. The Radio Communication Company have invited the Association to visit their offices at Newcastle-on-Tyne. The present membership is ninety-seven.

Hon. Secretary, Mr. H. G. MacColl, 1, North Elms, Sunderland.

### Reading Radio Research Society.

On March 25th last the above Society was formed, and the following officers were elected:—President, William Le Queux, Esq., Member I.R.E.; Chairman, Lieut.-Col. R. L. Pearson, A.M.I.E.E.; Hon. Secretary and Treasurer, Dr. L. L. Phillips, 73, London Street, Reading: Committee: Major H. MacCallum, B.Sc.(Lond.), A.M.I.E.E.; Messrs. J. E. Taylor, R. W. James, C.E. Tranter, W. H. Scarborough, F. B. White, E. A. Tunbridge and Captain F. M. J. White.

The objects of the Society are to promote the study of all matters connected with wireless telegraphy and telephony and kindred subjects, and to enable wireless amateurs in the district of Reading to meet one another, so that they may exchange ideas and obtain mutual help in the pursuit of their experiments. With this object in view it was thought well to allow time at the meetings for informal talk. It was hoped to form a library and a workshop for the use of members.

Rules were drawn up. It was decided that ladies could be admitted as members. It was decided to become affiliated to the Wireless Society of London.

The first meeting of the Society was held on April 3rd, when, despite very bad weather, quite a fair number of members attended to listen to a paper by Dr. L. L. Phillips, on the subject of X-rays.

# Questions and Answers

*NOTE.—This section of the magazine is placed at the disposal of all readers who wish to receive advice and information on matters pertaining to both the technical and non-technical sides of wireless work. Readers should comply with the following rules.—(1) Each question should be numbered and written on a separate sheet on one side of the paper only. (2) Queries should be clear and concise. (3) Before sending in their questions readers are advised to search recent numbers to see whether the same queries have not been dealt with before.* **(4) The Editor cannot undertake to reply to queries by post.** *(5) All queries must be accompanied by the full name and address of the sender, which is for reference, not for publication. Queries will be answered under the initials and town of the correspondent, or, if so desired, under a "nom de plume."* **(6) Readers desirous of knowing the conditions of service, etc., for wireless operators will save time by writing direct to the various firms employing operators.** *(7) Four questions is the maximum which will be accepted at a time.*

**"AMATEUR" (Rugby).**—(1) Set is satisfactory for spark, C.W. and telephony as it stands, except that a condenser is desirable across the telephones.

(2) Yes.

(3) About 50 turns, placed half a centimetre apart.

0·01 mfds. for the grid condenser will be suitable for the L.F.

**"R.K." (East Ham)** *submits a short wave receiver circuit and asks for criticism.*

A circuit of this type (impedance amplifier) is theoretically inefficient on short waves in exactly the same way as resistance amplifier is. We should strongly advise you not to use it below 1,000 metres, at which wavelength the values for the condensers, etc., will be about the same as in the normal resistance amplifier. An amplifier of this type needs very careful construction of the chokes with a view to keeping their self capacity low. If this is not low the chokes will by-pass a considerable amount of H.F. current, giving a serious weakness of signals.

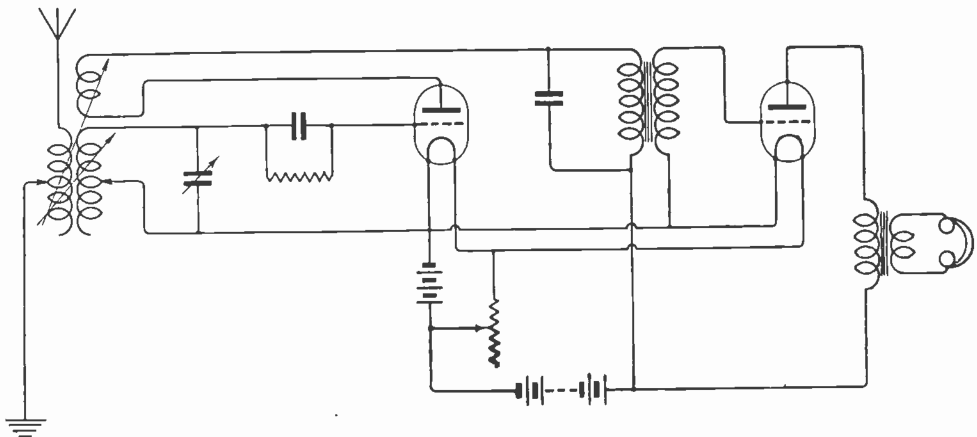


*Fig. 1.*

**"C.B." (Hyson Green)** *asks for a two-valve diagram, one valve detecting and the other L.F. amplifying.*

For suitable circuit see the diagram Fig. 1.

**"FORD" (Bexley Heath)** *asks* (1) *How to add a valve to an existing circuit.* (2) *Cost of an amateur's licence.* (3) *Maximum length of single wire aerial allowed.* (4) *If the English Concert will be heard on a crystal set with a valve magnifier.*

(1) See Fig. 5 or 8 in the March issue (queries column).

(2) 10s. per annum. Apply to the Secretary, G.P.O., London.

(3) 100 ft. including down-lead.

(4) Yes.

**"A.F.H." (Bishop's Waltham)** *asks* (1) *If special permission is required for the use of a frame aerial.* (2) *If a 60,000 ohm. resistance may be used in place of iron core transformer for a two-valve L.F. amplifier.*

(1) Only the usual permit for a receiving circuit is required.

(2) Yes, with a grid condenser and leak as in the usual resistance capacity amplifier. About

**"PERIKON" (Farnborough)** *asks* (1) *Which of two crystal circuits is the better.* (2) *If 30ft. high and 45ft. long aerial (twin) is suitable.* (3) *If it matters the set being at the same height as the aerial.*

(1) Your Fig. 2.

(2) Fairly good.

(3) Aerial should preferably be higher than the set.

(4) 4,000 metres with a 0·0005 mfd. condenser across the coil.

**"W.G.W." (Southsea)** *asks* (1) *If a circuit sketched is suitable for telephony.* (2) *How to add an additional H.F. valve.* (3) *If slab coils are preferable to solenoid coils for telephony.*

(1) The circuit shown is satisfactory, except that it is liable to reradiate rather badly if carelessly used. A double tuned circuit with a loose coupler, or loose auto-coupling is preferable. Negative of L.T. battery should be earthed.

(2) Some rearrangement is necessary. Circuit should be on lines of Fig. 6, page 708, February 4th issue.

(3) Immaterial, if about the same size wire is used on each.

"**E.G.D.**" **(Lingfield)** *asks* (1) *To whom to apply for a receiving permit.* (2) *If a heavily insulated lead-in should be used.* (3) *If lightning protector is essential.*

(1) To the Secretary, G.P.O., London.

(2) This may be done if you wish, but is not at all necessary.

(3) No, but the aerial and earth wires should be connected when not in use.

"**SPARKS**" **(Peebles)** *asks for help with a single wave set which used to give good results but now gives nothing on certain parts of its range.*

We cannot give you the exact reason for this without a detailed examination. It may be due to damp in the coils, which could be cured by drying out, or else to dirty switches or broken connections which can be detected by tracing out the circuits with a galvanometer.

"**J.H.A.**" **(Acton).**—(1) The aerial is very poor. It should be much higher and preferably longer. It is of very little use to use four wires so close together, and would be just as good to have two wires fout feet apart.

(2) You do not give enough information for us to state the wavelength, but it will probably be as high as is useful for a crystal set.

(3) A crystal battery will not improve results appreciably.

"**H.F.**" **(Deptford)** *asks* (1) *Whether a certain circuit is the best that can be done with his apparatus.* (2) *How a telephone transformer can be introduced.* (3) *If three or four Leclanche cells would improve the circuit.*

(1) Yes, except that the primary of the loose coupler should be on the earth side of the loading coil. A telephone transformer is essential with 120 ohm. telephones.

(2) See many circuits recently given.

(3) These might be used for a potentiometer with some good effect.

"**D.A.K.B.**" **(Cheltenham)** *asks questions about a crystal set.*

The circuit shown is very poor. See diagram Fig. 2 for correct circuit. A.T.I. may be 8″ × 10″ of No. 22. Closed circuit coils 8″×5″ of No. 26, with a 0·0005 mfd. condenser. There is no simple formula for calculating the range of the complete circuit. The closed circuit coil should slide into the A.T.I., which should be on a tube of ebonite or similar insulating material.

"**J.A.G.**" **(Ealing)** *shows an adaptation of the Mark III Tuner and asks* (1) *approximate wavelength.* (2) *Connections for adding a valve.* (3) *If the set would then be suitable for concert reception.*

(1) About 1,000 metres without the aerial condenser and considerably less with it.

(2) See article in the June 25th issue.

(3) Yes.

"**V.F.**" **(Brighton)** *asks* (1) *Cost of a "school valve receiving set," home made.* (2) *What issue gives diagram of circuit.* (3) *Whether it would give good results.* (4) *Who* **PCGG** *is, and what are the call letters of Carnarvon, Eiffel Tower and Nantes.*

(1) £3 to £6, including valve and telephones.

(2) See page 466, October 29th.

(3) Yes.

(4) **PCGG** is a telephone station at the Hague. Carnarvon is **MUU**, Eiffel Tower **FL**, and Nantes **UA**.

"**A.L.G.**" **(Darlington)** *asks* (1) *For the wavelength of a receiver with honeycomb coils.* (2) *If the back-lash during C.W. transmission is due to harmonics.* (3) *If flat tuning causes* **MFD** *and* **FL** *to be heard.* (4) *If Stockton* **BYT** *is a receiving station only.*

(1) We cannot calculate the inductance of the coils, but expect the 8,750 metres is a true wavelength and not a harmonic. The presence of harmonics can in general only be proved by circumstantial evidence, such as their strength and approximate wavelength.

(2) No, this is not due to harmonics but to the method of signalling used, viz., keying by means of a small change of wavelength.

(3) No, it is more likely due to the coils having a natural wavelength somewhere about 2,500 metres.

(4) This was so during the war, and is so still as far as we know.

"**IVAN**" **(Mill Hill)** *asks* (1) *For an A.T.I. from 150 to 1,500 metres.* (2) *Quantity of wire required.* (3) *Particulars of 120 ohm. telephone transformer.* (4) *Call letters of Hendon.*

(1) 4″×10″ of No. 22 with a slider.

(2) About 1 lb.

(3) Core ½″ diam. × 3″ long of soft iron wire. Wind this with 6 ozs. of No. 30 for the telephone winding, and 3 ozs. of No. 44 for the crystal circuit.

(4) No information.

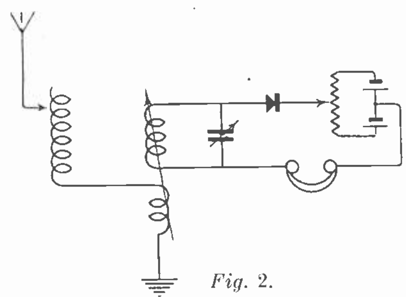


*Fig. 2.*

"**N.B.F.**" **(Finchley)** *asks re Fig. 4, page 526, November 12th issue* (1) *The cause of rushing noises in the telephones.* (2) *If it would be an improvement to connect the negative H.T. direct to earth.* (3) *If the noise might be caused by the absence of a condenser across the change-over switch, and* (4) *What its capacity should be.*

(1) Various causes are possible, such as (*a*) a bad valve, (*b*) bad H.T. battery, (*c*) bad grid condenser or leak, (*d*) absence of condenser as in (3), (*e*) too tight reaction. We cannot say which of these causes is operating.

(2) No. The H.T. circuit has to be completed to the filament, not to the earth.

(3) Very likely.

(4) About 0·001 mfds.

**"E.H.G." (Sheffield)** *asks if it is possible to add a two-valve resistance amplifier to an existing single-valve amplifier. (2) Wiring diagram of a circuit submitted.*

(1) This can be done. See diagram Fig. 3.

(2) The diagram you submit is as clear as any we could give you.

**"CHIKKO" (Acton).**—A telephone transformer is necessary for 120 ohms. telephones. For windings see reply to "Ivan," Mill Hill, above.

**"F.B." (Bayswater).**—(1) There are no general tables available of the number of turns, weight and gauge of wire, etc., for coils with particular condensers. If you state exact requirements we could probably give you the information you will need.

(2) There is no best arrangement of coils. Many different types of circuits are possible, as you will see by reference to diagrams in these columns.

(3) The use of the special winding machine you mention will not appreciably affect the size of the condenser to be used with the coils.

**"J.G.N." (Croydon)** *refers to Fig. 4, page 706, February 4th issue, and asks (1) The wavelength range of certain coils. (2) If it will receive* **PCGG** *at Croydon. (3) Ratio for the L.F. transformer. (4) If a small condenser would be advantageous across the reaction coil. (5) If the condenser across the switch is necessary, and if so what size it should be.*

(1) Probably about 7,000 metres.

(2) Yes.

(3) 1 to 2 or 2 to 3.

(4) No; this is undesirable.

(5) Yes. A fixed condenser 0·002 mfd. would be about right.

**"C.T.A." (Leicester)** *wishes to make a 180 metre telephone transmitter, and asks (1) Whether to use inductive coupling between circuits or a single circuit transmitter. (2) For a rough idea of the windings.*

(1) The second type will be quite suitable for a set of this nature.

(2) The inductance may be wound with about 24 turns of say No. 18 wire on a 4″ diam. tube, the turns being spaced about $\frac{1}{16}$″ apart. About half this coil should be in the plate circuit, and about half in the grid. For further information see page 866, March 19th, 1921.

**"—." (Uppingham)** *asks (1) For coils suitable for a set from 200 metres to 10,000 metres. (2) Advantages of certain arrangements of valves. (3) For diagram of resistance coupling set. (4) If an ordinary loose coupler will do for A.T.I. and reaction in a valve set.*

(1) For a big range like this you will require a set of honeycomb coils, the biggest of which should have about 400 turns with a mean diameter of 3″, and the smallest can have about 30 turns, mean diameter 2″.

(2) One H.F., one detector and one L.F. is a very good arrangement. Two H.F. alone is probably the best way of using two valves. Two L.F. alone is rather poor.

(3) See Fig. 3, page 640, January 7th issue, but making the grid condenser about 0·01 mfd.

(4) Yes, for moderate wavelengths. Gauges and sizes will depend on the range required.

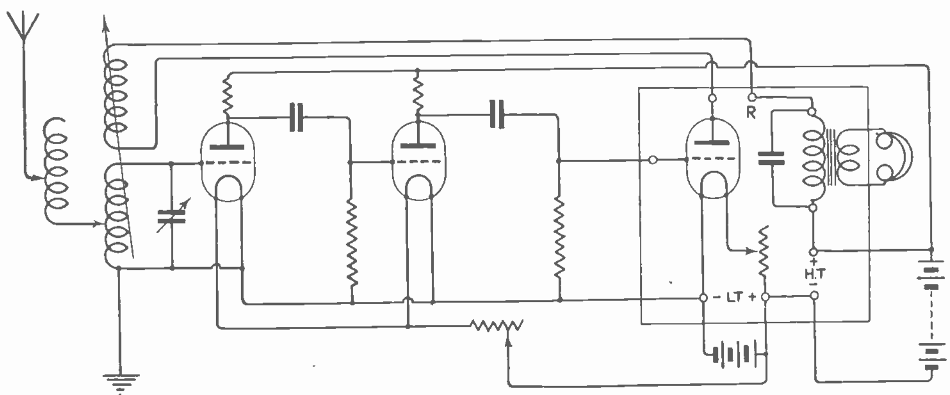



*Fig 3.*

**"L.H.P." (Market Harborough).**—(1) The general idea of the set is correct, but we fail to see the purpose of the condensers attached to the negative of the H.T. battery. This point should be connected to earth.

(2) A detailed design for a telephone transformer was given in March, 1920. For rough dimensions see reply to "Ivan," Mill Hill, above.

(3) No, we regret we are unable to supply complete constructional information for circuits given in these columns.

(4) H.R. telephones may be used in a single valve receiver if placed on the earth side of the H.T. battery, but their use is undesirable if more than one valve is employed.

**"F.D." (Nelson)** *asks (1) For a frame aerial set suitable for use up to 5,000 metres. (2) What additions will be necessary to receive* **PCGG**. *(3) For full details of the apparatus. (4) For a good book on the making of amateur sets.*

(1), (2) and (3) See issues 16 to 22 of Vol. 8, which may be obtained from the Publishers, and will give you all the information you require. This set will receive **PCGG** without alterations.

(4) "The Construction of an Amateur Valve Station," shortly to be published.

**"L.G.B." (Wandsworth)** *asks* (1) *If it is correct to use iron cores in transformers for wireless telephony.* (2) *If so, gauge and quantity of wire required.* (3) *How to determine the capacity of a condenser.*

(1) For L.F. and telephone transformers, yes. For H.F., no.

(2) This depends on the type of transformer. See replies to various enquirers.

(3) There is no very simple way which does not necessitate the use of apparatus. You might connect a coil across it, buzz it and determine the wavelength, which would be given by the formula wavelength $1885\sqrt{LC}$.

**"V.H.C." (London).**—(1) *For a circuit to utilise certain apparatus.* (2) *For value of grid leak.* (3) *For suggestions.* (4) *If a certain tuner may be used as reaction.*

(1) With a little additional apparatus a circuit shown in Fig. 1, January 7th issue, may be used effectively.

(2) The grid condenser and leak 0·0005 mfd. and 2 megohms respectively, may be connected in the grid circuit of the second valve.

(3) and (4) We have no detailed knowledge of this tuner and cannot say whether it would be suitable for the purpose required. It may be possible to use it as the secondary and reaction circuit in the diagram recommended with your small former as an A.T.I.

**"N.W." (Liverpool)** *asks* (1) *For criticism of a three-valve set.* (2) *For capacity value of two condensers.* (3) *For wavelength of a loose coupler.* (4) *For information regarding duolateral coils.*

(1) The circuit is quite good except that it is risky to use valves of different make with common H.T. and grid potentiometers owing to the differences in their characters. Use the potentiometer for the second valve only.

(2) C.1 is 0·0003 mfds. and C.2 0·0004 mfds.

(3) Aerial circuit maximum 5,500 metres with condenser C.1; secondary circuit with condenser C.2 maximum 6,500 metres.

(4) Information about these coils is given in the issue of 30th October, 1920, which can be obtained from the Publishers.

**"H.W." (Liscard)** *asks how long a 30-ampere hour accumulator will light four "Ora" valves.* (2) *How to recharge from A.C. mains.* (3) *For a good book on accumulators.*

(1) If 30 ampere hours is the continuous discharge rate, the cell will run the valves for about ten hours. If 30 ampere hours is the ignition rating, it will run the valves for about six hours.

(2) This can be done fairly cheaply by means of a "Nodon" valve, which is described in the issue of 19th March, 1921, or by means of a "Tungar" rectifier, as marketed by the B.T.H. Co. This is a better piece of apparatus, but much more expensive.

(3) "The A.B.C. of Storage Battery Management," by Ernest McKinnon (Electrical Press).

**"J.T." (Cheshire)** *asks* (1) *For a circuit to use certain apparatus.* (2) *If the set will receive C.W., telephony and spark.* (3) *For maximum and minimum wavelengths for given inductances.*

(1) The circuit will follow closely on the lines of the one given to "M.W.L." (Brentwood), above.

(2) Yes.

(3) Minimum about 300 metres, maximum about 3,000 metres.

**"E.M." (Wimbledon)** *asks* (1) *Which is the better of two kinds of aerial wire.* (2) *Dimensions of grid and anode coil for telephony transmission on 1,000 metres.* (3) *With what wire to wind an eight slot former for 1,000 metres.*

(1) There is no difference. We slightly prefer the 12/26.

(2) We cannot answer this without further particulars as to the circuit in which they are to be used.

(3) For the H.F. transformer the wire should be No. 44 gauge, but the number of turns can only be determined experimentally.

**"A.R." (Stockport)** *asks* (1) *For method of connecting two valve panels together.* (2) *If connections of first panel are correct.* (3) *If the set is suitable for telephony.*

(1) If the terminals EF are connected to AB, and with the switch at A1, the magnified oscillation will be put on to the second valve for rectification. Connect a 0·001 mfd. condenser across the L.F. transformer winding, which is in the anode circuit of No. 2 valve. It will be correct to connect the L.T. and H.T. to both sets of terminals.

(2) Yes, except that the lead which at present goes from the secondary inductance and condenser to the + 6 volt terminal, should go to the — 6 volt terminal.

(3) Yes, providing the windings are suitably proportioned.

**"V.N.N." (India)** *asks questions relative to the connection of grid and anode circuits to the negative side of the filament.*

It is impossible to give a general rule as to which side of the filament the grid should be connected to, though generally it is better to connect it to the negative side. It is customary to connect the — H.T. to the + L.T. Although this is not essential it is as well to have a rule to work to, to avoid cross connections when several pieces of apparatus are used on one set of batteries. There are not many four-electrode valves in use at present. They have been tried for various purposes, sometimes to do the work of three-electrode valves and also to give more amplification than can be obtained with a single three-electrode valve.

**"BASKET COIL" (Birmingham)** *asks* (1) *If a dry battery can be used for lighting filaments.* (2) *Why accumulators are always used.* (3) *If in the "school receiver" any ill-effects will result from altering the lengths of the leads.* (4) *If he should use solenoid or pancake coils.*

(1) Yes; but only if of very largest size obtainable, and for quite short periods.

(2) Chiefly because of the very great expense of providing the necessary fairly heavy and steady currents by means of dry cells.

(3) No, provided the alterations are only moderate in amount.

(4) Immaterial.

**"BEGINNER" (Kenilworth)** *asks for a telephone transformer for telephones of 500 ohms. per earpiece.*

Telephones of this resistance are best used without a telephone transformer, which, if made, would not be very efficient. The most suitable winding is primary 2½ oz. No. 44 S.S.C. wound over a secondary of ¾ oz. No. 42 S.S.C.

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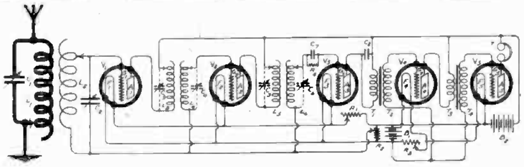

Fig. 34A. The best Amplifier Circuit for Experimental Reception.

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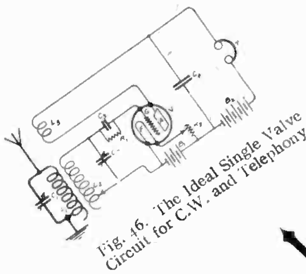
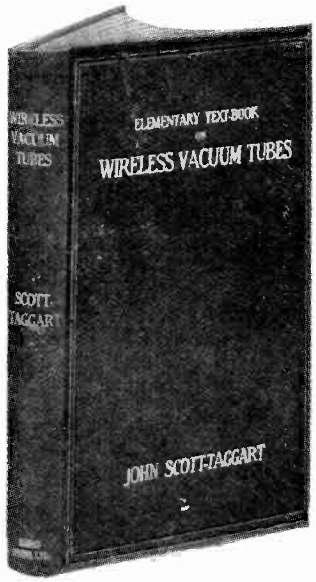


Fig. 46. The Ideal Single Valve Circuit for C.W. and Telephony.



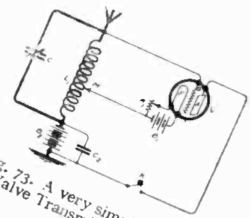



Fig. 73. A very simple Valve Transmitter.

These reduced diagrams are selected at random from a whole mass of practical information and circuits.

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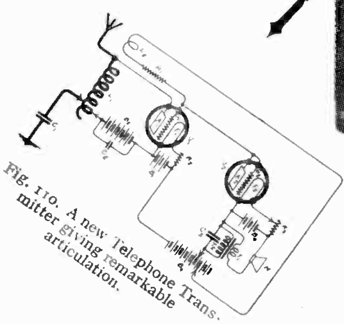

Fig. 110. A new Telephone Transmitter giving remarkable articulation.

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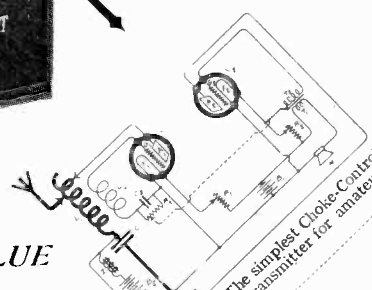

Fig. 100. The simplest Choke-Control Telephony Transmitter for amateurs.

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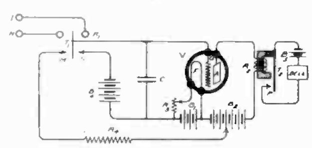

Fig. 125. A simple Call Device which rings a bell when a dash of predetermined length is received.

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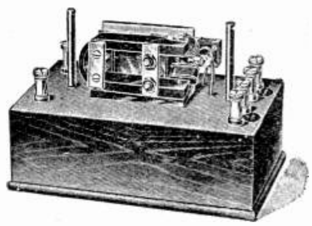

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**"J.H.G" (Forest Hill)** *asks* (1) *For a set to receive* **PCGG.** (2) *If valve and crystal set of April and May, 1920, or a single valve set would be most suitable.* (3) *For a diagram to modify the valve and crystal set.* (4) *For a loose coupler tuned to 400 metres.*

(1) See page 67, April 30th, 1921, issue.

(2) and (3) The valve and crystal set with additional note magnification should give very good results. The three-valve amplifier referred to is not suitable for this set. Do not cut out the crystal rectifier.

(4) Primary 4″ × 8″ of No. 22; secondary 3″ × 6″ No. 26, tuned with a 0·0003 mfd. condenser.

**"W.S." (Blackburn)** *asks questions about screening receiving circuits.*

Broadly speaking, copper or zinc should be used for H.F. screening, and iron for L.F. Two thin screens inside each other is far better than one thick screen. Screening should not be of perforated material, and in fact should have as few holes in it as possible. All joints should be well soldered together and the screens should be earthed. The screens should not be too close to windings.

**"C.V.H." (Ludlow)** *asks* (1) *For criticism of a three-valve set.* (2) *If coils are suitable for a given range.* (3) *For criticism of the aerial.*

(1) Circuit is O.K. Condenser C.6 would be better than C.5, which is rather small. The basket coils for reaction, and reaction coupling coil 3, are too small. Better results would be obtained with a 3″ former with 8″ of No. 32, made to slide in and out of the secondary.

(2) Yes.

(3) Little would be gained by changing the position of the wire or the lead-in. It would have been simpler in the first place to take the lead-in from the end of the wire, thus saving the work entailed in making the joints.

**"HETERODYNE" (Nottingham)** *describes a single valve set and asks if satisfactory.*

Aerial circuit is satisfactory. The secondary circuit should be tuned by a variable condenser, at present only shown dotted. The telephones should be in series with the anode battery, preferably with a 0·001 mfd. condenser across them. Reaction coil connected between positive H.F. and anode of the valve and coupled to the secondary circuit would be a great advantage. This coil may be 3″ × 8″ No. 28. Closed circuit condenser may be 0·0003 mfd.: maximum wavelength would then be 4,000 metres.

**"N.M.J." (Luton).**—(1) Range will be from 300 metres up to 10,000.

(2) Under conditions such as these the maximum wavelength is given very closely by that of the combined capacity and inductance, which may be calculated from the ordinary formula.

(3) For long wavelengths use a reaction coil somewhat smaller than the main coil; for short somewhat bigger.

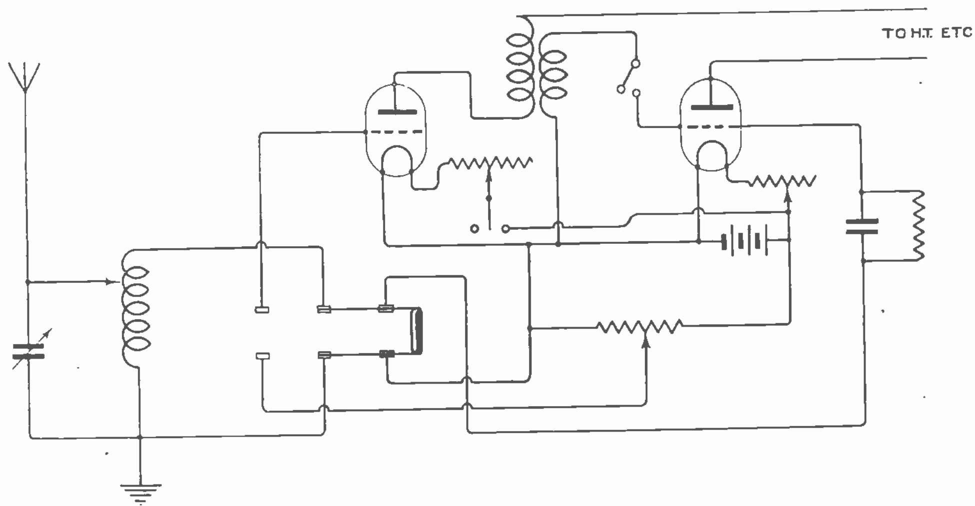


*Fig. 4.*

(4) It is better to use separate coils and not tappings on the coil.

**"C.C.J." (Weymouth)** *asks* (1) *If basket coils wound with No. 42 gauge wire will do for his circuit.* (2) *What is (a) the cheapest and (b) the most efficient way of adding a valve to his set.*

(1) No. 42 gauge is much too fine. The resistance added to the circuit by its use will prevent satisfactory results being obtained as well as being very difficult to wind. Do not use finer than about No. 32.

(2) (*a*) Probably the cheapest is to add as an L.F. amplifier, but (*b*) addition as H.F. valve, with either transformer or resistance coupling should be more efficient.

**"E.W.S." (West Norwood)** *asks for a diagram of a circuit to fulfil certain requirements.*

Capacity reaction is unsuitable for use in a circuit where the number of valves to be employed is to be altered. With magnetic reaction retained the first two valves should be as in the diagram Fig. 4, remainder of the circuit should be as in Fig. 4, page 526, to which you refer.

**"B.H.T." (Hythe)** *asks what will be the most suitable form of set for an amateur having no access to a supply of electricity.*

If you have no facilities for charging accumulators, the use of valves is almost out of the question and you are therfore reduced to the use of a crystal set, which is quite capable of giving good results in a somewhat limited sphere of application, or to the use of one of the various methods described in the article you refer to, all of which are, however, far inferior to the corresponding valve methods.

**"T.P.M." (Derby)** *asks* (1) *For criticism of a circuit supplied.* (2) *If it will work from 200 to 25,000 metres with suitable coils.* (3) *Which are better, slab or honeycomb coils.* (4) *If a separate heterodyne can be used.*

(1) The set is satisfactory as it stands.

(2) Amplification would be very poor below 700 or 800 metres.

(3) Honeycomb coils are somewhat the better.

(4) Yes. Introduce a coil in one of the H.F. grid circuits, coupled with the oscillating circuit of the heterodyne. The stronger the heterodyne the nearer to the rectifier it can be introduced.

**"M.W.L." (Brentwood).**—The results you are getting seem fairly good, but we should prefer a stage of H.F. amplification. Also ebonite would be much better for formers. For assistance in obtaining short wave signals see the reports published in recent issues on the reception of the short wave Transatlantic signals.

**"E.S." (Enfield)** *asks re the single valve long wave receiver of February, 1921.* (1) *If the capacity may be made up by a 0·0007 mfd. variable with fixed mica condensers in parallel.* (2) *If the two units described may be put side by side in one case without ill effect.*

(1) Yes.

(2) This is inadvisable unless the coils are kept fairly well apart and turned at right angles to each other.

**"HETERODYNE" (King's Sutton)** *asks* (1) *For criticism of set.* (2) *Best arrangement for telephony.*

(1) and (2) The whole set is of very indifferent type. It should be rearranged as in the diagram (Fig. 5). At least 45 volts should be used with an "R" valve.

**"INDUCTANCE" (Huddersfield)** *asks* (1) *For windings for a receiver from 300 to 25,000 metres.* (2) *For the difference between H.F. and L.F. amplification.* (3) *For information about a H.F. amplifier.* (4) *Criticism of a receiving circuit.*

(1) You will require a series of honeycomb coils ranging in size from about 40 turns to 1,000 turns with a mean diameter of 3″.

(2) H.F. amplification is amplification of incoming signals before rectification. L.F. amplification is amplification of the telephone note after rectification.

(3) See Nos. 41, 42, 43 and 52, of Vol. 9.

(4) The circuit is quite correct.

**"C.B." (Doncaster).**—We should advise you to read an elementary text book, such as Bangay's "First Principles." Your only essential apparatus for a crystal set is an inductance with a slider, a variable condenser, a crystal with potentiometer, and a pair of high resistance telephones. For diagram see reply to "D.A.K.B." (Cheltenham), above, but arrange the slider on the closed circuit coil and the earth to one of its ends. Two dry cells only will be required. Aerial should be as large as possible up to the maximum of 100 ft. allowed.

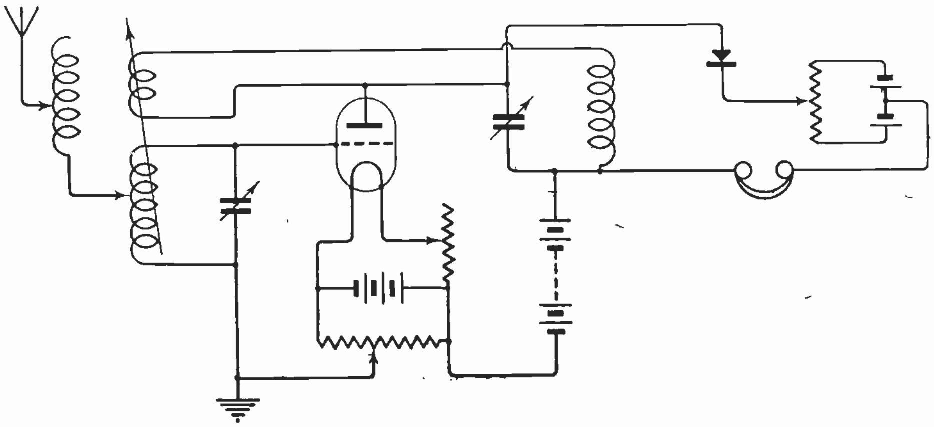

*Fig. 5.*

**"RADIOCON" (Battle)** *asks* (1) *Which of two circuits is the best for general purposes.* (2) *Maximum capacity of condenser across primary of H.F. transformer.* (3) *If a 6 volt dry battery as used for car lighting could be used for the filaments.* (4) *Best wire for connecting parts of the set.*

(1) That of Fig. 3, page 674.

(2) Generally about 0·0005 mfd.

(3) Probably, but would be rather expensive.

(4) Rubber covered flex of about 2 ampere carrying capacity.

**"T.W.A." (St. George's)** *asks questions about crystal set.*

(1) The wiring should be as in reply to "C.B." (Doncaster).

(2) Wavelength ranges will only be a few hundred metres. Increase the A.T.I. to about 6″ × 10″.

(3) An additional valve would improve results. You will find many circuits in these columns, but we should advise you to experiment with a crystal set first.

(4) Yes, but even your crystal set will receive telephony from fairly near stations.

"——." **(Upper Tooting)** *asks* (1) *Whether capacity reaction or a separate heterodyne would be best for the set described in January 8th, 1921, issue.* (2) *If aluminium wire could be used for a frame aerial.* (3) *For winding of a frame for 3,000 metres.*

(1) If you are referring to a frame aerial set, a separate heterodyne would be preferable.

(2) Aluminium wire could be used, but would have no special advantages. Gauge should be about No. 16.

(3) About 50 turns, spaced about one centimetre apart, with taps at the 10th and 25th turn.

**"DELTA" (Gosforth)** *asks for value of capacity, inductance, etc., for each circuit of a three circuit receiver for 1,000 metres.*

(1) A.T.I. 1,500 mhys. Intermediate condenser should be large, say 0·002 mfd., in which case the inductance of the two coils which are in parallel should be 300 mhys. each. Resistance of all circuits should be small. Coefficient of coupling should be about 5 per cent.

**"K.S.L." (Bournemouth)** *refers to Fig. 5, page 706, February 4th issue, and has added an additional switch to cut out the H.F. valve and use either a crystal of valve rectifier, and asks for criticism.*

Only a single-pole switch is necessary to change to either grid or crystal. The filament switch of No. 2 valve is wrongly connected. It should have nothing to do with the telephones, and as at present arranged, it does not light the valve.

**"CLIVE" (Welshpool)** *asks* (1) *The potential difference between the earth and the atmosphere at heights of 50′, 100′ and 150′.* (2) *For the specific heat of air.*

(1) There is no definite value. At times it is negligible, at others considerable with either sign. The values depend on climatic conditions and we are unable to give you definite figures. It may be as high as 50 volts per foot, the atmosphere being generally positive to earth in fine weather.

(2) This is not a wireless question and we should advise you to consult a good text book on theoretical physics, as air being a mixture of gases has more than one specific heat. However, we may say that the specific heat at constant pressure is roughly $6{\cdot}5 + 0{\cdot}0005$ T, where T is the centigrade temperature.

**"J.T.L." (South Norwood).**—(1) The coupler is not very good as the resistance of the primary will be too high. This will prevent it being used for crystal work, but it might be used for reaction in a valve set.

(2) 0·0034 mfds.

(3) This depends on the use to which the coils are to be put. Without knowing the circuit we are unable to give you values.

**"C.G.B." (Newport, Mon.)** *asks for suggestions as to extending the range of a German tuner.*

As this tuner is designed for efficient short wave reception it will be difficult to extend the range without dismantling. Completely strip out all the winding, remove wire from formers and rewind the large diameter A.T.I. with a two pile winding, and smaller diameter portion with a row of basket coils. Wind the rotating former with a four-pile winding and use as reaction. Arrange the barrel switches to eliminate dead end effect. Remove the buzzer, substitute a valve holder and connect up as a reaction tuner with tuned plate circuit. The "Zelle" and "Prufentaste" keys may be connected for short and long wave tuning.

**"B.H.C.M." (Portishead)** *asks* (1) *Why, in a simple one-circuit crystal set the current goes through the high resistance of the crystal and telephones rather than through the low resistance of the A.T.I.* (2) *If it would be better to wind the A.T.I. with No. 34 instead of No. 36.* (3) *What are the times, etc., of the half-hour weekly telephony.*

(1 and 2) For an adequate treatment you should see a book such as Bangay's "First Principles." We may point out that for the very high frequencies employed in wireless the inductance of the A.T.I. makes it offer a great impedance to the passage of current in spite of its low ohmic resistance. Using No. 34 wire is undesirable as it increases the ohmic resistance which leads to bad tuning and a weakness of signals.

(3) Tuesday evenings, 7 to 7.30 p.m., $\frac{1}{4}$ kW., wavelength 700 metres.

**"H.C." (Brighouse)** *sends sketch of a circuit and asks* (1) *Particulars of intervalve transformer and telephone-transformer.* (2) *Values of certain condensers.*

(1) Intervalve transformer, 1 oz. and 3 ozs. of No. 44, wound on a core of iron wires $\frac{1}{2}''$ diameter by 3″ long. For telephone transformer, see reply to **"IVAN" (Mill Hill)** recently.

(2) C about 0·001 mfd., D about 0·0005 mfds.

**"C.W.S." (Hurstpierpoint)** *refers to Fig. 10, page 726, February 18th issue, and asks* (1) *For values of condensers.* (2) *If suitable for a beginner.* (3) *If certain gear is suitable for the circuit.*

(1) The A.T.C. about 0·001 mfd. and the anode condenser 0·0005 mfd.

(2) We do not like this circuit at all. It will give great sensitiveness at times, but a double tuned circuit of this kind is always very tricky to handle. It will give serious reradiation, and the telephones should be on the earth side of the H.T. battery, and should also be shunted by a condenser. We should advise you to omit the 0·0005 mfd. condenser, to begin with at any rate.

(3) Yes.

**"TYRO" (London)** *asks* (1) *For a descriptive book on wireless dealing with the earlier work and also the more modern.* (2) *For a book describing the construction of a single valve receiver.*

(1) Most of the earlier books describe the initial work well. A good modern descriptive book is "Stanley's Wireless Telegraphy." More elementary books are "Bangay's First Principles" and his "Oscillation Valves."

(2) We do not know of such a book, but articles on the subject appeared in the issues for February 5th, 19th, and March 19th, 1921.

**"NIVICE" (London)** *asks* (1) *The cost of a small complete valve receiver, capable of receiving* **PCGG.** (2) *What instruments will be necessary to build one.*

(1) It is difficult to give exact figures as so many different types of set are possible. You should be able to buy a set complete with batteries, etc., for from £10 to £15. If you made it yourself it would cost about half this.

(2) Aerial, various tuning coils, two variable condensers, about two valves, filament battery, H.T. battery, filament resistance, telephone transformer, one or two block condensers and a pair of telephones.

**"J.E.S." (Oundle)** *sends sketch of a circuit and asks if it is correct. (2) If he can use No. 32 wire. (3) If a condenser of a type described will be useful. (4) If it can be used for the circuit shown.*

(1) No. The primary of a coupler should be in series with the A.T.I. and not in parallel with it.

(2) For useful wavelength range coils should be bigger than you suggest; A.T.I. say 6" × 12" of No. 22; coupler primary 4" × 3" of No. 22; Secondary, 7" × 5" of No. 26.

(3) Condenser should be fairly satisfactory if the plate systems are well insulated from each other with ebonite or similar material, but you will probably find the calibration will vary considerably from time to time.

(4) Yes. Your potentiometer arrangement is incorrect.

**"W.R." (North Shields)** *submits a diagram and asks for criticism. (2) If vulcanised fibre sheet may be used for mounting the set.*

(1) Set is O.K., except for the anode circuit arrangement. It is undesirable to pass the current from both valves through the telephones. The iron-cored winding in series with the reaction coil should have a condenser across it. The connections of the anode circuits may be as in Fig. 3, page 674, in which the telephones are supposed to be inserted across the 0·001 mfd. condenser.

(2) This material, if of good quality, should be quite satisfactory, providing your operating room is kept fairly dry.

**"THOMAS McGEE" (Hampton-in-Arden).**

(1) The set will probably work with these coils.

(2) Try about 0·001 mfd.

(3) Yes.

(4) Difficult to say exactly, probably up to about 600 metres.

**"J.B.B.M." (Bothwell)** *refers to Fig. 12, page 726, and asks (1) For dimensions per coil. (2) If "Ora" valves could be used. (3) What H.T. battery would be required. (4) If it should receive* **2MT**.

(1) About 9" × 5" of No. 26. The coil should, of course, have a slider.

(2) Yes.

(3) About 60 volts.

(4) It might, but we do not think a great deal of the merits of this circuit.

**"J.B." (Sittingbourne)** *submits a diagram of a two-valve set and asks (1) If it is the set or his own inexperience which prevents him getting* **PCGG.** *(2) How the valves function. (3) If it is correct to prevent reradiation by using as much filament resistance as possible.*

(1) We see no reason why the set should not receive **PCGG.** Failure is probably due to inexperience as you suggest.

(2) The first valve is H.F. amplifying and the second detecting.

(3) This will do so, but only at very serious expense of weakening of the signals. The results should be obtained by coupling the aerial very loosely to a closed circuit attached to the grid and filament of the first valve.

**"AMATURE" (Ramsgate)** *sends a diagram of a four-valve circuit and asks (1) For criticism. (2) If it should receive* **PCGG** *at 500 miles on a P.M.G. aerial. (3) Value for leaks. (4) If he should hear* **BYZ** *on a frame aerial.*

(1) Quite O.K., except more H.T. volts, say 80 are desirable.

(2) Yes.

(3) 2 to 5 megohms.

(4) Probably with a good frame of large dimensions.

**"V.B." (Reading).**—It is of no use your merely loading your aerial up to the wavelength of a normal P.M.G. For satisfactory results you will require to tune for much longer wavelengths than this, say 3,000 metres. For this purpose your coils should be about 6" × 10" wound with No. 22.

**"W.E." (Waterlooville)** *sends a diagram of a crystal receiver and asks (1) The use of a high resistance coil connected across the aerial and earth terminals. (2) For windings for 7,000 metres. (3) If certain samples of wire might be used.*

(1) This coil is a static leak, to prevent any charge picked up by the aerial from accumulating on the aerial condenser and finally discharging across it.

(2) With the A.T.C. used in parallel, A.T.I. might be 6" × 8" of No. 22; primary, 3½" × 12", also No. 22; secondary, 4" × 12", of No. 28.

(3) No. 2 or 3 will probably do for the aerial circuit. No. 4 or preferably 5, for the closed circuit.

**"S.A.W." (Croydon)** *sends a diagram of a two-valve set for criticism, and asks (2) If it will receive* **PCGG.**

(1) Circuit is satisfactory, except that reaction coil should couple with closed circuit coil and not with the A.T.I., and also there should be a capacity of about 0·001 mfd. placed across the telephone transformer primary.

(2) Yes.

**"F.S.G." (Derby)** *sends sketches of two circuits and asks (1) If correct, and if the three-valve circuit will receive* **PCGG.** *(2) For criticism of a frame aerial. (3) Capacity of two condensers. (4) What telephone arrangement would be best.*

(1) Crystal circuit is poor. See circuit in diagram given to "C.B." (Doncaster). Valve circuit is in order.

(2) O.K.

(3) About 0·001 mfd. each.

(4) L.R. telephones with transformer is best. H.R. telephones with a 1/1 transformer are generally inefficient, and H.R. telephones alone are undesirable in a multivalve set.

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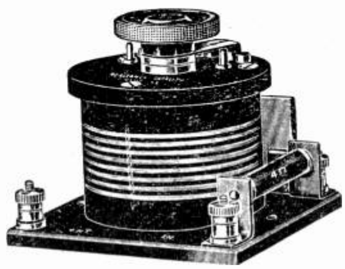

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A MAGAZINE DEVOTED TO WIRELESS TELEGRAPHY AND TELEPHONY

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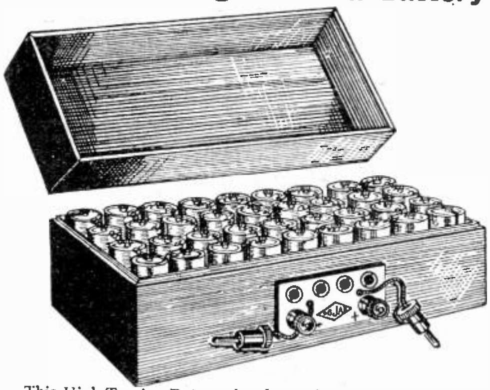

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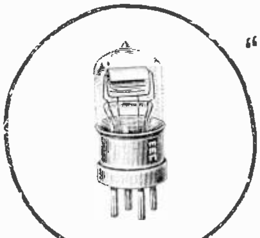

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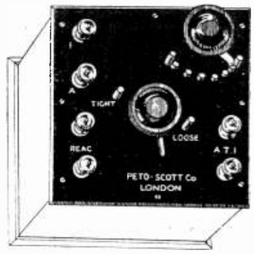


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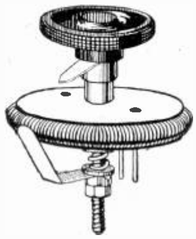

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THE
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AND RADIO REVIEW

THE OFFICIAL ORGAN OF THE WIRELESS SOCIETY OF LONDON

VOL. X. No. 5. APRIL 29TH, 1922 WEEKLY

# C.W. Reception Viewed from Another Standpoint

By PHILIP R. COURSEY, B.Sc., F.Inst.P., A.M.I.E.E.

THE reception of continuous wave signals introduces different problems to those encountered with the simpler receivers which were utilised for "spark" or damped wave reception only. As is generally well known, it is necessary either to cut up the transmitted waves into periodic groups following each other at an audible frequency, as is done in "Chopped C.W.," and in "Tonic Train" transmission, or to apply some similar method at the receiving end of the circuit. If this is not done, each dot and dash will merely give rise in the telephones at the receiver to a current which remains sensibly uniform throughout the duration of the signal.

The desired result will obviously be obtained if the received telephone current is interrupted by some suitable contact or commutator at a frequency within the audible range, so as to allow the flow through the telephones of repeated pulses of current during the continuance of the signal. Such an interrupter can be constructed out of a vibrating contact, such as a tuning-fork provided with a driving magnet and contact in addition to the contacts in the telephone circuit, or by any convenient form of rotary commutator that will give the desired frequency.

Various simple arrangements of this type—"tikkers" as they are usually called—have been described recently in these columns.* It may, however, be of interest to point out that the motor-driven commutator that was fitted into the various patterns of "Wilson" spark transmitting apparatus may be utilised for this purpose. Numbers of these motor-driven commutators have been sold by the "Disposals Board," and some interesting experiments on these lines can be performed with them. They may also, of course, be utilised if desired as a "chopper" in a C.W. transmitting circuit of small power to enable chopped C.W. to be sent out.

The more usual method used for receiving continuous waves is based upon applications of the "heterodyne" method in one or other of its forms, in which the incoming high-frequency oscillations forming the signal are caused to react with a supply of high-frequency oscillations produced locally, the frequency of the local oscillations being nearly the same as that of the incoming signal, so that "beats" are set up between them, much in the same way as beats are produced acoustically between two sounds of nearly the same pitch.

All of these methods can be considered from the viewpoint of *modulating* the steady C.W. by some means or other, so as to impress upon it some variations which will be of acoustic frequency. This modulation may be applied at either the transmitting or at the receiving end of the circuit, and there are, perhaps, some advantages in considering the question in this way. Everyone who has operated, or has listened to a radio-telephone transmitter will be familiar with the term percentage of modulation, and of the effects obtained when the percentage modulation is too low. A similar loss of effectiveness can and does occur when the "percentage modulation" of the C.W. receiver is too small.

For the sake of example, let us consider a few typical cases in turn. Taking first the modulation of the radiated waves from the transmitter, as in "tonic train" or "chopped C.W." transmission. This case is evidently very similar to ordinary radio-telephone modulation, so that a similar reasoning as to the percentage modulation applies. If this modulation is effected by feeding the transmitting valve with single-phase alternating current for tonic-train transmission, or by actual periodic interruption of the transmitting aerial circuit by some suitable form of commutator or interrupter, as in "chopped C.W." transmission, the percentage modulation will be all that is desired. If, however, the modulation of the transmitted radiation is effected by setting up two transmitting circuits of nearly the same oscillation frequency, using either closely adjacent but separate aerials, or by appropriate coupling to one common aerial, so that a beat frequency within the acoustic limits is produced, then the percentage modulation may or may not be satisfactory depending mainly upon the relative intensities of the two oscillating currents.

At the receiver, however, the conditions are very different, and the percentage modulation, if we may use the term in this case in the sense referred to

* *Wireless World*, 9, pp. 652–659.

above, may vary within quite wide limits. For example, consider the reception of C.W. signals by including some form of intermittent contact or interrupter in the aerial circuit in conjunction with a detector of any ordinary type. In this case, the energy in the aerial circuit will pass on to the detector only during those periods when the circuit is closed by the interrupter, but will be lost as far as the receiver is concerned during the remaining intervals. The efficiency of the arrangement will depend upon the relative duration of the open and closed contact periods, but will seldom exceed 50 per cent., and will often be lower. In a sense, however, the modulation by this method may be said to be complete, as the actual energy flowing to the detector varies between zero and the maximum possible value. The arrangement in which the interrupter or "tikker" is included in the telephone circuit—*i.e.*, the detector output circuit—gives, however, better results, since the energy received during the periods when the contact is open need not then be lost, but can be stored up in an appropriate shunt condenser ready for discharge through the telephones, and utilisation therein as soon as the contact closes again.

In the case of heterodyne reception in any of its well-known forms, the modulation of the incoming oscillations is effected by means of the local heterodyne oscillations, which are adjusted to have nearly the same frequency as the signal to be received. The percentage modulation may vary within wide limits depending upon the relative intensities of the signal and the local heretodyne oscillations. The modulated or heterodyned oscillations, have, however, to pass through the detector, and it is here that considerable loss occurs. If the detector were an ideally perfect rectifier, all the semi-oscillations of one sign would pass through it, and all the other half waves would be suppressed, so that the amplitude of the rectified current would be proportional to that of the oscillations applied to the detector. However, in most practical forms of detector—including the ordinary three-electrode

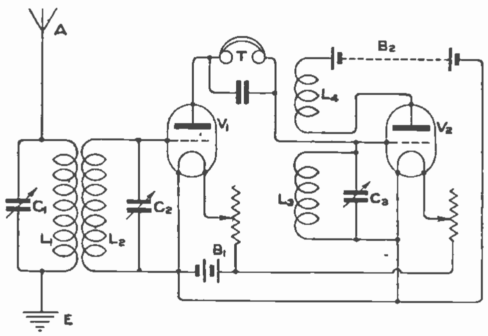
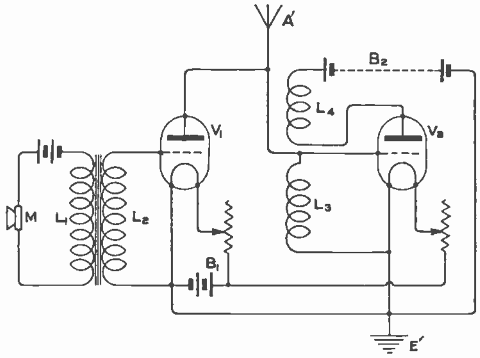



*Fig.* 1.

valve—the output is by no means directly proportional to the input, but falls off more rapidly than the applied input especially for small values of the input. In other words, if we have a given signal effect from a given oscillation source, if the strength of the received oscillation is reduced to one-half of its initial value, the output of the detector will fall off not to one-half, but more nearly to one-quarter of what it was originally. Hence, for very weak signals the ordinary detector becomes very inefficient. The output of an oscillating valve, or autodyne receiver, does not fall off quite so rapidly as does that of a simple detector valve, and this advantage is shared to the same extent by a properly designed heterodyne receiver. One of the main reasons for this improvement is due to the increased




*Fig,* 2.

energy provided by the local oscillations for the detector to handle. The total current passing through the detector can be adjusted by altering the strength of the heterodyne, so that the detector operates at or near its most effective working point.

Bearing in mind, however, what has been stated above with regard to the "modulation" of the signal oscillations, the question may be raised as to whether it is not possible to apply some of the more usual modulation circuits to the receiving apparatus. R. Jouaust in a recent communication to the French Academy of Sciences has pointed out that this may be done, and has stated that remarkably good results are obtainable. In any arrangement of this sort, a detector valve is no longer required, but the incoming signals are caused to modulate the output of a separate oscillating valve—much in the same way as the microphone is used to modulate the output of the oscillating valve of a radio-telephone transmitter. In order that the resultant modulated output may be audible in the receiving telephones, it is desirable to adjust the frequency of the oscillating valve to a value nearly the same as the incoming oscillations, so that the pulsations of the amplitude of the local oscillations at a frequency nearly equal to their own will cause "beats" to be formed which can be heard in the telephone receivers. Evidently to make use of this idea, many types of circuit are possible, since the modulation can be applied to the oscillating valve in a number of ways. In Fig. 1 is illustrated diagrammatically one such method—the incoming signal oscillations being employed to control a modulator valve which acts as an absorption shunt to the oscillation circuit of the local oscillator valve. The telephones T in that diagram are shown in series with the plate circuit of the modulator valve, so that they are influenced by the current shunted off from the oscillator.

The receiving aerial circuit A, $L_1$, $C_1$, E, is provided with the usual tuning and coupling arrangements for passing the incoming energy on to a tuned secondary circuit $L_2$ $C_2$, in the usual manner.

In place of joining the usual detector valve across the secondary circuit $L_2C_2$—or alternatively across the aerial circuit $L_2$ $C_2$ by direct connection—the grid and filament of the *modulator valve* $V_1$ are similarly connected. The local oscillator valve $V_2$ is provided with the usual oscillation circuits for generating oscillations in the closed circuit $L_3$ $C_3$ by the reaction coil $L_4$ connected in the anode circuit of this valve. The plate-filament circuit of the modulator valve $V_1$ is connected across this oscillation circuit $L_3$ $C_3$ of the valve $V_2$, so that the plate-filament path of the valve $V_1$ acts as a shunt of variable impedance across the oscillation circuit, $L_3$ $C_3$, thus controlling the amplitude of the locally generated oscillations. The telephones T should be shunted by a small by-pass condenser, since the currents drawn off or absorbed by the modulator valve are radio-frequency ones from the oscillatory circuit $L_3$ $C_3$.

The similarity of this arrangement to the shunt or absorption control method for a radio-telephone transmitter may be brought out by comparing Fig. 1 with Fig. 2, which shows the connections for the transmitter, the modulator valve $V_1$ here being controlled by the microphone M, and the output of the oscillator valve $V_2$ being applied to the aerial circuit A′ E′ instead of to the telephones T (Fig. 1) In both cases both valves can be fed from the common L.T. battery $B_1$, while the H.T. source $B_2$ is connected in the plate circuit of the oscillator valve only.

Some experiments on these lines that have been carried out by the writer, have shown that the method can quite easily be given the same order of sensitiveness as is possessed by the more usual detector arrangements, while doubtless a better arrangement of the apparatus would give improved results. It has in fact been claimed by Jouaust that by this method, used in conjunction with two high-frequency amplifying valves, it is possible in Paris to read signals from Annapolis using as a frame aerial a square coil of wire of 8 ins. side by 4 ins. long, and that the results obtained are much superior to those possible with ordinary apparatus.

In order to experiment with the method, any convenient separate heterodyne oscillator may be used for the valve $V_2$ (Fig. 1) and its associated circuits, and the modulator valve can be joined across the tuning condenser of the heterodyne in the manner indicated. It is convenient sometimes to add a potentiometer in the grid circuit of the modulator valve $V_1$, so as to control its absorption effect on the oscillation valve. Experiments show that as a rule no improvement of the arrangement is made by adding a D.C. voltage into the plate circuit of the modulator valve in addition to the H.F. voltage applied by the oscillator valve $V_2$, thus showing that the valve is functioning truly as a modulator rather than as a detector valve.

Evidently the modulation effect can be applied to the oscillator in many different ways, but these may not all be equally effective for receiving purposes, just as their operation as transmitters varies with the conditions of use. Further experiments on these lines are in progress, the results of which may be published at a later date.

# The Writtle Transmissions

IT is really only a matter of a few weeks since the introduction of the first officially recognised transmissions for amateurs in this country, and yet already the Tuesday evening telephony and transmission of calibration waves is looked forward to as an established feature in the amateur programme.

From the numerous reports on the reception of these transmissions which we have received, it would appear that the reception is good in almost every part of the country, and the transmissions, particularly the telephony, is very much looked forward to.

The Marconi Scientific Instrument Company, in their transmission of telephony on Tuesday, April 11th, gave some interesting information regarding the station and also notes on the reception in different parts of the country obtained from letters received from amateurs. For the information of those who did not record these remarks, we give below some of the more interesting of the observations transmitted.

The speaker at the Writtle Station announced that many hundreds of reports on their transmissions had been received, and that only a few would be quoted. An observer at an aerodrome over 100 miles distant from the transmitting station wrote that " out of all the telephony I have heard, both service and commercial, it is by far the best and most clear." Mr. G. W. Benzie, of Peterculter, Aberdeenshire, reported that he could follow the music with telephones on the table using three valves, and Mr. J. A. Crombie, of Guthrie, Forfarshire, using an amateur-built five-valve set, gets the music and speech in a loud speaker audible all over the room. It is interesting to note that some careful observers in Edinburgh have difficulty in getting the telephony and report that a fading off is marked. Those responsible for the transmissions state that the aerial amperage during transmission remains practically constant throughout, and, in consequence, they attribute this fading to local conditions in the Edinburgh district, and invite further reports and observations from that district in particular. In the Liverpool district the telephony is well received with a single valve set, though some jamming from Seaforth is experienced. Two of the most interesting reports of reception which were announced are those of Messrs. S. Lowley, of Liverpool, and C. Bain, of Newcastle-on-Tyne, the former reporting clear reception of the telephony on a four-wire indoor 12-ft. aerial, using a three-valve receiver, and the latter reporting that music is audible three feet from the telephones using an indoor aerial 25 ft. long, and a four-valve receiver, using two high frequency amplifying valves.

The accompanying photographs will be of interest as showing the aerial and apparatus used in the transmissions.

Fig. 1 shows the aerial at Writtle, the dimensions of which are 200 ft. long and 110 ft. high, the aerial

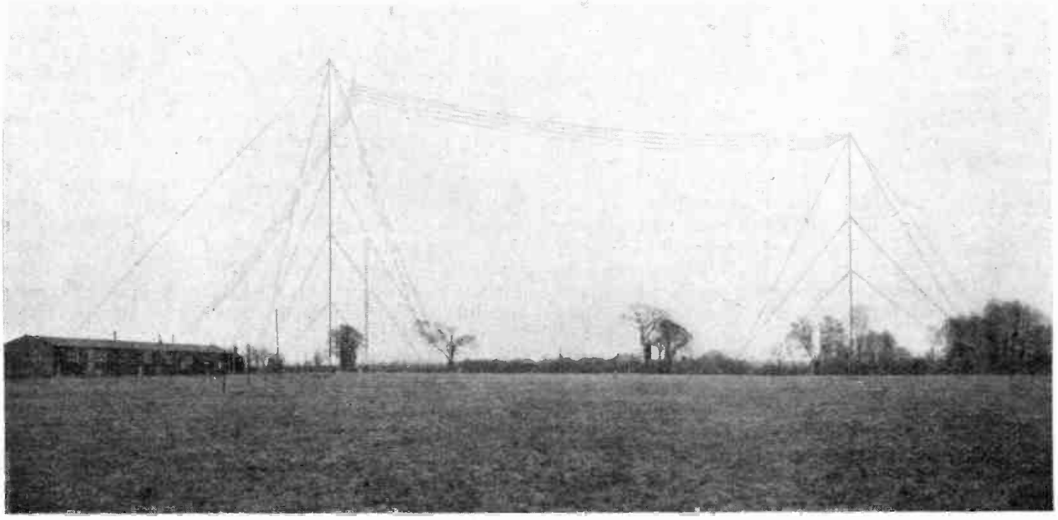


*Fig. 1. The aerial used for the* **2MT** *transmissions.*

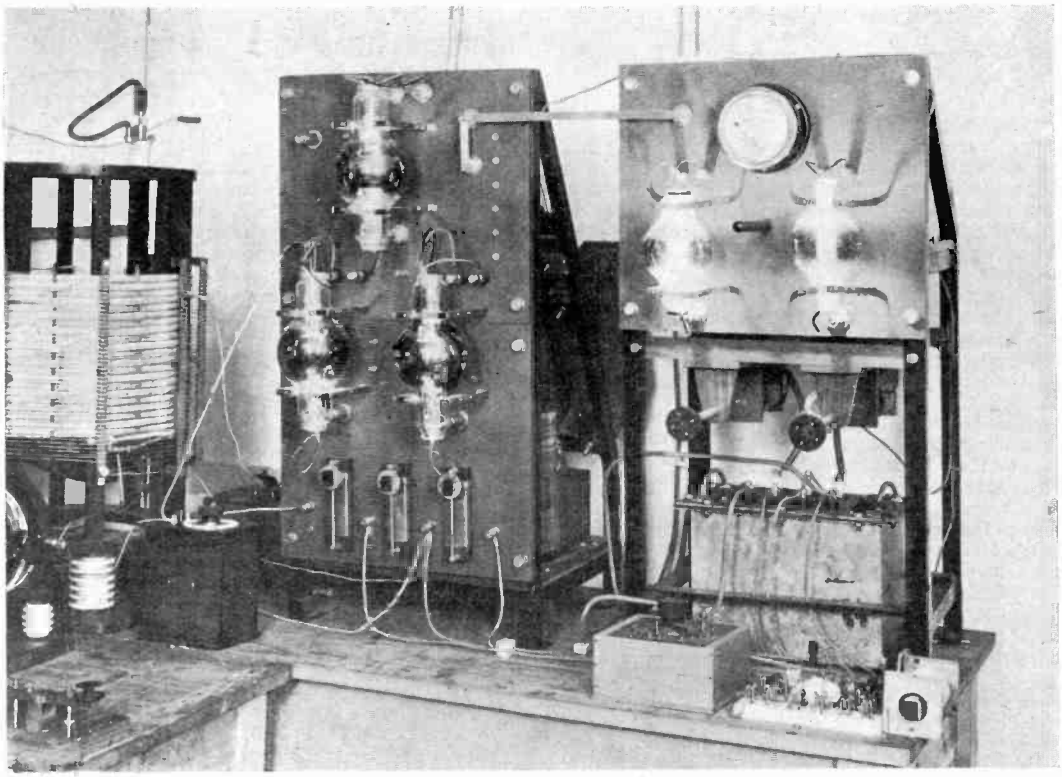


*Fig. 2. The transmitting apparatus of* **2MT.**

being of the inverted "L" type, employing four wires.

Fig. 2 shows the transmitter, including the rectifier valves, choke control being used in modulation. It is hoped to give a fuller account of the station at a later date.

The organisers of the transmissions notify us that they hope a change in wavelength may be effected at a later date in order to overcome some of the jamming which most of the reports received indicate gives a good deal of trouble. In this connection they suggest that frame aerials might be used to a greater extent by those who are able to employ several valves in their reception, and that perhaps some useful experimental work might also be done in the direction of eliminating interference by the execution of suitably directed aerials.

# An Amateur Station in Chester

By J. C. WALKER.

A YEAR ago I decided to re-erect the wireless installation which I had at my house prior to the war. I decided to make a single valve set of simple design and had no intention of constructing a large station or spending much time on it, but the accompanying photographs and description will show how resolutions can so easily be broken when one gets really keen.

I will spend no time in giving details of all the long from the free end to the instruments spaced for 54 feet of its length by two 7 ft. 6 in. ash spreaders. The free end is 54 feet high and the lead-in end is 34 feet high. The tallest mast is fixed to a 10 ft. baulk of oak, sunk five feet into the ground on a cement bed, and is so arranged that four men can lower the mast in a few minutes by means of a block and tackle. Except for slight screening near the lead-in the aerial is well clear of all trees

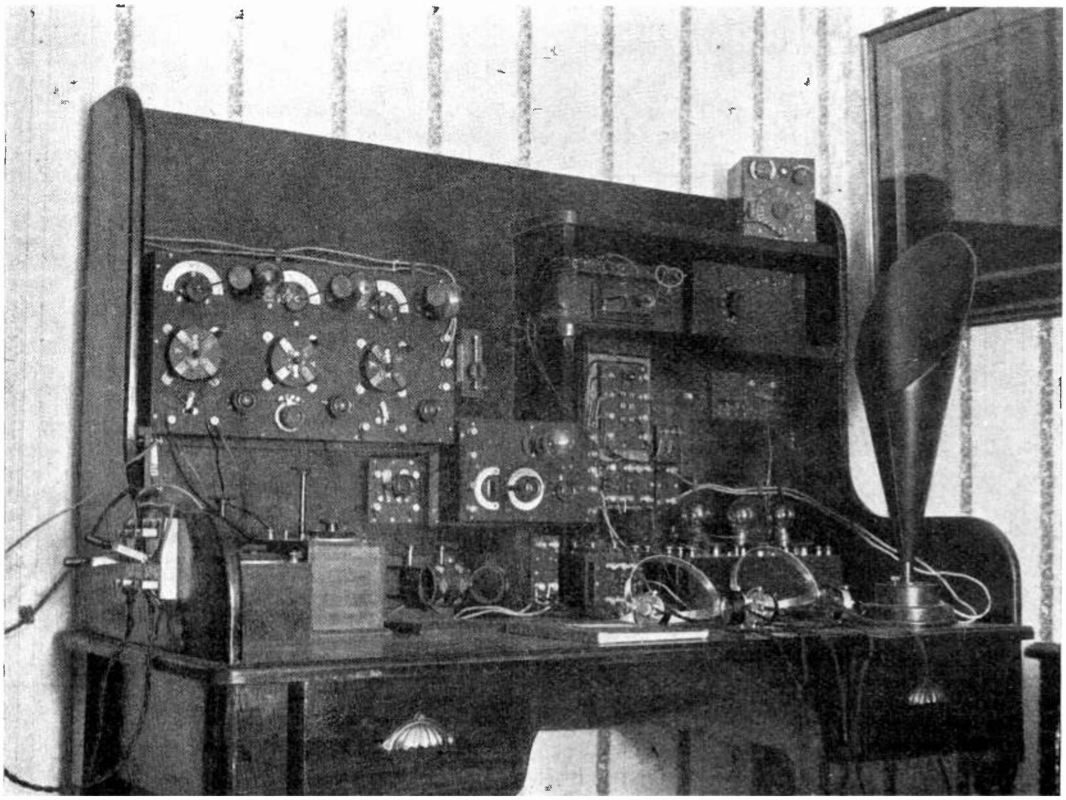


*Fig* 1.

various circuits and instruments I have made and scrapped before I considered my set was, in my opinion, nearly perfect, but will start now on a description of my present station.

The aerial is a twin wire phosphor bronze 70 feet and roofs. The earth is to a water pipe conveniently situated in the instrument room.

The set itself is easily explained by a glance at the diagram of connections.

Tuning is done entirely by honeycomb coils.

The first few honeycombs used were home-made and gave very good results, but to make a neat job of them took so much time that I considered it cheaper in the long run to buy them.

My formers were made of 2 in. diameter hard wood, $1\frac{1}{4}$ in. wide, 32 holes being drilled equally round each side to take thin crochet needles, the method of winding following that described in a back number of *The Wireless World*. I found that to get a pure honeycomb formation took me about five minutes a layer and a considerable amount of patience.

The honeycombs now used are those sold by Messrs. Ashleys, of Liverpool. I have about twenty of them and find that some of the coils have to be duplicated for best results for some stations, using them as a loose coupled tuner. The two tuning condensers are of 0·001 mfd., shunted by a vernier condenser for fine tuning.

The three valve H.F. amplifier has now been in use about eight months and gives good results. The transformers used were purchased, but extra valve sockets have recently been fitted to use transformers of my own make, having four valve pins fitted. A 4-point rotary switch is so wired that either none, one, two or three valves for high frequency amplification can be used, pulling out the transformer which is not required, breaking off the circuit of the unused valve. This I find useful since one does not require to use all three valves on high power stations.

Transformers wound to the following wavelengths are used: 400, 600, 1,000, 2,000, 5,000, 8,000, 10,000 and 13,000, and more are in course of construction.

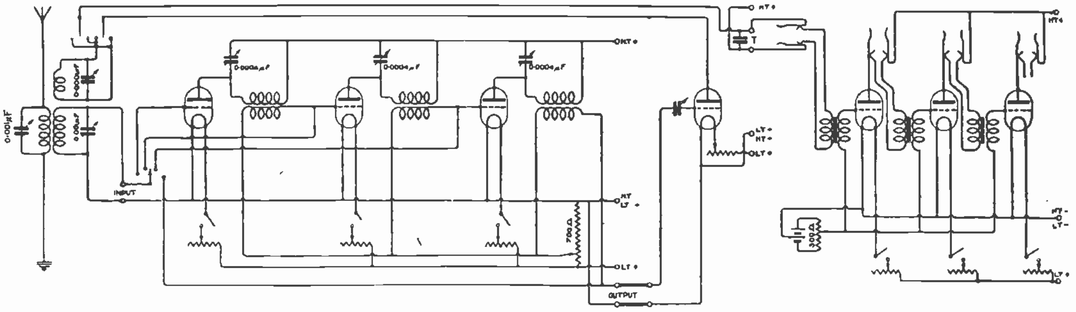


*Fig 2.*

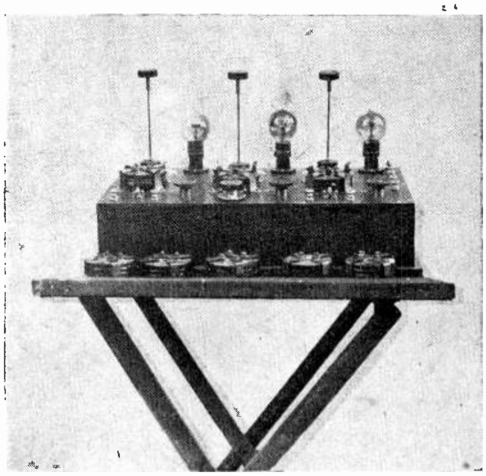


*Fig.* 3.

Three variable condensers are shunted across the primaries of the transformers. These condensers are fitted with long ebonite handles so that the capacity of the body does not upset the setting. (See Fig. 3). Each valve is controlled by a separate filament rheostat, a potentiometer of about 600 ohms, external to the instrument controlling the grids. I use Mullard valves on this amplifier.

The amplified oscillations are next brought to a separate unit, which is purely and simply a rectifier. This instrument can be used by itself as a single valve receiver and comprises reaction condenser, filament resistance, valve socket, grid leak, variable grid condenser of 0·004 mfd., telephone condenser and necessary terminals. Interposed between this rectifying unit and the 3-valve low frequency amplifier is a jack, mounted in a box with four terminals. All the telephones have plugs fitted to them, therefore it is quite an easy matter to plug in either the head telephones or loud speaker after the first four valves and thereby breaking the circuit to the low frequency amplifier.

The 3-valve low frequency amplifier follows standard practice. All the three transformers are spaced out as far as possible in the instrument, each valve has a separate rheostat and jacks are fitted so that either one, two, or three valves can be used at will. A potentiometer and local cells of 3 volts control the grids. Marconi " R " valves are used with this instrument. This instrument can be seen in the right-hand bottom corner of the table (see Fig. 1).

Since this amplifier works so quietly I have just constructed an extra stage so as to bring in concerts even louder than before. This comprises a separate unit (not in Fig. 1), having a Federal transformer, two valves in parallel, to cope with the heavy current, rheostat and switch.

The loud speaker is of 4,000 ohms. resistance, one pair of head telephones are of 120 ohms and are of the adjustable type (Brown's), used with a transformer, the others are Brown's A type, 2,000 ohms, which I find are slightly better for telephony.

Two H.T. batteries are used, one of 45-60 volts for the H.F. amplifier and rectifier; 75 volts on the L.F. amplifier, Siemen's 15 volt units being used.

A reversing switch is fitted in the reactance circuit (magnetic reactance being used). Three 6-volt, 100 amp. hour accumulators are used for the valves, these being kept continually charged on the premises.

All instruments are mounted on matt finished ebonite and the panels are fitted on to polished mahogany boxes, every terminal and screw-head is nickel-plated, so giving the set a very pleasing finish. The table and some of the instrument boxes were specially made for me, otherwise all the rest, with the exception of coils, transformers and some variable condensers, were home-made in my own workshop.

Although the photographs were only taken a few weeks ago, many detailed improvements have been made, the tuning condensers have been mounted in a more convenient position (they can be seen in the bottom left corner of the table), and wiring has been much simplified.

Results with this set are good. 2MT is excellent. Annapolis, New Jersey, etc., come in well. PCGG has been heard down in the garden 40 yards away from the set. Mr. Burnham and Mr. Wm. Le Queux have been heard, and the Sheffield, Manchester and Halifax amateurs come in loud. Paris, with her afternoon telephony, is good, but I have yet to wind some H.F. transformers to her wavelength for best results. All European stations come in well, in fact there is a regular "farmyard" on every wavelength.

I have omitted to go into a detailed construction of my set, but if anyone should care to know anything further about the various instruments I will be pleased to furnish particulars if they apply in writing to me at 9, Curzon Park, Chester, where my station is situated.

# A Detachable "Pin-Type" Resistance Capacity Coupling for H.F. Amplifiers

By H. G. EVANS, M.Sc.

ONE of the disadvantages of the invaluable "pin-type" interchangeable H.F. transformers, now so commonly used in H.F. amplifiers, is the expense of winding them for the higher wavelength ranges. This expense is unnecessary for wavelengths above 2,000 metres if the ordinary resistance-capacity coupling can be quickly substituted for that of the transformer, as it is well known that there is little to choose between the two methods on the higher range of wavelengths.

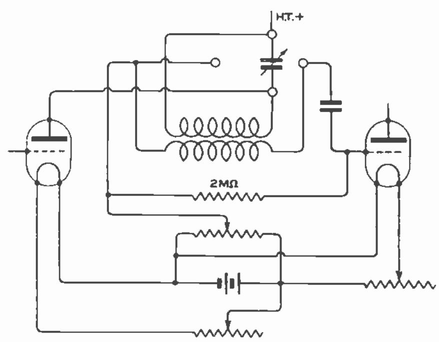



*Fig.* 1.

The writer has found the following pin-type high-resistance-capacity coupling very efficient when used in conjunction with a one-valve H.F. set having grid condenser and leak attached to a second detector valve. The coupling between these two valves is as shown, when using transformer.

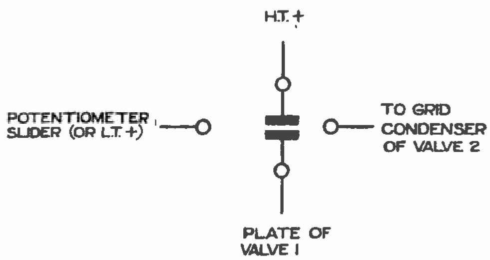



*Fig.* 2 (a).

The ordinary internal connections for an interchangeable transformer are as shown in Fig. 2*a*.

An ordinary valve holder or better a small oblong piece of ebonite having four valve pins attached can be substituted for the transformer Fig. 2*b*, as shown in Fig. 2*c*.

Connected across the "filament" or "primary" pins is a 50,000 ohms anode resistance, and the pin nearest to the plate of valve 1 is connected to the "grid" pin. It will be observed that the pin which in the transformer was connected to the potentiometer slider (or L.T.+) is now idle, but this is of no importance as the grid of No. 2 valve is still connected to the potentiometer (or L.T.+) through the grid-leak.

The variable condenser which was across the primary of the transformer now serves a useful purpose in giving greater effect to the variations in potential across the high resistance.

In sets having no grid-leaks and grid-condensers, and also in coupling up a *series* of H.F. amplifying

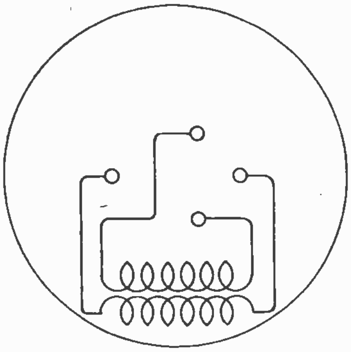


*Fig.* 2 (b).

valves, it will, of course, be necessary to substitute a small capacity for the direct connection between "grid" pin and "filament" pin of Fig. 2c. As a matter of fact the tuning condenser usually employed for the primary of the transformer can

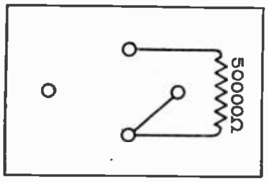



*Fig.* 2 (c).

be placed across these two points in the set, and would then serve for both purposes (Fig. 3*a*).

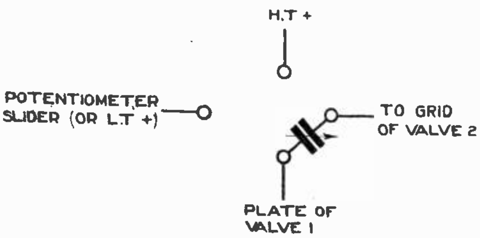



*Fig.* 3 (a).

Then for rapidly converting from transformer to high resistance amplification it is only necessary to have a resistance of 50,000 ohms and a grid-leak of 2 megohms mounted as in Fig. 3*b*. This applies when the internal connections of the set are as in Fig. 3*a*.

Finally, a perfectly safe arrangement which will give satisfaction either between H.F. valves or between H.F. Valve and Detector on all ordinary sets, whether internally connected as in Fig. 2*a* or Fig. 3*a*, is a combined resistance-capacity and grid-leak on the detachable unit as in Fig. 4.

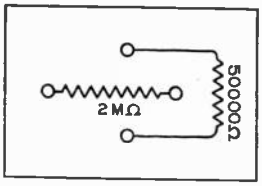



*Fig.* 3 (b).

The whole can be mounted on a piece of ebonite of about 2 ins. by 1 in., and forms a very useful adjunct to a transformer H.F. amplifier set. It is of great use for experimental purposes for rapidly comparing the efficiency of the different resistances, grid-leaks, etc., for different wavelengths and signal strengths.

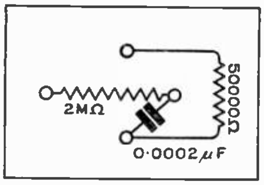
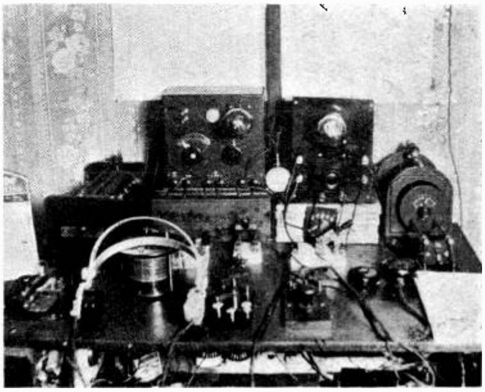



*Fig.* 4.

The idea is, of course, capable of extension to impedance-capacity amplification. For relative tests on this subject small terminals could be mounted to facilitate interchanges.

## Experimental Station



*Station of Mr. George E. Basham at Bush Hill Park, N.*

# A Method for the Measurement of R.F. Resistances*

By Prof. P. O. PEDERSEN.

## Introduction.

THE exact measurement of radio-frequency resistance is still a rather difficult problem although the development of convenient generators of continuous waves has considerably diminished these difficulties.

The older methods† were nearly all based on the fundamental investigations of V. Bjerknes ‡ on resonance in simple and coupled circuits. These old measurements were often carried out in the following manner :—Spark discharges were produced in the circuit under test and the resulting oscillations were investigated by means of a separate auxiliary circuit loosely coupled to and in resonance with the test circuit. The measurements in connection with the auxiliary circuit were mostly carried out by means of a quadrant electrometer, the deflection of this being proportional to the time integral of the square of the potential difference.

With regard to the more modern methods I may refer to a paper of J. H. Dellinger.§ This paper also treats some of the difficulties met with in these measurements.

It would in several respects be of great advantage to have to do with only one single circuit, viz., the circuit to be tested. All difficulties connected with the tuning and the coupling would, in this way, be eliminated.

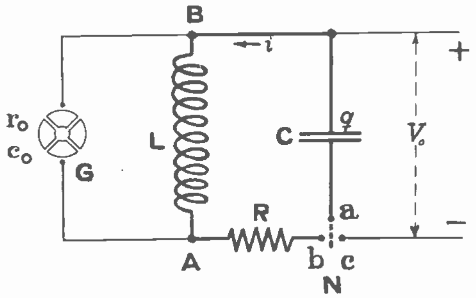



*Fig. 1. Simple Diagram of Connections.*

Of methods working along these lines we shall later on mention one or two, but before doing so, we shall very briefly consider the oscillations of the circuit shown in heavy lines in Fig. 1. Using the symbols of Fig. 1 the current will be given by

$$i = \frac{V_0}{\sqrt{\frac{L}{C} - \frac{R^2}{4}}} \epsilon^{-Rt/2L} \sin\left(t\sqrt{\frac{1}{LC} - \frac{R^2}{4L^2}}\right) \quad ..(1)$$

or very nearly by

$$i = V_0 \sqrt{\frac{C}{L}}\, \epsilon^{-Rt/2L} \sin \frac{t}{\sqrt{LC}} \quad . \ . \ . \ . \ . \ . \ . \ (1a)$$

This current is shown in Fig. 2, and with the symbols used there we have—

$$\frac{a_1}{a_2} = \epsilon^{\frac{1}{2}\pi R\sqrt{C/L}} \quad \text{or } R = \frac{2}{\pi}\sqrt{\frac{L}{C}} \log \frac{a_1}{a_2} \quad . \ . \ (2)$$

The values of $L$, $C$ and the ratio $a_1/a_2$ being known the radio frequency resistance $R$ may be calculated from equation (2). This principle has been used by E. Rutherford ‖ and J. Zenneck.¶ The first-mentioned author used magnetised steel needles, the last mentioned a Braun tube. Both

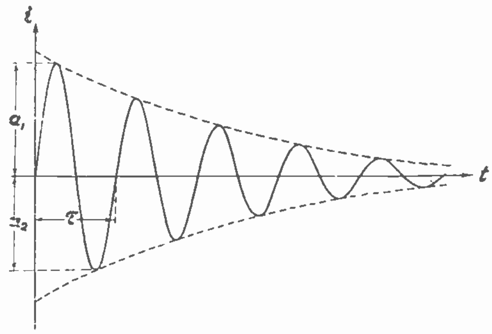



*Fig. 2. Oscillating Current Curve.*

methods are beautiful in principle but rather complicated, and they can hardly be used in connection with feebly damped circuits.

## 1.—Method.

The method treated of in the following is similar to that used by V. Bjerknes and his pupils**, in so far as both use a quadrant electrometer giving deflections proportional to the time integral of the square of the potential difference. But in our method this quadrant electrometer is connected directly to the circuit under test—see Figs. 1, 3 and 4—and not to a separate circuit, loosely coupled to the test circuit.

We shall now consider the arrangement shown in Fig. 1. The condenser C at present supposed to be without leakage, is charged to the p.d. $V_0$ when the key N is in the position ac. And when the key is then depressed to the position ab the condenser is discharged through the circuit shown in heavy lines, and containing the coil L, having a radio-frequency resistance $R$.

* Received December 28, 1921.

† E. Nesper: Die Frequenzmesser und Dämpfungsmesser der Strahlentelegraphie, p. 165-238, Leipzig, 1907.

‡ V. Bjerknes: Dampfung schneller electrischer Schwingungen (*Wiedmann's Annalen*, 44, p. 74, 1891). Ueber den zeitlichen Verlauf der Schwingungen im primären Hertzschen Leiter (*ibid.* 44, p. 513, 1891). Ueber electrische Resonanz (*ibid.* 55, p. 121, 1895).

§ J. H. Dellinger: The Measurement of Radio Frequency Resistance. (*Proceedings of the Institute of Radio Engineers*, 7, p. 27-60, 1919.)

‖ E. Rutherford: A Magnetic Detector of Electrical Waves, and some of its Applications. (*Transactions of the Royal Society*, Vol. 189A, p. 1, 1897.)

¶ J. Zenneck: Verfahren, um die Dämpfung electrischer Schwingungen sichtbar zu machen. (*Annalen der Physik*, 4, p. 801, 1902.)

** V. Bjerknes: *Wiedmann's Annalen* 44, p. 77, 1891.

S. Lagergren: Ueber elektrische Energiausstrahlung. Stockholm, 1902.

B

The time integral $P$ of the square of the p.d. between the terminals A and B of the coil L is then given by—

$$P=\int_0^{\infty}\left(L \cdot \frac{di}{dt}\right)^2 dt=\frac{L}{2R} V_0^2 \qquad (3)$$

$$\text{or} \quad R=\frac{L}{2P} V_0^2 \qquad (3a)$$

The value of $P$ may be determined by means of a quadrant electrometer, one pair of quadrants and the needle being connected to the terminal A of L, the other pair to the terminal B (see Fig 3). The throw of the electrometer will then be proportional to $P$. The determination of the ballistic constant of the electrometer will be discussed later on*.

The values of $V_0$, $L$ and $P$ being known, the value of $R$ is determined by means of (3a).

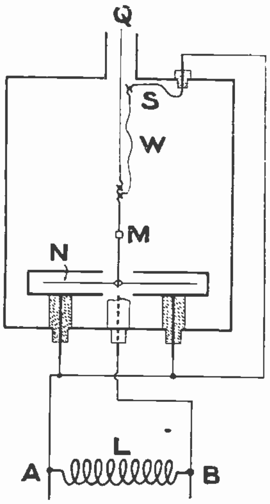



*Fig.* 3. *Quadrant Electrometer with Connections.*

If $V_0$ and $L$ are kept constant and an extra resistance $r$ is inserted in the circuit and the corresponding value of $P$ denoted by $P'$, we have

$$R + r = \frac{L}{2P'} V_0^2.$$

From this equation and (3a) we get

$$\frac{R+r}{R} = \frac{P}{P'}, \quad \text{or} \quad R = r\,\frac{P'}{P-P'} \qquad (4)$$

By measurement of the two electrometer throws corresponding to $R$ and $R + r$ respectively, the value of $R$ can be calculated from (4), provided, of course, that the p.d. $V_0$ is the same in both cases.

*V. Bjerknes and S. Lagergren used a quadrant electrometer of which one pair of quadrants was removed, the needle being insulated and each one of the two wires from the circuit under test connected to one of the two remaining quadrants. In this case it is not necessary that the suspension wire should be conducting. We were, however, unable in this way to obtain a sufficiently high sensitiveness, and at the same time a sufficiently high stability.

**2.—Investigation of the possible Sources of Errors.**

If the condenser is *leaky* it will lose some of its charge in the interval between the breaking of the contact at c and the closing of the contact at b (see Fig. 1). The error introduced in this way may be rather serious if the said interval is not *very* short, and it will be shown later on that there are some particular difficulties which prevent this interval from being reduced with certainty, below, say, 0·01 second. But happily it is possible to eliminate this error altogether, or at least to reduce it to a quite insignificant amount by means of the arrangement shown in Fig. 4. The leads from the

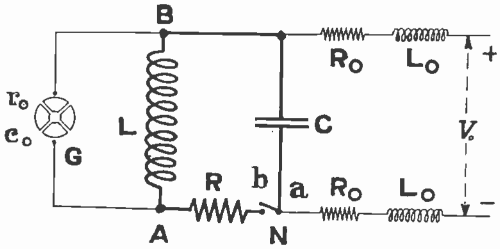



*Fig.* 4. *Diagram of Connections for use with a Leaky Condenser. The choke coils* $L_0$ *and resistances* $R_0$ *keep the oscillations from the leads.*

source of e.m.f. are both connected permanently to the terminals of the condenser C, and in the leads are inserted two large resistances $R_0$ and choke coils $L_0$. The resistances $R_0$ should be large, for example, between 0·01 and 1 megohm, but on the other hand $R_0$ must be very small compared with the insulation resistance of the condenser. There is generally no difficulty in complying with both conditions.

In this way the error caused by the leaking of the condenser is eliminated but another error is introduced as a continuous current will flow through the coil L as long as the key N is closed, and this current will give a p.d. of $V_0\, r'/2R_0$ between A and B, $r'$ being the continuous current resistance of L. This error is, however, altogether insignificant. For instance, if $V_0 = 400$ volts, $r' = 1$ ohm, $R_0 = 10{,}000$ ohms, and if the key is closed for 5 seconds,

$$p = (\text{p.d.})^2 \times \text{time} = 2 \times 10^{-3}\ (\text{volts})^2\ \text{sec.}$$

We shall see later on that the corresponding value of $P$ will be about

$$P = 100\ (\text{volts})^2 \cdot \text{sec.}$$

The value of $p$ is therefore negligible compared with that of $P$.

In the derivation of equation (3) we only considered the self-inductance of coil L and neglected its effective *resistance*. It is easily shown that the error thereby committed is insignificant.

The resistance $r_0$ in the lead to the needle of the electrometer in conjunction with the capacity $c_0$ between the needle and the pair of quadrants to which it is not connected, may introduce appreciable errors in two ways :—

(1) By absorbing power from the oscillating circuit and thereby increasing its effective resistance.

(2) By reducing the p.d. between the needle and the opposing pair of quadrants.

We shall consider both of these possible sources of errors.

(1) If the p.d. across the condenser at a certain moment is $V$, the average loss $\Delta W$ of electrical energy in the element of time $\Delta t$ will be

$$\Delta W = \tfrac{1}{2} V^2 \frac{C}{L} R\Delta t.$$

The corresponding loss in the lead to the needle will be

$$\Delta w = \tfrac{1}{2} V^2 \frac{c_0^2}{CL} r_0 \Delta t.$$

Therefore,

$$\frac{\Delta w}{\Delta W} = \frac{c_0^2}{C^2} \cdot \frac{r_0}{R} \quad . \quad . \quad . \quad . \quad . \quad (5)$$

On the other hand equations (5) and (6) show that the resistance $r_0$ ought not to be too large, but if the suspension wire is rather short and stout, the sensitivity of the electrometer will be too small. We tried the usual remedy for this trouble—viz., to let a wire hanging down from the needle dip in sulphuric acid but without success. The arrangement shown in Fig. 3 proved, however, satisfactory. The needle N is suspended on a quartz wire Q while the electrical connection is made by means of the Wollaston wire W, connecting the stout copper wire S with the stem of the needle. The core of the Wollaston wire consists of a platinum wire 0·007 mm in diameter, but the silver coating has been left at both ends of W and these ends serve as hooks connecting W with the wire S and with the stem of the needle. The resistance of W in the electrometer actually used was about 180 ohms.

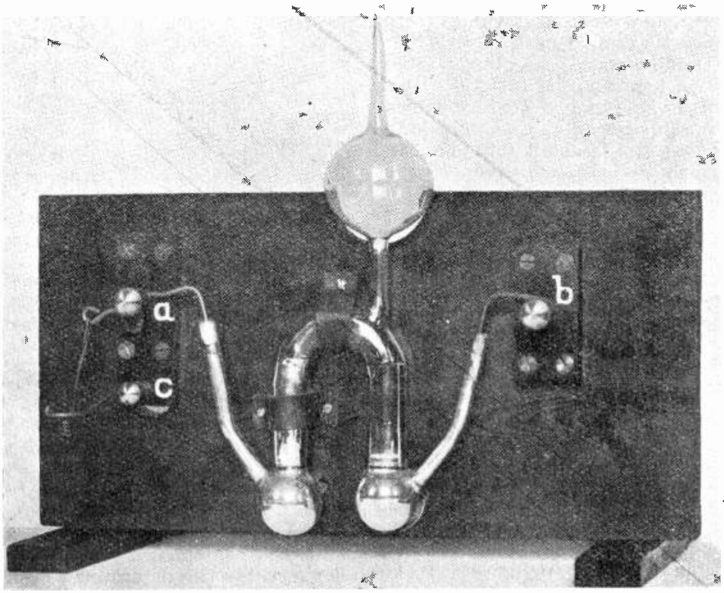



*Fig. 5. The Mercury Lamp used as Discharging Key.*

Examples :—

If $c_0 = 5$ cm, $C = 10{,}000$ cm, $r_0 = 180$ ohms, $R = 0{\cdot}6$ ohms, then

$$\frac{\Delta w}{\Delta W} = 7{\cdot}5 \times 10^{-5}$$

If $C = 500$ cm and the other constants remain unaltered we get $\dfrac{\Delta w}{\Delta W} = 0{\cdot}03$.

This error is therefore in most cases negligible.

(2) The ratio, $\eta$, of the loss of p.d. in the lead to the needle to the total p.d. across the condenser is given by

$$\eta = \frac{c_0}{\sqrt{CL}} r_0 \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

Example: If $\dfrac{1}{\sqrt{LC}} = 10^6$, $c_0 = 5$ cm, $r_0 = 180$ ohms, then $\eta = 0{\cdot}001$.

### 3.—The Discharging Key.

There remains still one source of error to be considered, viz., the energy lost in the discharge key in making the connection ab (Figs. 1 and 4). It became immediately evident that the key question was a very difficult one. We first tried a well cleaned and well polished ordinary discharge key, but the throws of the electrometer obtained in this way were very much too small and extremely capricious. We may, for instance, quote the following set of consecutive readings, 19, 5, 7, 12. It was later ascertained that the readings ought to have been about 105.

There could be little doubt that this error was due to the minute spark which appears at contact b when the circuit CL is closed at that point. We therefore tried a number of contact-making arrangements, such as polished copper, and steel hammers making contact with polished copper or steel plates, the impact being made with great velocity. The said hammers and plates were carefully rubbed over with *clean* emery paper. None of these methods where the contact was made between pieces of solid metal proved successful. We then tried contact-making between a very clean surface of mercury and clean stout wires of steel, tungsten, or platinum. In this case the throws were large and constant, provided that after every contact-making the surface of the mercury was renewed and the wire carefully cleaned with clean emery paper.

We next tried to let the contact-making take place between two masses of mercury in vacuum, the apparatus used being the mercury lamp shown in Fig. 5. The terminals abc in Fig. 5 are identical with abc in Figs. 1 and 4. The contact-making is effected simply by tilting the lamp sufficiently, a jet of mercury then passes from one limb to the other. The cross-section and length of this jet is not exactly the same every time, but the uncertainty resulting herefrom is always below 0·005 ohm, and this value may be further reduced by altering the construction of the mercury lamp. The resistance of this key is about 0·01 ohm and is in the following included in the effective resistance of the circuit.

*With this key the throws of the electrometer were large and remarkably constant* as will be proved later on.

No light is seen in the lamp at the contact-making but the further discussion of the physical nature of the key difficulties must be postponed to a later occasion.

## 4.—Determinations of the Ballistic Constant of the Electrometer.

In order to obtain the ballistic constant of the electrometer we have used the arrangement sketched in Fig. 6. $R_1$ is a large resistance with very little self-inductance $L_1$ and with a very small capacity $c_1$. A well-insulated mica condenser $C_1$ is by means of the key N charged to the p.d. $V_1$, and afterwards discharged through the resistance $R_1$. The time integral of the square of the p.d. between the terminals A and B of $R_1$ is then measured by the throw of the electrometer G.

The value, $B$, of this time integral is easily calculated if we neglect, for the present, the capacity $c_1$ of the resistance $R_1$.

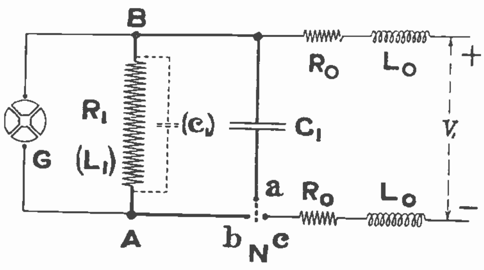



*Fig.* 6. *Diagram of Connections used in order to obtain the Ballistic Constant of the Electrometer.*

The instantaneous value of the p.d. across the condenser $C_1$ is denoted by $v_1$ and we use the following abbreviations:—

$$K_1 = \frac{R_1}{2L_1} \quad \text{and} \quad h_1^2 = \frac{1}{L_1 C_1}.$$

We have then

$$v_1 = \frac{V_1}{2\sqrt{K_1^2 - h_1^2}} \left\{ (K_1 + \sqrt{K_1^2 - h_1^2})\,\epsilon^{(-K_1 + \sqrt{K_1^2 - h_1^2})t} + (-K_1 + \sqrt{K_1^2 - h_1^2})\,\epsilon^{-(K_1 + \sqrt{K_1^2 - h_1^2})t} \right\} \quad (7)$$

and

$$B = \int_0^\infty v_1^2 dt = \tfrac{1}{2} V_1^2 \left( R_1 C_1 + \frac{L_1}{R_1} \right) \quad . \quad . \quad . \quad (8)$$

The last term on the right hand is generally extremely small in comparison with the first term. We may therefore use the following approximation

$$B = \tfrac{1}{2} V_1^2 R_1 C_1 \quad . \quad . \quad . \quad . \quad . \quad . \quad (8a)$$

It is easily shown that if the capacity of the resistance $R_1$ is represented by a capacity $c_1$ (as shown in Fig. 6) having no resistance in its leads, we get instead of equation (8a) the following formula:—

$$B_1 = \tfrac{1}{2} V_1^2 R_1 \frac{C_1^2}{C_1 + c_1} \quad . \quad . \quad . \quad . \quad (9)$$

The ratio

$$\frac{B_1}{B} = \frac{C_1}{C_1 + c_1} \quad . \quad . \quad . \quad . \quad . \quad . \quad (10)$$

will with good resistances be very nearly equal to 1.

In this case we also meet with some key difficulties of the same nature as those treated of above, but they are not so serious here, and they may be overcome in the same way, namely, by using as key the mercury lamp shown in Fig. 5. When the lamp is tilted the connection between a and c (see Fig. 6) is broken automatically by means of the copper wires shown to the left of Fig. 5.

With this key and for p.d.'s up to at least 440 volts—greater p.d.'s have not been tried—the throws of the electrometer are fairly constant, and the arrangement shown in Fig. 6 may then be used for the determination of the ballistic constant of the electrometer. We need only calculate the time integral $B$ according to formula (8a) and measure the corresponding throw $S$, the ballistic constant $\beta$ is then determined by—

$$B = \beta S \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (11)$$

## 5.—Tests.

We first ascertained that the ballistic constant $\beta$ was independent of the throw. To this end we used a Helmholtz pendulum which for $T$ seconds connected a p.d. of $V$ volts to the terminals of the quadrant electrometer. $T$ was kept constant and $V$ altered within wide limits. There was a very nearly straight line relation between $TV^2$ and the throw.

We then made a series of measurements on a circuit having a coil with a self-inductance $L = 1{\cdot}345 \times 10^{-3}$ H, and a capacity of about 20,000 cm (air condensers). Using the arrangement shown in Fig. 4 we first investigated the proportionality of the throw to the square of p.d. The results are given in Table I.

TABLE I.

| Voltage $V$. Volts. | Throw $S$(observed). mm | Throw $S$(calculated) mm | $S_{(cal.)} - S_{(obs.)}$. mm |
|---|---|---|---|
| 440 | 107·3 | 107·3 | 0·0 |
| 220 | 27·0 | 26·8 | − 0·2 |
| 110 | 5·9 | 6·6 | + 0·7 |

The difference between the observed values and those calculated on the basis of the square law are not greater than can be accounted for as casual errors.

Another series of tests is recorded in Table II. An extra resistance, $r$, was here inserted in the circuit and the corresponding throws, $S$, measured. The value of the effective resistance, $R$, of the circuit itself was then calculated by means of formula (4).

TABLE II.

$V = 432$ volts. $L = 1{\cdot}345 \times 10^{-3}$ H.

| $r$ ohms | $S$ mm | $S_{mean}$ mm | $R$ ohms | $R - R_{mean}$ ohms | $f$ Per cent. |
|---|---|---|---|---|---|
| 0 | 102·0<br>101·9<br>101·5<br>101·4 | 101·7 | | | |
| 0·1 | 88·2<br>89·0<br>89·1<br>89·0 | 88·82 | 0·689 | + 0·006 | + 1·0 |
| 0·3 | 71·1<br>70·7<br>69·9<br>72·0 | 70·93 | 0·690 | + 0·007 | + 1·0 |
| 0·5 | 58·2<br>58·5<br>58·5<br>58·6 | 58·45 | 0·676 | − 0·007 | − 1·0 |
| 1·0 | 41·5<br>40·7<br>40·1<br>40·5 | 40·70 | 0·669 | − 0·015 | − 2·2 |
| 2·0 | 26·1<br>25·8<br>26·0<br>26·5 | 26·1 | 0·691 | + 0·008 | + 1·2 |
| $R_{mean} = 0{\cdot}683$ ohms. | | | | | |

The close agreement between the observed and the calculated throws in Table I, and between the calculated values of $R$ in Table II seems to prove conclusively that the energy losses in the mercury-vacuum key are extremely small, and may, without appreciable errors, be neglected.

As a last check of the method, the ballistic constant $\beta$ of the electrometer was determined in the manner sketched in Fig. 6. The data were :— $V_1 = 432$ volts, $C_1 = 0{\cdot}25 \times 10^{-1}\mu$F, and $R_1 = 8{,}000$ ohms. The corresponding value of $B$ is, according to (8a)—

$$B = 186{\cdot}6 \text{ (volts)}^2\text{.sec.}$$

The throw of the electrometer was $S = 109{\cdot}5$ mm, and we have accordingly—

$$\beta = \frac{B}{S} = 1{\cdot}701$$

During the same tests the throw caused by a discharge through the oscillating circuit was equal to 108 mm. We have, accordingly,

$$\tfrac{1}{2}V^2 \frac{L}{R} = \tfrac{1}{2}\, 432^2 \frac{1{\cdot}345 \times 10^{-3}}{R} = \beta.108 = 183{\cdot}6,$$

or

$$R = 0{\cdot}684 \text{ ohm.}$$

This value agrees very well with the mean value, $R = 0{\cdot}683$ ohm, found in Table II. This close agreement also indicates very strongly that the error due to the energy loss caused in the contact has been eliminated.

The ballistic constant of the electrometer being known, the effective resistance of an oscillating circuit may be determined by the measurement of one single throw, as we have

$$R = \frac{L}{2\beta S} V^2 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (12)$$

## Conclusion.

The main advantages of the method are :—

(1) The method is very convenient in use, being simple, reliable and quick.

(2) The method gives very accurate results as compared with other methods.

(3) The method does not demand any h.f. generator, and also completely eliminates all inconveniences and troubles in connection with tuning and coupling.

In carrying out this investigation I have been ably assisted by Mr. Chr. Nyholm, E.E.

Telegraph and Telephone Laboratory of
The Royal Technical College, Copenhagen.

## The Modern View of Electricity and the Three Electrode Valve.

We have been asked to point out the following corrections to the paper bearing the above title recently published :

On page 70, col. 2, line 4, for "other" read "ether."

On page 73, col. 1, for "an increase of plate voltage of 20·5 negative gives us a rise of about 7 M.A.," read "an increase of plate voltage of 20·5 gives us a rise of 0·7 milliamps."

# A Single Valve Station

By N. WHITELEY.

No doubt there are many amateur wireless enthusiasts who would like to erect their own stations, but are prevented from doing so from lack of space in which to erect an aerial out of doors, so that probably the few notes below of my experiences with an indoor aerial, together with a brief description of the apparatus I am using, will be of interest.

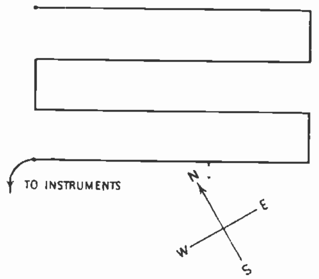



*Fig.* 1.

Fig. 1 shows the form of aerial in use. It is made of ordinary bell wire (insulated) and is stretched horizontally between two wooden beams just below the roof. There is a total length, including lead to instruments, of approximately 50 ft. and the lines of the loop are 2 ft. apart.

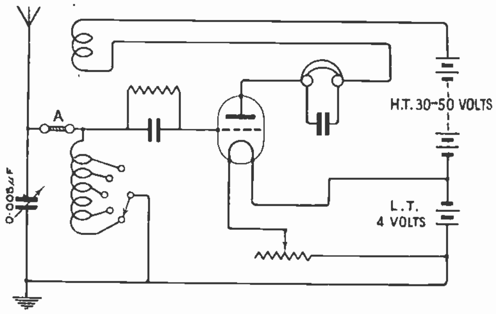



*Fig.* 2.

Fig. 2 shows the theoretical connections of the set, the master instrument of which is a short-wave tuner designed for wavelengths from 300 to 1,200 metres approximately. This instrument was made for me by Mr. W. G. A. Daniels, one of my colleagues of the Bradford Wireless Society, and it has proved very satisfactory.

The A.T.I. is a basket coil wound with No. 24 D.C.C. wire, and tappings are taken from it at five points and brought to a switch on the ebonite front panel. The tuning of the aerial circuit is completed by means of a 0·0005 mfd. variable condenser, which for short waves up to 1,200 metres is connected in series. A switch is provided, by means of which the condenser can be put in parallel when necessary.

The Reactance Coil is also of the basket type, and is wound with No. 28 D.C.C. wire, and the two leads from it are taken outside the case to facilitate changing the value of reactance for long wave. The coil is mounted on the back of the case, which is hinged so that tight or loose coupling can be obtained.

The wood of the case acts as grid leak, the grid condenser being screwed down to it.

I am at present using an "R" valve, which functions very well with 50 volts H.T. and 4 volts on the filament.

The telephones are 8,000 ohm Sullivans.

Fig. 3 gives a rough sketch of the front panel of the main instrument, the case of which is finished in mahogany, stained and polished.

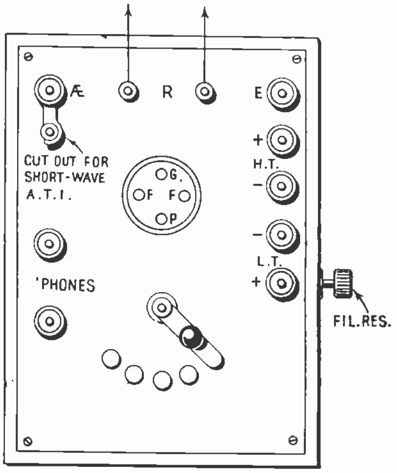



*Fig.* 3.

Fig. 4 shows a home-made "Slab Coil" tuner for long wave, and by the interchange of various coils, wavelengths from 1,200 to 20,000 metres are obtained, the 0·0005 condenser being in parallel.

As regards construction. The base is a polished wood block (recessed), such as electricians use for mounting tumbler switches, etc., and the upright "D" is a piece of polished wood curtain rod, 1 in. in diameter, with a $\frac{3}{16}$-in. hole drilled half through. Into this hole is fitted a vulcanite rod (in this case a chemical stirring rod) on which the mounted slab coils slide. "A" is the A.T.I. and "B" the Reactance, the two leads from each coil being brought down to terminals on the base.

By opening the strap marked "A" in Fig. 1, the short wave A.T.I. is disconnected. Similarly, the two S.W. reactance leads are freed and the front panel of the instrument then becomes a valve panel only, and to it the long wave tuner is connected in the usual manner.

The Slab Coils are wound with No. 36 D.S.C. wire and immersed in wax and flexible leads are connected to the two ends of each. Each coil is then wound with tape. The method of mounting is very simple, and is shown in Fig. 5. Discs of stiff card of suitable diameter are cut, and each disc

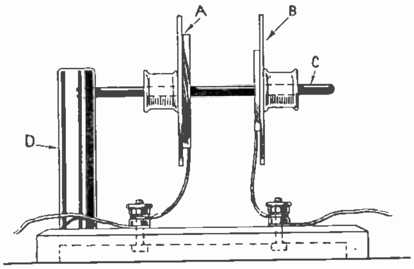



*Fig.* 4.

is glued concentrically to an ordinary wooden cotton reel, and the centre of the card is pierced to fit the rod on which the coils slide, "C." The prepared coils are attached to the card discs by means of adhesive tape. I find that this arrangement works very well.

I have been very agreeably surprised with the performance of the set. All the principal European

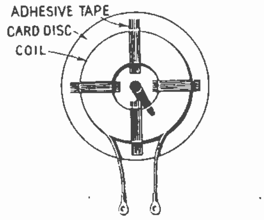



*Fig.* 5.

stations come in quite loud, **FL, POZ, HB, PCH** and **SAJ**, to instance a few, and Shipping comes in very well on the pure note. Telephony is not so good except from one or two local stations, but taking all factors into consideration, the apparatus has far exceeded my expectations.

# Amateur Inter-Valve Resistance Construction

By E. W. KITCHIN A,M.I.C.E.

VERY few amateurs who use circuits requiring non-inductive resistances of many thousands of ohms each, seem to care to tackle the problem of making such for themselves; and yet it is not a very difficult matter to construct an article giving results equal to those professionally made.

The writer has already described in these columns* how a piece of wet cotton can be used for this purpose, and a resistance made in such a manner functions well.

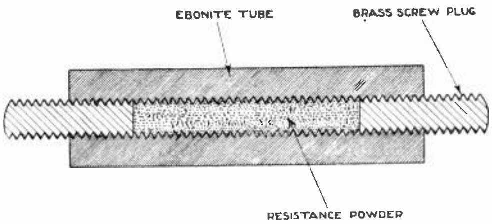



*Fig.* 1.

In response, however, to several requests, the following notes have been prepared giving details of how to construct a dry resistance of cylindrical pattern; which has obvious advantages, as its overall length need not exceed one inch.

For each resistance there will be required a piece of ebonite rod about three-quarters of an inch long; its diameter may be ¼ inch. A hole should be drilled through the rod from end to end and then tapped with No. 6 B.A. thread for ¼ inch at each end, or, if preferred, right through. Ebonite tubing can, of course, be used if of correct bore.

Two screw plugs will be needed, each about ¼ inch in length, and can be made from brass wire threaded so as to screw into the tube. The ends of the plugs which enter the tube should be filed quite flat and smooth, the other ends may be rounded to fit a depression in a spring clip.

We have now an insulating tube with a metal plug screwed in each end, and an air space separating the plugs. This space is to be filled with a powder giving the required resistance.

Now carbon is a material possessing electrical resistance, but not sufficient for the present purpose if used alone. It is therefore necessary to dilute the carbon, which will be in powder form, with some inert powder; and a convenient one is chalk, preferably the precipitated variety. Ordinary blacklead which is used for blacking stoves will furnish the carbon, and a piece of this should be carefully and lightly scraped with a knife until a sufficient quantity of powder has accumulated. This should be thoroughly dried, and the same remark applies also to the chalk.

The carbon and chalk should next be very thoroughly mixed together in the proportions of 1 part carbon to 2½ parts chalk, all lumps being crushed well. The resulting powder will be of a moderately dark grey colour, and should give a resistance in the tube of between 30,000 and 100,000 ohms. One of the plugs may now be screwed in ⅛ inch into the tube, and the tube filled with the powder, which should be rammed tight with a match; the filling and ramming process being repeated until the tube is nearly full. The second plug may then be inserted and both should then be screwed in as tight as possible, due care being observed that the ebonite tube is not split during the operation. Each plug should now project ⅛ inch, but if less than this, a little more powder should be put in, and the plug again screwed up hard.

A trial test may now be made of the filled tube, as the required resistance will probably be in the

* See *Wireless World*, July 10th, 1920.

neighbourhood of 80,000 ohms, and some adjustment of the filling may be needed. If no means are at hand of making a quantitative test the tube may be inserted in the circuit, and tried on actual signals: if additional resistance (such as a piece of wet cotton) in parallel with the tube improves results, then the powder mixture requires a little more carbon. This can be added to the unused mixture, and the tube emptied and refilled; and by this trial-and-error method any desired value, within limits, may be given to the resistance. The correct value should be arrived at by the third trial, and the mixed powder remaining over can then be regarded as "standard," and used for filling other tubes.

It is of course an advantage if during these trials the tube can be tested for results against a professionally made resistance of the value required.

It will no doubt be recognised that it is of little use attempting to give *exact* quantities for the proportions of the powders necessary to produce a given resistance, for these would have to be different each time in accordance with the varying amount of ramming given when filling the tube: the amounts given above, however, will form a very good starting point.

Should it be desired to alter the resistance of a tube very slightly it may suffice to remove one plug and take out a little powder, or add a very little chalk, as may be needed: in the latter case the end of the powder column, which will be glazed with pressure, should be broken up with a pin and the added chalk incorporated with part of the powder already there.

It will be understood that the dimensions given above for tube and plugs can be varied if desired, any change being compensated for by altering the length of the powder column or its carbon percentage, or both.

When finally declared of the correct value the tube should have a little shellac varnish run round where brass and ebonite meet, after which it may be regarded as permanent provided the powders were quite dry before filling.

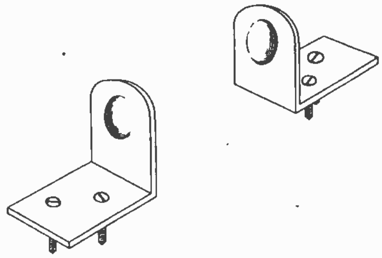


*Fig.* 2.

A convenient way to hold the tube in position in the circuit is to make two clips of thin springy brass, as shewn in Fig. 2, with a recess in each made with a round punch. The tube can then be sprung into place.

# A Simple Rotary Converter

BY E. A. PYWELL.

AFTER trying numerous ways of utilising the A.C. mains for wireless purposes, I finally decided on the small, home-made rotary converter which is described below.

This machine has given every satisfaction in charging the accumulators which I use on my wireless set, consisting of the usual filament lighting batteries, and also a Hart 50-volt accumulator, which I installed some time ago in place of dry batteries. It consists principally of an "Alterna" cycle generator, which is a six-pole machine and has a wound stator with a revolving field magneto.

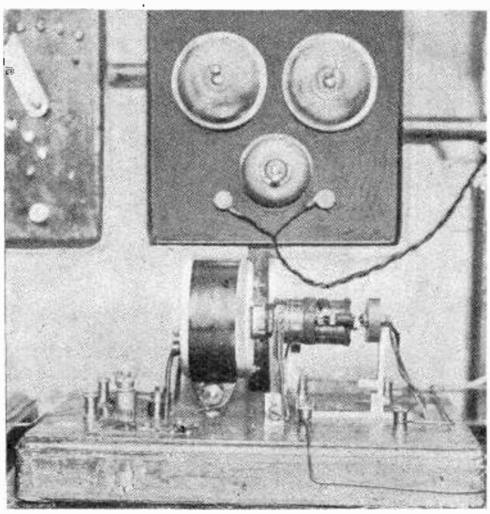


*Fig.* 1.

I found that this machine worked very well as a synchronous motor when its stator windings were supplied with A.C. at about 5 volts, the speed being 1,000 R.P.M. at 50 v. after being started by some external means.

The converting gear consists of two slip-rings and a twelve-part commutator, mounted on the projecting shaft. Alternate segments of the latter are simply used as spacers to prevent short-circuiting, leaving six "live" segments, three of which are connected to one slip-ring and three to the other, alternately, a brush rocker being provided so as to obtain maximum rectified current.

I have adapted an old core type 200/50 v. lighting transformer for use with this machine, and by means of the switchboard, seen in the top left-hand corner of the photograph (Fig. 1), any voltage in 5-volt steps can be obtained.

The whole arrangement will probably be better understood after a careful study of the diagram of connections (Fig. 2).

It will be seen that provision is made for electrical starting from the commutator side. With 6 or 8 volts the machine will run as a D.C. motor when

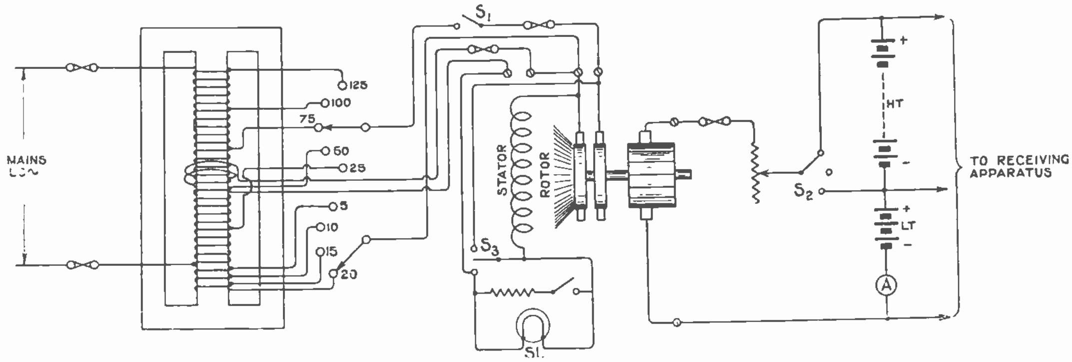



*Fig.* 2.

the stator winding is connected temporarily across the slip-rings by switch S 3, the speed being controlled by a variable resistance, R. When the correct speed is reached, the synchronising lamp, S.L., only just glows, and S 3 is put into the down position. The machine then runs as a synchronous motor, and after the correct A.C. voltage is obtained, say 10 per cent. above accumulator voltage, S 1 is closed and the charging current adjusted by variable resistance. A "charge" and "discharge" ammeter is used so as to be sure that the current is in the right direction. It is found, however, that the polarity is always correct when the machine is started up in the manner indicated.

This rotary converter will safely give 100 watts D.C. and any voltage with proportionately less current, if reasonably good insulation is provided, and the efficiency is remarkably good for so small a machine, the only appreciable loss being the power required to drive it—about 10 watts.

In conclusion, a study of the wave-form of the rectified current illustrated in Fig. 3, may be of interest.

It will be seen that a series of peaks is obtained and that when the A.C. instantaneous voltage falls below the accumulator voltage the circuit is automatically opened by the spacing segments on the commutator. Consequently, no reverse current can flow from the batteries and the charging current is due to the difference between the average rectified voltage and the accumulator voltage.

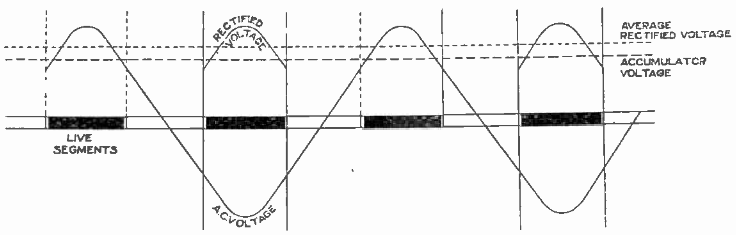



*Fig.* 3.

# The Future of the Wireless Telephone

ONE has only to pick up an American newspaper in order to appreciate how fully the wireless telephone has entered into the every-day life of Americans, who have been quick to appreciate its value, not only as a source of entertainment in the transmission of musical selections for the benefit of every home equipped with a wireless receiver, but also a tool in the purpose of education and the distribution of general information. Just as the cinematograph, which was at first launched solely as an entertainment, is now being used more and more in the purpose of education, so the wireless telephone can be employed for purposes of much greater value to the community than the mere transmission of concerts to individual homes.

Undoubtedly there is a fast-growing interest in wireless in this country and no stronger indication could be given than the very considerable attention which has been devoted recently to the subject by the daily press. This public interest has been largely stimulated by the action of the Wireless Society of London in obtaining recently the official sanction for the transmission of a weekly programme of telephony and calibration waves specially intended for the benefit of the amateur. These weekly transmissions, conducted by the Marconi Scientific Instrument Company, Ltd., are now listened to by an appreciative and ever-increasing audience, but it is not likely that the progress of the wireless telephone will stop here, and we may look forward to the time, when the wireless telephone will take its place amongst domestic equipments.

In this connection, the opinions expressed by Mr. Godfrey Isaacs, Managing Director of Marconi's Wireless Telegraph Company, Ltd., are of extreme interest.

Mr. Godfrey Isaacs looks forward to the time when there will be a wireless receiving apparatus in every home and he outlines a programme for an organised public service which the Marconi Company is ready to put into operation as soon as the necessary authority has been obtained. In a statement made to the Press, Mr. Godfrey Isaacs said :

"You will probably have seen what has been taking place in the United States. There the thing has become a very great trade, and has developed very quickly. In my opinion, wireless telephony is destined to play a big part in the future in every country. Personally, I think that we shall be dependent on it in many ways, especially in the matter of general home propaganda, such as important speeches or proclamations, or anything of great importance which has to reach all parts of the country promptly. In addition, much will be done in the way of education, music, and, no doubt, by the transmission of weather news to farmers.

"My hope is that, in time, every home will have a wireless set. Our programme is more particularly to supply the instruments to the householder on hire. Our idea is to have 'broad-casting' stations, say, two or three, in different parts of the country, and to have a programme for different hours of the day. We shall transmit by particular wavelengths —if we get assistance, as I have no doubt we shall, from the authorities—which will be so confined as to reach only those who hire these particular receivers, so that nobody else will be disturbed, and the telephonic receivers will not be disturbed either by wireless telegraphic or telephonic communication.

"This, I think, will be the first start of the organisation, and subsequently, not only will there be a home service, but it will be possible to subscribe for a Continental service as well, from any part of the world, which one desires. I do not mean, of course, that that will happen to-morrow or the next day, but that I foresee as the ultimate development of what is now known as 'broad-casting.' I can quite well imagine that it will be possible before long for a man to have an apparatus fixed in a motor-car or train and to receive information while he is travelling."

Referring to the United States, Mr. Isaacs said that wireless telephony there had gone ahead very quickly—too quickly, he thought. He should not aim at doing the thing in this country in quite the same way as it is done there. He should want to see the problem more seriously handled here ; in America it was becoming somewhat of a craze. They were only waiting for the necessary facilities, and he thought that the Government intended to give them. In America there was no Government control at all ; in this country, of course, there was. While there were certain advantages in America from the lack of control, he thought that here we should eventually derive benefit if a certain amount of reasonable Government control was exercised, so as to prevent what might otherwise become a nuisance.

As to the question of cost, Mr. Isaacs said that he calculated the system could be carried out very economically. The receiving apparatus, which would be all that the householder would require, would be leased at quite a modest amount per annum. In America the apparatus was being sold, but he thought that was a great mistake. Modifications would be introduced from time to time in the apparatus, and once a man had bought his property he would not feel happy if, soon after, he had to buy something better. Of course, if the public wanted to buy the apparatus they could do so, but he recommended a system of hiring.

"I do not think," added Mr. Isaacs, "that anybody realises how big a thing this is going to be. A message sent out by the Government or the police could be in every home in the country in a second. We have been perfecting this system for a long time. At present, owing to regulations, we have been only able to give wireless concerts for about a quarter of an hour each week, but I anticipate that very shortly matters with regard to regulations will be more or less settled, and then we shall be prepared to go forward. We have been working in close touch and co-operation with the big American, German and French firms."

In an interview granted *The Wireless World and Radio Review*, Mr. Isaacs emphasised that everything was ready, so far as the Marconi Company was concerned, for going ahead with the supply to the public of wireless telephones in the home and that the moment the necessary authority could be obtained the project would be put into operation. The type of set which would be supplied would vary according to the distances over which reception would be required, a guarantee of good reception with the apparatus would be a strong point. Asked whether such a service to the public might not lead to competition with the daily newspapers, it was pointed out that the services of the daily press would not be interfered with in any way.

# Notes

### The Genoa Bulletins.

Press Bulletins relating to the Genoa Conference are being transmitted from the station **IDO**, S. Paolo, Rome, daily on 1,850 metres C.W. The periods of transmission are 1500 G.M.T. for 30 minutes, and 2300 G.M.T. for 2 hours.

### The Berne Service.

On the occasion of the opening of the new high speed wireless service between Berne (Switzerland) and Ongar (Essex) on April 12th a number of messages of appreciation of the new service were exchanged between prominent persons in this country and in Switzerland. The service opened with a message to the King from the President of the Swiss Federation, in the following terms :—

His Majesty, King George V, Windsor.

I am sure that I shall comply with the sentiments of the Swiss people in renewing to Your Majesty by this first message transmitted by the radio telegraphique service linking up our two countries the sentiments of traditional and constant friendship of Switzerland for Great Britain, and in expressing the wish that the ties which unite them already may develop each day.

HAAB, President of the Federation.

In the note regarding the Berne-Ongar Service, which was published in the issue of *The Wireless World and Radio Review* for April 22nd, the call of the Berne Station was incorrectly given as HBD, this should have been given as **HBB**.

**Programme of the 2MT Transmissions.**

We are informed that on Tuesday, May 2nd, in the transmission of telephony from **2MT**, it is hoped to include solos by the famous Scandinavian tenor, Mr. Laurencz Melchior, and on that occasion also, an address will be given by Mr. Stanley Lupino, of the Gaiety Theatre.

# Correspondence

*To the Editor of* THE WIRELESS WORLD AND RADIO REVIEW.

*Re Harmonics.*

SIR,—I would like to confirm the opinion of your correspondent, Gordon Barnes, that Mr. Clinker's explanation of the phenomenon noticed by "Experimenter" is correct. It is really a contradiction in terms to speak of a "lower" harmonic, implying one whose period is greater than the fundamental, the prefixes "higher" and "lower" being redundant unless used in a relative sense.

Fourier's principle states that any physical quantity which is periodic in time, *i.e.*, which repeats its variations exactly in periods is resolvable into a series of sine components (usually of decreasing amplitude) of fundamental, and a number of harmonic frequencies which are (and this is the point of Fourier's principle) exactly multiple frequencies of the fundamental. The lowest component in the series is necessarily the fundamental.

In any kind of oscillation, it is necessary to distinguish between the ordinary harmonics which are really nothing else than irregularities in the fundamental (*e.g.*, those caused by working beyond the straight portion of a valve characteristic curve, or those existing in an alternator voltage wave, which may be called "forced" harmonics), and other free modes of oscillation. A system can have other modes of oscillation which are not exactly multiple frequencies of the fundamental, though in simple cases, *e.g.*, that of the stretched wire, referred to by your correspondent, the free modes of oscillation are exact multiples. If, however, the string were weighed at any point, it would then have other free modes of oscillation which were not multiples of the fundamental, whilst at the same time the fundamental could have irregularities which were.

An electrical example which will occur to your readers is that of a receiving coil shunted by a condenser in which, owing to distributed capacity effects, oscillations can occur at higher frequencies, not exactly multiple, of the fundamental. Thus the total effect would not necessarily be strictly periodic.

It would appear that the oscillation generated by an arc or valve transmitter is perfectly periodic because we do not seem to be able to tune in on any other wavelengths than the exact sub-multiples, though there appears no reason why other free modes of oscillation should not be excited (the arc or valve being only an agent, not determining the frequencies like an alternator), each of which has its own fundamental, with *its* irregularities, *i.e.*, harmonics.

On my own set, at present of the single valve auto heterodyne arrangement, ranging from 300 to 35,000 metres, I can frequently hear stations well above Bordeaux, Carnarvon particularly, on 28,000 metres, and I have never considered this otherwise than that it is a forced oscillation of Carnarvon frequency beating with the second harmonic of my own oscillation. One of the tests for this has already been described in your columns, viz., that the maximum strength of such a signal appears with a relatively larger amount of reaction than in the case of a fundamental or ordinary harmonic, but there is another, namely, that the rate at which the beat note rises on either side of the dead point in such a reception is twice (or more as the case may be) as great as for the ordinary fundamental.

Further remarks from Mr. Clinker would be interesting.

E. FOWLER CLARK.

Derby.
*April 7th,* 1922.

NOTES ON A DIRECT-READING RADIO DIRECTION FINDER.

*To the Editor of* THE WIRELESS WORLD AND RADIO REVIEW.

SIR,—As THE RADIO REVIEW ceases publication and is incorporated with your journal, I beg you to allow publication of this letter, answering Mr. Artom's letter published in the last number of THE RADIO REVIEW under the above title.

Mr. Artom's letter, besides its discourteous and peremptory tone, contains several inexactitudes:

1.—It is incorrect that the County Court and the Cassation Courts of Turin have established Mr. Artom's priority to the invention of the magnetic radiogoniometer. The County Court Judgment (July 18th, 1914) neatly declares: "IT IS NOT DECIDED HERE WHETHER THE INVENTIONS MAKING THE OBJECT OF THE ITALIAN PATENTS NO. 88,765 AND 88,766 WERE MADE BY THE SCIENTISTS BROWN AND BLONDEL OR BY MR. ARTOM OR BY MESSRS. BELLINI AND TOSI . . . . . . . . . ." The Cassation Courts (June 8th, 1915) did not affirm anything, as their duty was simply dealing with formal matters. The public act of April 5th, 1912, does not deal at all with radiogoniometers. I hold these three documents at the disposal of any who may be interested to see them.

What is most striking is the fact that at the discussion I and my partners asked the Courts to decide who was the inventor of the magnetic radiogoniometer and that it was Mr. Artom who was opposed to the Courts taking this point into consideration. The object of the litigation was the Artom directive system employing circularly or elliptically polarised waves.

2.—The Italian, French and German Patents cannot be referred to for claiming priority, as these Patents can be obtained in anyone's name, be he the inventor or not. Only the British, Canadian, Indian, U.S., Australian, etc., Patents can be referred to for this purpose as to obtain these

Patents it is necessary to declare or to swear to be the sole and real inventor. All these Patents for the magnetic radiogoniometer are in the names Bellini and Tosi.

The Patents for the electrostatic radiogoniometer are also all in my name.

3.—It would be too long and tedious to explain how Mr. Artom was able to obtain the Italian, French and German Patents in his name. What is interesting to know is that I had communicated my invention to Mr. Artom with my letters to him dated February 27th and March 1st, 1907, and that Mr. Artom answered me on March 4th acknowledging receipt of my letters and of my invention. The translation of the part of this letter concerning the invention of the magnetic radiogoniometer is as follows :—

"I THANK YOU FOR YOUR LETTERS OF FEBRUARY 27TH AND MARCH 1ST. I VERY MUCH APPROVE THE APPARATUS PROPOSED AND IMAGINED BY YOU FOR THE DETERMINATION OF THE AZIMUTH AND I HOPE THAT YOU WILL ALSO SUCCEED IN OVERCOMING THE DIFFICULTIES OF CONSTRUCTION WITH WHICH YOU WILL MEET. ALTOGETHER IT WOULD BE CONVENIENT TO COVER THE THING IMMEDIATELY BY A PATENT."

The photographic reproduction of this letter appeared in the *Electrician* advertisement pages for January 2nd and February 13th, 1920.

4.—Mr. Artom does not answer my technical observations upon the direct-reading radiogoniometer set forth by him. I am, therefore, justified in admitting that he finds my observations right, in spite of his contrary declarations.

E. BELLINI.

Enghien-les-Bains,
*April 10th*, 1922.

*To the Editor of* THE WIRELESS WORLD AND RADIO REVIEW.

SIR,—This is to tell you I have just received very good signals from station **2 CV**. I heard him several times from 2103 till 2126 G.M.T., when I closed down.

His signals were pure C.W. on about 400 metres and were quite strong and remarkably steady ; I could read them easily through heavy QRN. He was working with station **2 DM**.

Being unable to find this station on the lists I have I would very much appreciate your letting **2 CV** know of his reception here and that I am at his entire disposal for more details.

Yours sincerely,
LÉON DELOY.
"French 8 AB."

Radio-Club de la Côte D'Azur,
Nice.

*Sunday, April 16th*, 1922. (2200 G.M.T.).

**8 AB.**—(M. Léon Deloy, Villa des Hautes-Roches, 55, Boulevard Mont-Boron, Nice) transmits almost daily on 525 metres C.W. from 2100 to 2115 and listens in on 200 metres between 2045 and 2230 B.S.T.

# Calendar of Current Events

**Saturday, April 29th.**

LUTON WIRELESS SOCIETY.
Public Exhibition.

SUNDERLAND WIRELESS AND SCIENTIFIC SOCIETY.
At the Technical College, "Telephony," by Mr. T. Brown Thomson.

**Tuesday, May 2nd.**

TRANSMISSION OF TELEPHONY at 7 *to* 7.25 *p.m.* on 700 metres, followed by C.W. Calibration Signals on 1,000 metres, by **2MT** from Writtle, near Chelmsford.

**Wednesday, May 3rd.**

COWES AND DISTRICT RADIO SOCIETY.
"The Application of Three-Electrode Valves to Transmitting."

INSTITUTION OF ELECTRICAL ENGINEERS (WIRELESS SECTION).
6 *p.m.*—"Prevention of Interference in Wireless Telegraphy" (Provisional), by Mr. C. S. Franklin.

**Thursday, May 4th.**

KENSINGTON WIRELESS SOCIETY.
8.30 *p.m.*—At 2, Penywern Road.
"The Inner Mysteries of Thermionic Valve Manufacture," by Mr. J. F. Turner (Wandsworth Wireless Society).

WEST LONDON WIRELESS AND EXPERIMENTAL ASSOCIATION.
"Lantern Lecture and Demonstration," by Mr. Oswald Carpenter, Associate I.R.E.

**Friday, May 5th.**

WIRELESS SOCIETY OF HIGHGATE.
"Production of Low-Frequency Oscillations by the Valve," by Mr. L. Grinstead.

INSTITUTION OF ELECTRICAL ENGINEERS (LONDON STUDENTS' SECTION).
7 *p.m.*—"Electrically Oscillatory Discharges," by Mr. R. P. Howgrave-Graham.

**Thursday, May 11th.**

LIVERPOOL AMATEUR WIRELESS SOCIETY.
Demonstration of Recording, by Mr. W. A. Brooke.

WEST LONDON WIRELESS AND EXPERIMENTAL ASSOCIATION.
"Transformer Coupled H.F. Amplification," by Mr. Edward Mc.T. Reece.

**Friday, May 12th.**

PHYSICAL SOCIETY.
5 *p.m.*—At the Imperial College of Science, South Kensington. "Experiments with Neon Gas Filled Lamps," demonstration, by Mr. S. O. Pearson, B.Sc., and Mr. H. Anson.

WIRELESS SOCIETY OF HIGHGATE.
"The Action of the Valve in the Light of the Electron Theory," by Mr. D. H. Eade.

LEEDS AND DISTRICT AMATEUR WIRELESS SOCIETY.
"The Principles of Tuning," by Mr. H. F. Yardley.

**Saturday, May 13th.**

INSTITUTION OF ELECTRICAL ENGINEERS (LONDON STUDENTS' SECTION).
*Afternoon.*—Visit to Victoria Telephone Exchange.

# Wireless Club Reports

*NOTE.—Under this heading the Editor will be pleased to give publication to reports of the meetings of Wireless Clubs and Societies. Such reports should be submitted without covering letter in the exact form in which they are to appear and as concise as possible, the Editor reserving the right to edit and curtail the reports if necessary.* **The Editor will be pleased to consider for publication papers read before Societies. An Asterisk denotes affiliation with the Wireless Society of London.**

### Bradford Wireless Society.*

Hon. Secretary, Mr. J. Bever, 85, Emm Lane, Heaton, Bradford.

A meeting was held in the Club Room at 7.45 p.m. on April 7th, Mr. W. C. Ramshaw in the chair. Following the business of the meeting, three new members were elected.

The Chairman, then called upon Mr. N. Whiteley to give his address on "Mesopotamia." The lecturer commenced with a brief geographical survey of the country and followed this up with an outline of the British campaigns there, ending with his own personal wireless experiences in that country and India. The lecture was admirably illustrated by lantern slides made from the lecturer's own photographs and was very much enjoyed by those present. A hearty vote of thanks was carried unanimously.

Will all interested in the Society please note that during the temporary absence of the Hon. Secretary, all communications should be addressed to the Organising Secretary, Mr. N. Whiteley, 8, Warrels Terrace, Bramley, Leeds, when they will receive prompt attention.

### Dartford and District Wireless Society.*

Hon. Secretary, Mr. E. C. Deavin, 84, Hawley Road, Dartford.

The members of the above Society held their usual fortnightly meeting on Friday, April 7th, 1922. Mr. J. R. Smith, A.M.I.E.E., Vice-President, in the chair. Opportunity was taken on this occasion to thoroughly test the aerial since the desired alterations had been carried out and it was very gratifying to note a considerable improvement.

The Society's crystal receiving set had been overhauled and reconditioned by Mr. Lyne and is now satisfactory, giving good signals. A 3-valve set with reaction was brought for demonstration by Mr. O'Keeffe, also a single valve amplification set, using a 5 electrode valve, by Mr. Prangnell, the Assistant Secretary. This valve amplifies approximately six times and is provisionally patented by Mr. Prangnell. Extremely good signals were received, the results on these home-constructed instruments being very satisfactory.

Mr. Prangnell also gave descriptive circuits for transmission and reception, using his special valve.

### Kensington Wireless Society.*

A meeting was held at 2, Penywern Road on Thursday, April 6th. After the business of the evening had been disposed of, Mr. F. H. Haynes presented a paper on "Methods of Amplification and the Construction of Amplifying Apparatus."

He described all the modern methods of obtaining amplification and the merits of each, giving constructional details of the transformers, resistances, condensers, etc., used in each case.

The meeting was temporarily adjourned at 9.15 p.m. to "listen in" to the concert which was being transmitted to the Aeolian Hall, and to examine a Johnson-Rahbeck Agate Loud Speaker Amplifier made by Mr. Haynes, the instrument being capable of giving tremendous amplification without distortion.

On resuming, the lecturer concluded by giving details of some novel types of amplifier with which he is experimenting.

Some discussion ensued, after which Mr. Haynes was very heartily thanked, and the meeting was adjourned.

Next meeting, Thursday, May 4th.

Hon. Secretary, Mr. W. J. Henderson, 2, Hollywood Road, South Kensington.

### Leamington Spa and Warwick.

Mr. Frank A. Sleath, of 31, Archery Road, Leamington Spa, and late Secretary to the Gravesend Wireless Society, is desirous of forming a Wireless Society in the Leamington and Warwick district.

Will all those who are interested communicate with him, or call between 2.30 and 4 p.m. on Sundays.

Judging by the interference on "Concert" nights there must be several amateurs in the immediate vicinity who are either experiencing great difficulty in getting **2 MT**, or they are getting the music with a beautiful "howl" accompaniment.

### The Leeds and District Amateur Wireless Society.*

Hon, Secretary, Mr. D. E. Pettigrew, 37, Mexborough Avenue, Chapeltown Road, Leeds.

A General Meeting was held on Friday, April 14th, at the Leeds University, Mr. G. P. Kendall, B.Sc. (Vice-President), taking the chair at 8.30 p.m. The Chairman called upon Capt. F. A. Whitaker, R.E. (Vice-President), to deliver a paper on the subject of "High Frequency Amplification."

As the subject has been receiving much attention lately, the lecture was particularly enjoyable and in keeping with the times. Capt. Whitaker commenced with a brief explanation of the terms rectification, high frequency amplification, and low frequency magnification, and with the aid of rough blackboard characteristic curves showed just how it was possible to work the valve accordingly. He proceeded to show why H.F. amplification is to be preferred for general reception. H.F. amplification is by no means as straightforward a procedure as L.F. magnification, but in the long run it pays to put in the valves on the H.F. side of the rectifier. Moreover, it is practically essential to use H.F. amplification to get really strong and clear speech or music when receiving telephony.

Various methods of coupling triodes together when operating at radio frequency were next considered; the lecturer touching on the practical side of business frequently. These modes of coupling included many types of inductively coupled circuits, such as the ordinary copper wire aperiodic tightly coupled air core transformer; ditto, with condensers in shunt across the primary and/or secondary for "tuned" transformers; resistance wound aperiodic and periodic transformers, etc. Capt. Whitaker did not definitely state that these various H.F. transformers did transform electromagnetically or whether it was an electrostatical effect; but one thing is certain, and that is by not committing himself, Capt. Whitaker undoubtedly saved the meeting from a heated discussion later on. He also explained certain methods of direct coupling, wherein it is usual to rectify at the next valve with the aid of a grid condenser, which in addition successfully insulates the grid of that valve from the positive H.T. supplying the H.F. valve. Resistance capacity and reactance capacity couplings were next considered and explained in detail. Nevertheless the lecturer, unknowingly, completely ionized some of those present (including the Hon. Secretary) with regard to the latter type of coupling. He referred the meeting to the current issue of *The Wireless World and Radio Review* for further information on this particular system of coupling. Radio frequency amplifiers using iron core transformers were touched upon, as were certain types of H.F. sets using condensers only. Capt. Whitaker had on view numerous types of H.F. transformers, including one of the iron core type.

A lively discussion was then opened, and Capt. Whitaker was kept very busy for some time. The subject offered so large a field for argument that the discussion could have proceeded almost indefinitely, but eventually the meeting came to the conclusion that, as Capt. Whitaker said in the course of his lecture, "some very funny things happen with H.F. amplifiers," and so the meeting was closed after a hearty vote of thanks had been accorded to Capt. Whitaker at 10.40 p.m.

### Sheffield and District Wireless Society.*

Hon. Secretary, Mr. L. H. Crowther, A.M.I.E.E., 156, Meadow Head, Norton Woodseats, Sheffield.

On the 7th inst., at the Department of Applied Science, George Square, Sheffield, Mr. F. Gilberthorpe gave an interesting paper on "Syntony and Resonance" as applied to radio communication by slides, diagrams and formula.

The importance of resonance in its application to physical phenomena was clearly demonstrated, also the accidental production of resonance in low frequency circuits and the effect of resistance and damping.

A full discussion followed, after which the lecturer was given a very hearty vote of thanks.

The Society has now received a transmitting licence for permission to communicate with the Manchester Wireless Society between certain defined hours, which will be advised later.

### Sussex Wireless Research Society.*

Hon. Secretary, Mr. Edward Hughes, B.Sc., A.M.I.E.E., The Technical College, Brighton.

At a meeting of the above Society held at Cottesmore School, Upper Drive, Hove, the President, Capt. Hoghton, M.Inst.P., gave a lecture dealing with "Recent Developments in Valves." The action of the 4-electrode valve was explained and the applications of these valves to transmission and reception circuits was dealt with. Capt. Hoghton also explained at length the principle underlying the action of the dynatron, and emphasised the advantages and immense possibilities of a valve possessing "negative" resistance. The lecturer finally dealt briefly with the developments that are taking place in regard to filament construction and the mechanical design of valves.

### The West London Wireless and Experimental Association.*

Hon. Secretary, Mr. Horace W. Cotton, 19, Bushey Road, Harlington, Middlesex.

At the meeting held on Thursday, April 6th, buzzer practice was given by Mr. Winnett and many members availed themselves of the opportunity to brighten up their Morse.

Following this the Association's apparatus was tuned up and the concert specially transmitted by the Marconi Scientific Instrument Co. to the Aeolian Hall at 9.15 p.m. was successfully picked up and with the aid of the loud speaker all present were able to hear the music sent out. After this the President announced that the Committee hoped to fix up a half-day outing during June and the Secretary was going to get in touch with the authorities with a view to paying a visit to the Croydon Radio Station and Aerodrome. However, more of this anon.

Members are specially requested to make a note of the forthcoming lectures (*see Calendar of Current Events*).

The Secretary will have much pleasure in replying to applications regarding objects of the Association and on qualifications for membership.

Another successful meeting was held Thursday evening, April 13th. Morse practice was again kindly given by Mr. H. P. Winnett: afterwards "listening in" with the aid of the loud speaker resulted in the reception of music and telephony. A paper was then read by Mr. Winnett entitled "Land Telegraphy." The simplex and duplex systems were minutely described and explained with the assistance of diagrams. Questions were invited and the speaker fully replied to those who had questioned him.

The Vice-President, Mr. F. E. Studt, took the opportunity to present a short wave tuner, of his own construction, together with a chart of curves to the Association, and a very hearty vote of thanks was accorded him for this very useful gift. With this latest addition to our apparatus it will now be possible to receive signals and radio telephony on very short wavelengths.

The Secretary desires all members to bear in mind the previously announced demonstrations.

It is hoped to shortly announce definite date for half-day outing and members are asked to carefully watch the "Calendar of Current Events" for all future information.

The Secretary will have much pleasure in answering any enquiries respecting objects of the Association and qualifications for membership.

### The Wireless and Experimental Association.*

At the Central Hall, Peckham, on April 12th, the Association had the pleasure of listening to a lecture on transmitting by their old member, Lieut. Owen.

Few of our members have transmitting licences, but, like the boy who cut his drum open, we dreadfully want to know where the sound comes from and it adds greatly to our interest in receiving signals if we know perfectly well how they are sent out. A trial has been arranged for comparison of a 500 cycle transmission and a 50 cycle transmission and many of the ears will be strained to detect the difference, if any. Many were the useful hints and data given as to winding transformers for transmission, and no longer should our wireless neighbours 20 miles away make cursory remarks about the broadness of front of our spark transmission wave.

Hon. Secretary, Mr. George Sutton, A.M.I.E.E., 18, Melford Road, S.E.22.

### The North Essex Wireless Society.

Headquarters, 15, Rayne Road, Braintree.

On April 4th the members of the North Essex Wireless Society arranged a free public lecture and demonstration of Wireless reception at the Y.M.C.A. Hall, Braintree. The President of the Society (Mr. H. E. Adshead, B.A.) gave the lecture and the apparatus was demonstrated by Messrs. Gordon Castagnoli and F. T. Smith. The former gentleman kindly lent all the apparatus, including home-made loud speakers. The Hall was well filled and the audience were able to hear the well-known Marconi concert from **2 MT** and applauded each item to show their appreciation.

The apparatus used consisted of two H.F. transformer coupled valves, one detector and four L.F. valves, making in all a very efficient seven-valve receiver.

The Secretary made formal announcements on the work of the Society and suggested that the occasion should bring several new members.

Thanks were accorded to the lecturer and demonstrators in the usual hearty manner and several donations were received by the Secretary towards the Society's work.

### Southampton and District Wireless Society.

Hon. Secretary, Mr. T. H. Cutler, 24, Floating Bridge Road, Southampton.

At the meeting of the above Society, held at its Headquarters, the Kingsland Assembly Rooms, on Wednesday last, April 12th, a most interesting and enjoyable evening was spent. After the usual buzzer practice, business of the Club was commenced. Minutes of the last meeting were read and approved.

The Secretary announced that a cheque had been received from Sir G. Cooper for the Club funds, also that General Sir I. Phillips, M.P., and W. Dudley Ward, Esq., M.P., had both accepted the Presidency of the Club, and had both kindly presented cheques, the one from Mr. Dudley Ward being a particularly substantial one, much needed.

It was also announced that Dr. J. T. M. McDougall and G. South, Esq., had accepted the Vice-Presidency of the Club and also promised to assist the Society in whatever they required. After all the correspondence was read Mr. Bateman was asked to continue his lecture on "Accumulator Charging," and the "Wheatstone Bridge." The lecture outlined most clearly the working of the Wheatstone Bridge. At the conclusion all questions put to the lecturer were answered to the satisfaction of the members. The meeting finally closed at 10 p.m.

The large numbers of members present indicate the keen interest which is being taken locally in Wireless Telegraphy, and also in the lectures.

### Stoke-on-Trent Wireless and Experimental Society.

Hon. Secretary, Mr. F. T. Jones, 360, Cobridge Road, Hanley, Stoke-on-Trent.

The Society held an exhibition and demonstration of wireless apparatus in the Town Hall, Burslem, from March 30th to April 1st.

The exhibition was attended by considerable success, this being in a great measure due to the hearty and loyal co-operation of the members. A considerable amount of apparatus (representative of all types) was placed on exhibition by the members and the room showed quite an imposing and pleasing appearance.

An attractive programme was arranged, three different types of apparatus being used in turn for demonstrations in reception. At intervals Messrs A. H. Wilson and F. Jenkinson treated the visitors to a short but apparently much appreciated lecture on the subject of "New Wireless Works."

Arrangements were made for the showing, in an adjoining room, of two "Bray Pictorial" cinematograph films, the first illustrated the working of the ordinary telephone and the second conveyed in a very simple manner to the lay mind the principle underlying wireless telephony. This was followed by a description of and demonstrations with X-rays. At one time a considerable stir was caused amongst the visitors by the reception of telephony which was audible to all by means of an amplifier and loud speaker.

Our thanks are due to the Wireless Press for a good selection of books, which were much appreciated, and to the Hart Accumulator Co., for the loan of accumulators for show purposes.

Many expressions of appreciation have been received from members of the public, and all the Society's members feel that they have been amply repaid for the time and trouble expended by these alone. The Society's funds have been substantially benefited and an appreciable increase in the membership has resulted.

### Wolverhampton and District Wireless Society.

On the 5th April, at a General Meeting held at Headquarters, 26, King Street, Wolverhampton, the Vice-Chairman, Mr. Geo. W. Fairall, read a paper on "The Early History of Electricity." Commencing with the lodestone and its discovery he took his hearers through the years of progress to modern electric lighting and telegraphy, interspersing his remarks with anecdotes of the great men to whom we owe so much. Some of these were amusing, and his description of Edison rubbing two cats together to generate electricity showed a humorous side of science. A piece of the first Atlantic cable was handed round for inspection and Mr. Fairall's paper came to an end all too soon.

At the meeting held on the 12th April, Mr. A. E. Jones gave a lecture on Accumulators, pointing out the necessity of using the correct proportions of brimstone sulphuric acid and distilled water and the general care of accumulators if trouble was to be avoided and what to do when matters went wrong. His lecture will probably save some of the members' batteries "going west," and incidentally, their pocket money.

Hon. Secretary, Mr. Geo. W. Jones, 8, Roseberry Street, Wolverhampton.

### Border Wireless Club.

Mr. James W. Blake, The Square, Kelso, Scotland, will be pleased to hear from gentlemen in the Border Counties who are interested in wireless, and who are desirous of forming a Border Wireless Club.

### Lincoln Wireless and Scientific Society.*

With a view to attracting new members a public exhibition of wireless apparatus was given by the Society in the Gymnasium at the Municipal Technical School, Lincoln, on April 11th and 12th, 1922. Most of the apparatus shown was home-made by members of the Society, and sets were exhibited by Messrs. Astill, Bates, Cottam, Elsey, Friskney, Harrison, Herring, Issott, Mawer and Townhill.

A set of "Tingey" units, the property of the Technical School, was also on view.

C.A.V. accumulators supplied the current for the various sets and the local agent had a stand of various electrical apparatus.

On Tuesday evening the concert given by 2 MT was picked up on Mr. Harrison's home-made set, and by means of a loud speaker, the visitors, numbering about 300, were given a musical treat, which to many of them was a great surprise, and numerous comments were heard on the clearness of the speech. Later in the evening Mr. A. E. Collis, M.I.M.E., Whit.Ex., Head Master of the Technical School, expressed his appreciation of the trouble taken and the great amount of work done by the Chairman and members of the Wireless Society to give the public such splendid results of their study of wireless.

At intervals during both Tuesday and Wednesday evenings, Mr. C. Friskney (Chairman of the Society) explained to the visitors the various pieces of apparatus and invited questions from any who were interested in wireless.

Each evening part of a "CQ" message from Leafield was received and written on a blackboard by Mrs. Elsey (wife of the Secretary), much interest being created thereby.

Altogether the event was quite successful as an exhibition, and it is hoped that it may be the means of drawing the attention of those interested to the fact that there is a live wireless society in Lincoln, and that a number of new members may be the result.

Great credit is due to the Exhibition Sub-Committee, Messrs. Friskney, Harris and Issott, with Mr. F. Mawer as Secretary, for the splendid work done in organising such a successful show.

Hon. Secretary, Mr. H. E. Elsey, Rosebery Avenue, Lincoln.

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# An Echo of the Transatlantic Tests

IN the issue of *The Wireless World* for October 29th, 1921, in outlining the conditions of entry for the recently conducted Transatlantic Tests, we quoted a criticism of the capabilities of the British amateurs to receive the signals which had appeared in the American journal, *Q.S.T.* The quotation was as follows :—

"Such reception is a new field for British experimenters, and they hardly can be expected to show the same performance as an American dyed-in-the-wool ham who has learned how to get amateur DX only after years of patient struggle. We have tested most of the circuits used by the Britishers, and find them one and all decidedly inferior to our standard American regenerative circuit using variometer tuning in secondary and tertiary circuits. We would bet our new spring hat that if a good U.S. amateur with such a set and an Armstrong Super could be sent to England, reception of U.S. amateurs would straightway become commonplace.

"We do not mean to deprecate the loyal co-operation shown by our English confrères, however. For the admirably complete way in which they go into a problem we have the greatest respect, and we are most sincerely grateful for their interest and enthusiastic co-operation in this, our first attempt to get overseas on schedule. We will all hope for better luck next time."

The author of this criticism was Mr. Kenneth B. Warner, of the American Radio Relay League, and his bet of a "new spring hat" was taken up in this country by Mr. W. W. Burnham.

Success rewarded the efforts of the "good U.S. Amateur," and although the laurels were shared with the British amateurs, the bet of the "new spring hat" still stood. We give here an illustration of the hat prepared for Mr. Warner, which has just been dispatched to the States by Mr. Burnham.

The hat is of light grey felt and bears on one side the stars and stripes, and on the other the Union Jack united by wireless flashes encircling the crown. In front can be seen the inscription of dedication. Unfortunately, the photograph cannot


reproduce the colours of this work of art, so that a full appreciation of its beauty is not possible.

We wonder if Mr. Warner will make use of his new hat for official occasions, and we expect from him a photograph with the hat on.

We wonder also whether Mr. Burnham took his measurements before or after the success of the Tests!

# Questions and Answers

*NOTE.—This section of the magazine is placed at the disposal of all readers who wish to receive advice and information on matters pertaining to both the technical and non-technical sides of wireless work. Readers should comply with the following rules.—*(1) *Each question should be numbered and written on a separate sheet on one side of the paper only.* (2) *Queries should be clear and concise.* (3) *Before sending in their questions readers are advised to search recent numbers to see whether the same queries have not been dealt with before.* **(4) The Editor cannot undertake to reply to queries by post.** (5) *All queries must be accompanied by the full name and address of the sender, which is for reference, not for publication. Queries will be answered under the initials and town of the correspondent, or, if so desired, under a " nom de plume."* **(6) Readers desirous of knowing the conditions of service, etc., for wireless operators will save time by writing direct to the various firms employing operators.** (7) *Four questions is the maximum which will be accepted at a time.*

**"F.E.S." (Ealing)** *asks* (1) *If it is possible to reproduce speech and music for a large room of as good quality as that of a modern gramophone.* (2) *For any literature on distortionless speech reproduction.*

(1) Speech and music can be reproduced to fill a large room but there is always a certain amount of distortion present. This is due partly to wireless troubles and partly to reproduction troubles, *e.g.*, with a loud speaker. The wireless troubles can be largely got over by using valves whose characteristic is very straight over part of their range, and by so arranging the circuit that operation occurs on the straight part. High-frequency amplification is recommended. The reproduction part of the trouble cannot be regarded as properly solved at present. As you suggest, the loud speaker is not very good and we advise you to adopt a loud speaker of the Rahbek and Johnston type, experimenting to find the most suitable practical arrangement. (2) We do not know of any recent publications on this matter which will meet your requirements.

**"C.A.N." (Bury St. Edmunds)** *asks* (1) *The advantages of a two circuit receiver over one with a single circuit.* (2) *If it is normal for his simple crystal set to give Croydon telephony and C.W. Stations.* (3) *If any stations send out between 5 and 7 p.m. such news as appears on tape machines.* (4) *Asks which of several valves to use for a detector.*

(1) A two circuit receiver gives better selectivity and also minimises re-radiation. (2) Reception of Croydon is normal; reception of C.W. signals, if with a clear note, is abnormal and probably due to interference by some oscillating circuit in the neighbourhood. If, however, you get these stations with a barely readable hiss the result is nothing unusual. (3) We do not know of any such stations. (4) Any of the valves you mention should be suitable.

**"A.E." (Cambridge)** *asks* (1) *For criticism of a crystal set.* (2) *If it would receive* **2 MT.** (3) *What time* **2 MT's** *concert takes place.* (3) *If an aerial would be satisfactory with telephone lines about 30 ft. away and a little higher than the aerial.*

(1) O.K. (2) Yes, if the coil is of the right size. (3) Tuesdays, 7 to 7.30 p.m. (3) Fairly well, but it will be desirable for the aerial not to be parallel to the telephone wires.

**"ANODE" (Wendover)** *asks* (1) *For criticism of a single valve set.* (2) *For windings of the A.T.I. and reaction coil with No. 26 for wavelengths of 300 to 3,000 metres.* (3) *A few stations he should get.*

(1) A circuit as shown is correct, but a two circuit receiver would be freer from re-radiation and more selective. (2) A.T.I. 9″ × 7″ of No. 26 with a slider; reaction coil 6″ × 4″ of No. 26 with three or four tappings. It would be desirable to have separate coils for the short wavelengths. (3) You should be able to get almost any of the larger European stations up to 5,000 metres. (4) A list with times of transmissions, see January 7th issue.

**"TYRO" (Catford)** *asks for winding for a coil suitable for 8,000 metres and a condenser of 0·002 mfd.*

If the condenser is used in parallel with the coil for the longer wavelengths, 8″ × 6″ of No. 26 will be sufficient.

**"C.W.R." (Bloemfontein)** *asks* (1) *A question about certain coils.* (2) *How to test a crystal.* (3) *If the substitution of the potentiometer method for the grid leak and condenser method is worth the extra expense.*

(1) You might try the next larger with A.T.I., and the next smaller as reaction coil. We cannot advise you further without knowing the size of your tuning condenser. (2) Buzz some part of the receiving circuit, listen in the telephones, and adjust until the desired sensitivity is obtained. (3) As a rule this is of no extra expense, but there is little to choose between the methods. Broadly speaking, the condenser method is more sensitive and the potentiometer method more stable in operation.

**"J.W." (Walthamstow)** *asks if a sample of wire is suitable for an aerial.* (2) *What times and on what wavelengths telephony is transmitted.* (3) *For a single-valve circuit.* (4) *What stations have the call signs of* **GSS** *and* **PST.**

(1) No. As the wire is steel it is quite unsuitable. (2) Excluding **2 MT** and **PCGG**, the only stations working regularly are air stations on a wavelength of about 800 metres. Times of transmission irregular. (3) See Fig. 2, page 811, March 18th issue. (4) We do not know.

**"C.N." (Merton Park).**—For the information you require concerning the Moscow tune signals, see the issue of April 22nd.

**"J.G.C." (Ealing)** *asks where to obtain information about* (1) *Intervalve transformers for wavelength range of 400 to 4,000 metres.* (2) *Honeycomb coils.* (3) *How honeycomb coils should be mounted relatively to each other.* (4) *Where design of a three valve panel has been given.*

(1) The only way to obtain such a range with one

pair of coils is to use high resistance winding untuned. The transformer is described on page 781. If wound with No. 47 Eureka wire instead of that specified should be about right for this range. (2) A description of these coils is given in the issue for October 30th, 1920, and a simple machine for winding them, with illustrations of the coils, is described in the issue of July 23rd, 1921. (3) They may conveniently be supported in line on a rod of insulating material. (4) We do not think that a set of exactly this type has been described in detail—the nearest approach being the frame aerial set of Nos. 16 to 21, Vol. VIII.

**"W.J.F." (Hornsey).**—(1) The coils might be used for a wavelength of about 7,000 metres. The larger coil as A.T.I. and the smaller as reaction coil. (2) A.T.C. 0·0015 mfd. with a condenser of 0·001 mfd. across the telephones. (3) Yes, but omit the variable condenser in the plate circuit and put a condenser across the telephones as above. (4) **PCGG** is the call sign of the station transmitting the Dutch Concerts, which you might hear with very careful adjustment.

**"T.P." (Sunderland).**—It will be best to run the aerial from your receiving room as far away as possible from all the buildings, using a single wire, but failing this you might run it across as a double wire aerial stayed out from the house to a pole on the roof above the point marked "pipes."

**"J.W.O." (Hull)** *asks* (1) *For criticism of a circuit.* (2) *How to avoid oscillation when receiving telephony.* (3) *How much of a certain foil and paper condenser will be required for a capacity of 0·002 mfd.*

(1) The circuit is O.K. (2) Firstly, by weakening the reaction coupling, and if this fails, by re-arranging the leads so that the grid leads of each valve are as far away as possible from the plate lead of the same valve. (3) Two foils about 3″ × 4″ will be sufficient.

**"VALVE" (Bristol)** *asks* (1) *For help with a set which "howls" badly.* (2) *If addition of H.F. valve in the manner shown would be satisfactory.* (3) *If he should get American stations with the H.F. valve added.*

(1) Three stages of L.F. amplification generally do give trouble in this way, and matters are not helped by the use of H.R. telephones directly in the anode circuit. We should recommend you to get rid of one stage of L.F., or to try reversing some of the windings, separating them as far as possible apart or shielding them in closed iron boxes. (2) Yes, over the range you specify. (3) Yes, under favourable conditions. Little would be gained by using a separate battery for the H.F. valve, but this might be done if desired. V. 24 valves can be used for the H.F. but are poor rectifiers.

**"C.M." (Cwnbryn)** *asks questions about an amplifier.*

(1) Filament resistance will be sufficient for the two H.F. valves. (2) Two H.F. transformers will be required unless resistance capacity methods are used. (3) Connect the output of the H.F. amplifier to the grid and filament of the detector panel. (4) The H.F. connections, see Fig. 5, page 813, March 18th issue.

**"PERPLEXED" (Brighton)** *submits a circuit and asks* (1) *For criticism.* (2) *If it could be improved for telephony.* (3) *For a diagram of a three valve amplifier.*

(1) Except that your H.T. battery is shown short circuited, which is evidently a slip, the circuit is quite all right. (2) Only by use of a loose coupled circuit for greater selectivity. (3) See Fig. 3, page 674, January 31st issue.

**"E.F.T." (Tulse Hill)** *asks* (1) *If capacity reaction can be employed with a single valve receiver.* (2) *If so, for the best circuit.* (3) *For values of condensers required.*

(1) Yes, but it is liable to give very erratic results. (2) Can be used with any circuit by the introduction of a small condenser between the grid and the plate. (3) Quite a small condenser is necessary, say about 0·00005 mfd.

**"H.B.D.W." (Oswestry)** *asks whether messages could be received with aerial at right angles to twenty lines of telegraph wires, no signal being obtained when the aerial is parallel to the wires.*

Conditions would certainly be more favourable, but the absence of signals with the aerial in any other position seems to suggest that there is something wrong with your set itself.

**"B.S." (Darwen).**—(1) The loose coupler for Fig. 2 might have primary 10″ × 6″ of No. 22 and secondary about the same size. (2) Double head-piece telephones would be preferable. (3) None of these circuits are very good. No. 12 or 13 might receive **PCGG.**

**"J.M.M." (Nottingham)** *asks* (1) *For criticism of an aerial.* (2) *If ordinary Low Resistance telephones can be used with a Telephone Transformer for the reception of wireless signals.* (3) *How capacity of condensers may be calculated.*

(1) There will be a certain amount of screening if the factory roof is of metal, but this should not be very serious. (2) As a rule ordinary telephone receivers have too low resistance for satisfactory wireless work. Some results could doubtless be obtained with a transformer specially wound to suit the telephones in question. (3) Formula for the calculation of different types of condenser will be found in Nottage's "Calculation of Capacity and Inductance," published by the Wireless Press.

**"E.H." (Battersea)** *asks* (1) *If constructional details for a frame set for the Dutch Concert have appeared in recent numbers.* (2) *If 150 ohms marked on Sullivan telephones refers to each earpiece.*

(1) Not very recently, but a set suitable for the purpose will be found described in Nos. 16 to 21 inclusive of Vol. 8. (2) No, this is the total resistance; each earpiece being 75 ohms in the case of telephones of this make.

**"WIRELESS MAD" (Crofton Park)** *has a crystal set which gives no results.*

The set can only give very poor results as shown. Aerial should be of copper not steel. Secondary circuit should be tuned by means of a small variable condenser. We cannot state resistance of the telephones. There is no simple way for you to measure it without instruments. The windings of the circuit are only suitable for about 600 metres. The simplest way to add a valve would be as L.F.

amplifier, but this is useless with the present arrangement.

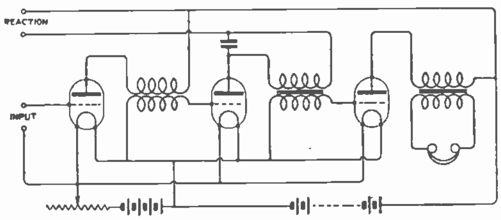
**"P.E.M.E." (Bambury)** *asks* (1) *If the connection of the grid and negative side of filament of a note magnifying valve to the telephone terminals of a crystal set is correct.* (2) *If a diagram is correct.*

(1) Yes, the set should be quite satisfactory. (2) Yes, except that there is no connection from the negative 6-volt battery to earth. If "R" valves are used about 100 volts H.T. will be required, because of the high value of the anode resistance.

**"F.H." (Rayton)** *asks about a frame aerial set for receiving the Dutch Concerts.*

For satisfactory results you will want about five valves with H.F. transformer coupling, the natural wavelength of the transformers being about 1,000 metres. This with a frame four feet in diameter. With an attic aerial of parallel wires joined to the set at one end you will probably get equivalent results with about one valve less.

**"N.E.K." (Malines)** *asks questions about a three valve amplifier for 200 to 2,000 metres receiving set.*




*Fig,* 1.

Two H.F. valves and one L.F. valve is a good arrangement but efficient coupling over the whole range is very difficult with either resistance capacity or transformer coupling. The former is inefficient below 1,000 metres, and the second method will not give a wide range with a single set of transformers. For best results you should use transformer coupling with separate transformers for 400, 600, 1,000 and 1,600 metres. For circuit see diagram (Fig. 1). L.F. intervalve transformers may have any ratio between about 1/1 and 1/3.

**"W.V.R." (Bristol)** *has a crystal set on which only a breathing sound is heard and asks for advice.*

The circuit is correctly arranged and should give signals from ships. The breathing sound is probably caused by the crystal being defective or else by a bad contact in the closed circuit, in either case allowing a slightly unsteady current to pass through the telephones. Try a fresh crystal and examine the wires carefully.

**"A.G." (Teddington)** *asks* (1) *Where to obtain good ink for a syphon recorder.* (2) *Where to get tape for a recorder.* (3) *The approximate capacity and inductance of an aerial sketched.*

(1) and (2) From dealers in telegraph apparatus or from Messrs. Waterlow Bros. (3) Capacity about 0·0001 mfd., inductance 50 mhys.

**"H.F.M." (Bilston)** *asks for the values for the construction of a circuit shown on Fig. 4, page 561, December 10th issue.*

This is not a straightforward circuit, and is only suitable for experienced workers. It is not possible to give suitable values for the capacity and inductance of parts without experimental test. We advise a simple circuit upon which experiments can be made as experience is obtained.

**"C.D.H." (Leigh-on-Sea)** *asks* (1) *If diagram enclosed is correct for a three valve set.* (2) *What voltage to use with "V 24" and "R" valves.* (3) *Which is the better of two circuits for telephony.* (4) *If H.F. transformers are suitable for 1,000 ms.*

(1) The resistance R1 should be so connected as to control the L.F. mag. filament in addition to H.F. mag. and detector. Otherwise the circuit is O.K. (2) This is rather a bad arrangement of valves. 30 volts for the "V 24" will probably not be sufficient for the "R" type L.F. valve, while 50 volts for the "R" valve will not give any appreciable increase of signal with the "V 24" valves in the present circuit. Substitute a "V 24" for the L.F. magnifier and use 30 volts. (3) The circuit enclosed will give very good results. (4) It will probably give signals but we cannot say if it is most efficient on that wave without experiment.

**"P.W.B." (Kilburn)** *asks* (1) *If 30 volt valves may be used in a 3-valve receiver designed for use with 70-100 volts.* (2) *If 15 volt valves will also do.* (3) *If 2·2 volt Hart cells are good for filament lighting.* (4) *Best type of aerial to use.*

(1) and (2) If this is a resistance amplifier the anode resistances will most probably be of too great resistance, but they should be tried out. If L.F. set, the transformers will not be the most efficient for the type of valve, but the set will probably work quite well. (3) Two or three of such cells joined in series will be suitable, provided they are of sufficient capacity. (4) An outdoor aerial will give better results from a frame.

**"B.H." (Mansfield)** *asks* (1) *For the address where iron bands for magnetic detectors may be obtained.*

Probably about the only place where you will obtain these bands is from the Marconi Company, who are the makers of almost all the magnetic detectors still in use.

**"RADIO" (Southend)** *asks* (1) *The wavelength of a crystal set.* (2) *Size of the foils for the condenser for bridging 2,000 ohms telephones.*

(1) Maximum wavelength 2,000 metres. (2) The capacity required is about 0·001 mfds. Make Tinfoil into strips ½″ wide, and allow 1″ of overlap between plates of opposite polarity. The mica dielectric should be 0·005″ thick, and 12 tinfoils in all should be used.

**"E.X.E." (Exeter)** *wishes to alter a "Tb" amplifier to use with an H.P.R. receiver.*

We regret that we have no diagram of this receiver, and therefore cannot say what alterations, if any, are required. Consult the makers of the receiver, who can probably give you the required information. If the 3 valves do not howl with a crystal, they should not do so with a rectifying valve. On one valve the **2 MT** telephony would probably be weak, but you should certainly hear it.

**"THEORIST" (West Wratting Pash)** *asks* (1) *For L.F. intervalve transformer windings.* (2) *A* *question regarding an instrument for measuring the distance between two plates by means of valve oscillators*

(1) On a ½″ diameter core of soft iron wires, 3″ long, wind 10,000 turns of No. 44 S.W.S. for the primary, and 15,000 turns of the same wire for the secondary. The primary and the secondary should be wound over one another, with a layer of insulating material between. (2) We are afraid the use of a single valve for this method is quite impossible, as for successful working elaborate precautions have to be taken to prevent the two oscillating circuits from reacting on each other, and the common valve to which you propose to connect them would introduce far too much coupling between them. In practice it is very difficult to induce one valve to make two separate H.F. circuits oscillate independently. In almost all cases the whole system starts oscillating as a one unit with a single frequency determined by the whole of the apparatus in use.

**"BEGINNER" (Brighouse)** *asks (1) For a criticism of a 2 valve set. (2) If further information regarding this set would have been useful.*

(1) With the exception that the 0·001 mfds. bye-pass condenser across the anode winding of the L.F. transformer has been omitted, and also the filament resistance, the circuit is O.K. (2) Information regarding the size of the coils and the capacity of the A.T.C. would have been useful in estimating the correct proportion of A.T.I. and reaction for the oscillator.

**"E.G.B." (Sunderland)** *asks (1) If the zincite-copper pyrites crystal combination requires a battery and potentiometer. (2) Wavelength, etc., of a crystal set.*

(1) No, it is unnecessary. (2) The wave range with the present set would be up to 4,800 metres. The wire, No. 28, is too fine for an aerial circuit without reaction. The former should be rewound full of No. 24, which will reduce the maximum wavelength to 3,200 metres; just sufficient for time signals. At your distance careful adjustment of crystals will be necessary. Connect a 0·001 condenser across the telephones, which will be quite satisfactory.

**"W.A.N." (Petersfield)** *asks (1) Why the two large slabs of a certain set cannot be made to oscillate. (2) How to make an ex-Army transformer and Brown 120 ohms telephones as good as 4,000 ohms telephones.*

(1) There is probably not sufficient reaction coupling for oscillation, with the considerable resistance these coils will probably have. Also the coils may be defective, owing to having a few turns short circuited. You might try interchanging the coils. (2) There should not be very much difference between the arrangements, but what difference there is cannot be altered. An improvement will be obtained if a small condenser of 0·0005 mfds. is connected across the H.R. winding. We presume you connect the telephones to the L.R. winding of the transformer.

**"L.J." (Trondheim)** *asks for a single valve diagram to use with slab inductances for telephony and also for telegraphy.*

In the March 4th issue several single valve circuits are shown. Any of these will be suitable for telegraphy, but for telephony you will probably require more valves unless there is any work being done near to you, in which case the sets referred to will be satisfactory.

**"A.D." (Dumfries)** *submits a diagram of a two valve transmitter and asks for criticism and suitable windings.*

This diagram is of unsuitable type for small powers, and is also incorrect. The circuit shown on page 774, March 4th, Fig. 1, will be found more suitable and easy to work. For 1,000 metres the A.T.I. should be 4″ × 8″, wound full of No. 20. The best value for reaction should be determined experimentally. For a start try a 3″ × 5″ coil of No. 24.

**"G.H.V." (Shrewsbury)** *refers to Marconi Type 16 Receiver and asks (1) How to convert to a two-valve set. (2) Windings for a tapped H.F. transformer from 180 to 6,000 metres. (3) What is the intensifier of this set.*

(1) Rearrange as in diagram (Fig. 2). Note change of aerial condenser. (2) We are afraid such windings can only be determined by experiment and in any case strongly advise you not to attempt to cover so big a range on one transformer. (3) This is the coupling coil between the aerial and secondary circuits.

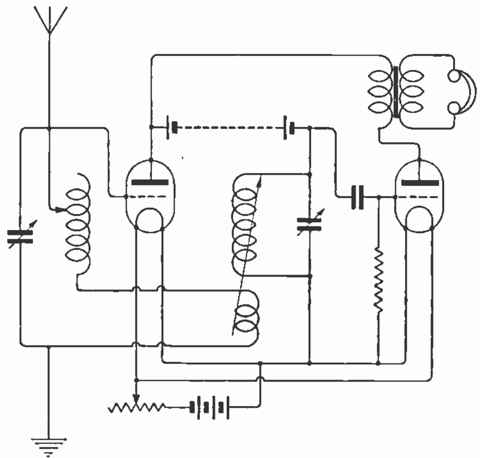


*Fig. 2.*

**"CURIOSITY" (Cambridge)** *asks (1) For size and windings for a frame aerial from 85 to 30,000 metres. (2) Best method of radio-frequency coupling. (3) What extra payments are necessary for having a portable set as well as a fixed set. (4) If permission can be obtained to use an aerial with more than 140 ft. of wire.*

(1) A satisfactory 7-valve amplifier for such a range is almost an impossibility. Moreover several frames would be required, the smallest having, say, 6 turns, 3 ft. diameter, and the largest 60 turns, 5 ft. diameter, with suitable loading coils. (2) For wavelengths above 1,000 metres resistance capacity coupling is the simplest to use. Below 1,000 metres use interchangeable transformers. (3) If a separate licence is issued in respect of the portable set you will presumably be required to pay an additional fee. (4) We cannot express an opinion

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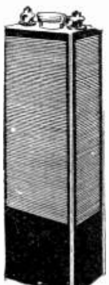

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and we would advise you to write to the P.M.G., stating the special circumstances warranting such a concession.

"**POLYGON**" **(Windsor)** *asks if a loading coil would improve a single valve short wave set.*

A loading coil would increase the wave range and would therefore probably be an improvement. It will be necessary to alter the reaction coil at the same time. We cannot give sizes as you supply no particulars of your present set.

"**C.S.M.D.**" **(Catford)** *asks how to connect a telephone transformer in a single valve circuit.*

Connect the H.R. winding with a 0·001 mfd. condenser across it, in the anode circuit between the positive of the H.T. battery and the reaction coil.

"**ARCHANGEL**" **(Kennington)** *asks* (1) *Wavelength of set.* (2) *Loading coil for* **FL** *and* **POZ.** (3) *Why he hears Croydon but not Lympne.* (4) *Suggestions for improvements at small cost.*

(1) Aerial circuit 2,200 metres, secondary circuit 1,700 metres. (2) For both circuits make loading coils 5″ × 7″. Wind aerial coil with No. 24 and secondary coil with No. 28. (3) Croydon being strong and near does not require a very sensitive set. Lympne, however, being so much further away will probably require an extra valve. (4) The next improvement would be to add a valve as a L.F. amplifier.

"**H.C.E.**" **(Willesden)** *asks* (1) *If a single valve circuit is correct.* (2) *If* **PCGG** *will be received on one ORA valve.* (3) *What is the cause of humming in a crystal circuit.*

(1) The circuit appears to be intended for the Armstrong regenerative circuit, but is not correct. The correct arrangement of this circuit would be as in diagram (Fig. 3). (2) Yes, with a carefully adjusted reaction circuit, but for good readable speech two or more valves is desirable. (3) This is probably due to the circuit arrangement. Connect the aerial side of the telephones as shown in your circuit to the earth side of the blocking condenser.

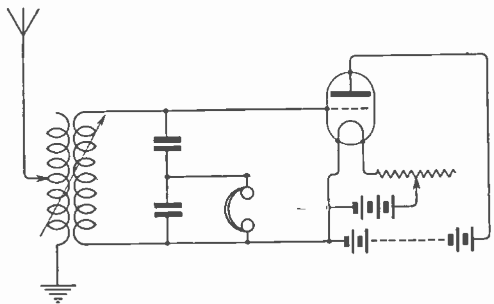


*Fig.* 3.

"**J.R.B.**" **(Scunthorpe)** *asks* (1) *If sample of wire is suitable for crystal set.* (2) *Apparatus necessary for receiving spark and telephony.* (3) *Which of several crystal combinations is most suitable.*

(1) Wire is No. 36, which might be used for the secondary circuit, the size of coil depending on the condenser available. (2) A crystal set is only useful for short distance telephony. At least two valves are desirable for good results. For spark work you will obtain fair results from either of the circuits shown on page 585, December 10th issue. (3) Carborundum is the simplest and most reliable, but zinc-bornite is very sensitive.

"**RUBBER COVERED**" **(Ealing)** *has a three valve set on which he does not receive telephony.*

With a rectifier circuit and two L.F. valves it is essential that the rectifier should work pretty efficiently. Be sure that the grid condenser and leak are satisfactory, and do not allow the set to oscillate. Connect a 0·001 mfd. condenser across the anode winding of first transformer. Most telephony is on about 900 metres, to which the No. 100 coil does not tune the aerial. The No. 200 coil is the correct one to use.

"**S.W.H.**" **(Colchester)** *asks for criticism of a three valve set and suggestions for improvement.*

The set shown is quite good and the results obtained satisfactory. It would, however, be better to introduce leaks of about a megohm each between the grids of the second and third valves and earth. Another improvement might be the substitution of telephone transformer, preferably with L.R. telephones, in place of H.R. telephones shown.

"**C.J.P.S.**" **(Holland Park)** *submits a circuit which he proposes to use with an indoor aerial of four wires of 10 feet long. He asks for criticism and the size of certain condensers.*

The circuit shown is of a freak type which we greatly dislike, involving as it does the raising of the filaments to the full potential of the H.T. battery with no provision for locating the grid potential at the proper point of the characteristic. Results might be obtained if the leak resistances of the various parts of the circuit happen to be about right, but we strongly recommend a more normal type. In any case more than one valve would be necessary for results with such a small aerial, which would be better replaced by a large frame.

"**BEGINNER**" **(Dulwich)** *sends a diagram and asks* (1) *Value for grid condenser and leak and* (2) *Value for variable condenser.* (3) *The most distant station he is likely to obtain.* (4) *If there is a better set of this type.*

(1) About 0·0005 mfd. and 1 megohm. (2) 0·005 mfd. (3) The coils are undesirably small. Use the present A.T.I. for reaction and make a new A.T.I. 8″ × 5″ of No. 26. You should then get any European station up to about 5,000 metres. (4) No, but a condenser across the telephones would be desirable.

"**W.B.**" **(Cheltenham).**—(1) Put the microphone transformer in the grid circuit between the variable condenser and the grid leak condenser. (2) Transmission will be C.W. with a superimposed note of the frequency of the coil break. It will probably heterodyne all right, but would be audible at short distances on a crystal. We do not think a choke would improve matters much. (3) For a 30 mile range reception should be as for C.W. (4) Use about 4″ × 3″ of No. 22 with a series condenser, and reaction coil 3″ × 2½″ of No. 28

"**J.D.**" **(Wandsworth)** *asks what gauge wire should be used for H.F. transformers; what resistance the winding should have; if the coils should be wound in opposite directions; what wire to use for an air cored slab transformer.*

The windings depend on the wavelength required, which you do not specify. In general about No. 40 copper should be used, or finer for a long range. Resistance is immaterial, the wavelength produced by the coils being the important point. If both windings are in the same direction the terminating ends should be taken to plate and grid and starting ends to H.T. + and L.T. – respectively.

**"BEGINNER" (Newark)** *asks* (1) *If two circuits are correct.* (2) *If a condenser should be used across the telephones on a crystal set.* (3) *If it is better to use a small double slide inductance or a long single slide.* (4) *What "mhys." stands for.*

(1) First circuit, yes. Second circuit, yes, either with one end of the inductance left free as shown, or with this end connected to earth for longer wavelengths. (2) Yes. (3) We cannot say without knowing the sizes of the two coils. In general the single slide coil will do all that is required. (4) Microhenries, a convenient practical unit of inductance.

**"E.J.M." (Repton)** *asks for further information about the article on simultaneous H.F. and L.F. amplification in the issue of December 10th, and for advice on working these circuits.* (2) *If we can give the address of the author.*

(1) We are afraid we have not space to treat this subject at any further length. Circuits are all quite sound and you should have no difficulty, particularly with Nos. 2 and 5. These circuits are, however, complicated and need much patience to arrive at satisfactory proportions for all the parts. (2) Referred to Editor.

**"BUZZER" (Bishop's Stortford)** *asks* (1) *Probable reason for failure of the filament of an "R" valve after a week's careful use.* (2) *If it would improve reception to break metal stays to a mast with insulators.* (3) *Windings for a telephone transformer for 8,000 ohm telephones.* (4) *Capacity of a condenser.*

(1) We cannot say. Probably a defective length of filament. (2) Not very much with such very short stays. (3) Use a closed iron core with about 10,000 turns of No. 44 for each winding. (4) Your spacing of ·3 mm. seems very small, but if this is correct the capacity will be about 0·0006 mfd.

**"H.S.T." (Huddersfield)** *refers to page 103, May 14th, and page 427, October 1st, and asks* (1) *How the two circuits could be used together.* (2) *If the Dutch Concerts could be heard on this combination.* (3) *If the result will be satisfactory on 100 cycles.* (4) *If on page 103 two variable condensers and two variable inductances will be required.*

(1) Couple the two units by means of a small coil in the aerial circuit, coupling inductively with the coil L, shown on page 427. (2) and (3) The induction hum will be very much more serious on 100 cycles than on 50. So much so, that we are afraid it will prevent you from getting useful results with **PCGG**. (4) Two variable condensers, say, 0·0005 mfds. each, and two inductances, not necessarily variable.

**"JOHNIE" (St. Leonards)** *asks* (1) *For particulars of a single valve receiver with range to 24,000 ms.* (2) *If a transformer with a ratio of 70/1 may be used with 120 ohm 'phones.*

(1) The circuit should be that shown in Fig. 2, page 811, March 18th issue. To cover such a range you will have to use a set of honeycomb coils, the smallest having about 30 turns, and the largest about 1,000, with a mean diameter of about 3″. (2) A more usual value is about 7/1, and 70/1 is hardly likely to be efficient. You might try it, if the resistance of the L.R. winding is not less than about 30 ohms.

**"CORONA" (Whetstone).**—(1) The circuit will be fairly good, except that a reaction coil will be a very great help in the reception of **PCGG.** It would also be much better to tune the grid circuit. (You speak of a reaction coil, but you do not show one.) (2) Bring down lead from end of wires. Doubling the down lead is almost immaterial. You omit to say how long the spreaders are. (3) A useful H.F. transformer is described on page 781, March 18th. Data for L.F. transformers have been given several times recently.

**"E.P." (Guildford)** *asks* (1) *If French valves could be used instead of "V 24" valves in the four-valve amplifier, described in October 30th, 1920, issue.* (2) *In what issue the construction of a 0·0015 mfds. condenser was described.* (3) *Whether a system sketched for filament lighting with separate resistances to each valve is correct.*

(1) Yes, if additional H.T. voltage is used. About 100 volts will be desirable is "R" valves are used. (2) August 21st, 1920. (3) Yes.

**"N.M." (Gosport)** *asks* (1) *If, when a former is wound with equal numbers of turns of wire of two different gauges, the inductance will be the same in the two cases.* (2) *If halving the number of turns of wire on a coil will halve the inductance.*

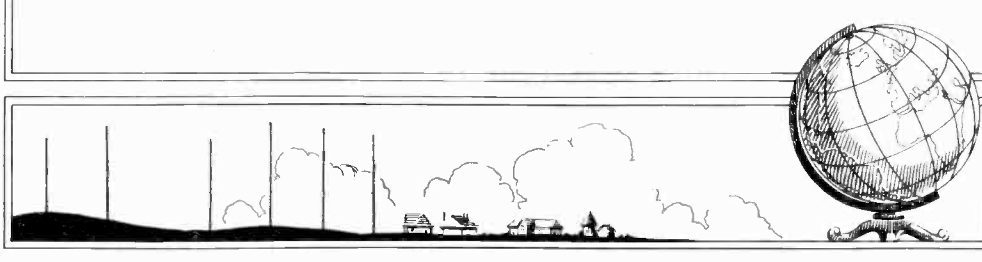
(1) No, the coil with the finer wire will have the bigger inductance. To a first approximation the inductances will be inversely proportional to the distance along the former occupied by the winding. (2) No, again to a first approximation, halving the number of turns will give a quarter of the original inductance.

**"R.S." (Herne Hill)** *asks*, re *Fig. 4, page 526, November 12th,* (1) *The value of the capacity across the transformer winding.* (2) *If a variable 0·0005 mfds. in this position would assist tuning.* (3) *If the filament lighting switch could be combined with the throw-over switch in a manner sketched.*

(1) and (2) About 0·001 mfds. is a normal value. The variable condenser might be used if set at near maximum, but it would not assist tuning. (3) Yes, except that it would be better to arrange for the switch, also to cut out additional resistance when the second valve is introduced, otherwise the first valve will light up too brightly when the second is switched off.

**"J.J.J." (Wanstead)** *asks the respective merits of slab, basket, lattice and solenoid coils.*

The solenoid type is the easiest made and is highly efficient. Considerations of size make it undesirable above about 5,000 ms. Basket coils are about the same in efficiency, more trouble to make and not mechanically as strong. They are more compact, but their limit of usefulness is probably about the same as for solenoids. Slab and lattice coils are not quite as efficient as the former types, but considerations of size and expense make their use almost necessary above about



5,000 ms. Of the two, the lattice coils, if properly made, are the better, but they are rather more liable to defects in winding.

"**SPARK**" **(Hanwell)** *submits a circuit for criticism, and asks* (2) *Whether it would receive* **PCGG** *with two additional stages of L.F.* (3) *Windings for* 1,500 *ms.* (4) *Capacity of the variable condenser.*

(1) This circuit is, to the best of our knowledge, unique. It may be best described as a crystal set with reaction supplied by a valve. It should receive C.W. as well as spark. While theoretically interesting, it cannot be regarded as an efficient way of using a valve and a crystal. (2) We should not care to say, but it is possible that it might. (3) A.T.I. About 7″ × 5″ of No. 22. Reaction coil 5″ × 3″ of No. 28. (4) 0·0005 mfds.

"**ELECTRON**" **(York)** *asks where to purchase poles or masts for a wireless installation.*

For the small masts usually required for amateur work we should advise consulting a local builder. McGuire hollow spar masts are very suitable for erection on a roof, owing to their lightness. The necessary tackle can be supplied by various of our advertisers. Larger masts of various portable or semi-portable types could probably be supplied complete from stock by the Marconi Company, but may be costly dimensions.

"**P.N.P.**" **(Redditch).**—(1) There is very little difference between the circuits, but we should rather prefer "A." (2) Windings and condenser should be as for "**SPARK**" **(Hanwell)** above. We should strongly advise you to buy the condenser, as the construction of a good variable condenser is not an easy job for a beginner. (3) Apply to the Secretary, G.P.O., London, furnishing sketch of the circuits to be used, with approximate dimensions of the parts. The licence costs 10s. per annum.

"**A.S.W.**" **(Forfar).**—An article on the conversion of the Mark III tuner for use as a single valve set with reaction was published in the issue for June 25th, 1921.

"**H.P.**" **(Cobham)** *asks* (1) *For criticism of two sets.* (2) *For their wavelength range.* (3) *Size of the reaction coil for one of them.* (4) *Winding for a filament resistance for one valve.*

(1) In crystal set, connect bottom of A.T.I. to earth, slider to aerial and top to condenser and crystal. Valve set is O.K. (2) Up to about 4,000 ms. in either case. (3) 6″ × 3″ of No. 28 or No. 30. (4) Three yards of No. 22 "Eureka" wire, wound on a former, preferably of slate, about 1″ in diameter, with a good slider.

"**R.B.B.**" **(Prescot).**—(1) The circuit shown is quite correct. (2) Make the reaction coil 5″ × 4″ of about No. 28, to slide or the A.T.I. (3) The 'phone blocking condenser need not be variable. (4) The 'phones should have a resistance of not less than 4,000 ohms.

"**A.F.A.**" **(Woolwich).**—(1) The circuit is quite correct. (2) Either because the value of the grid condenser or leak is wrong, or more likely because you are allowing the set to oscillate. (3) Exactly as in the circuit shown, connecting as many of the pancakes as may be required in series. (4) The circuit may be as in Fig. 4, page 813, March 18th issue, with the aerial circuit remaining as in your own sketch.

"**W.R.S.**" **(Ely)** *wishes to make a tuner on the lines of the panel tuner in September 3rd issue. He asks* (1) *The best way to increase the wavelength to* 30,000 *metres.* (2) *If any alterations to the set will be necessary.* (3) *Capacity for a series aerial condenser.* (4) *If a series-parallel switch will be useful for condenser.*

(1) It will be necessary to increase all the windings very considerably. We think you will find the attainment of such a range very difficult without the use of either a set of honeycomb coils or numbers of basket coils in series in place of the tapped solenoids shown. (2) No, unless you are using inter-valve transformers in the amplifier, in which case special transformers will be necessary for the longest wavelength. (3) About 0·003 mfd. (4) Yes, if you wish to cover both long and short waves.

"**M.B.B.**" **(Falkirk)** *refers to Fig.* 5, *page* 706, *and asks* (1) *If the circuit will operate on all wavelengths with interchangeable H.F. transformers.* (2) *Suitable size for telephone transformer and condenser for use with* 120 *ohm telephones.* (3) *If extra stages of H.F. and L.F. could be added.*

(1) Yes, except that the switching off of the first valve will no longer be suitable as shown. It will be necessary to rearrange the switch with extra contacts to break the secondary of the first inter-valve transformer when the first valve is not in use. (2) Windings might be 3 ozs. No. 44 and 6 ozs. No. 32 on a core ½″ in diameter. Condenser 0·001 mfd. (3) Additional stages could be added, but if it was desired to throw the middle out of circuit in the same way switching would become complicated and liable to give much trouble.

"**SEMI-AUTO**" **(Dewsbury)** *asks* (1) *If it is possible to use* 220 *volt D.C. supply for all the current required for a receiving set.* (2) *Best type of aerial to use.* (3) *How to calculate the capacity of a condenser.* (4) *For a good text-book on telephony, describing the construction of apparatus.*

(1) This could be done, but is undesirable, as the use of a 220 volt supply for filament lighting would be very wasteful and, moreover, the use of mains for either L.T. or H.T. is liable to give unpleasant induction troubles. (2) Either a single wire 100 ft. long, or a twin wire 70 ft. long, may be used. (3) Various formulæ are required according to the type of the condenser. The commoner forms have been given in back issues, and a number are collected in Nottage's "Calculation of Capacity and Inductance." (4) Coursey's "Telephony Without Wires" is a very good general text-book but does not deal with the constructional side. We do not know of any book in which this is at all well treated.

"**H.D.**" **(Manchester)** *submits a circuit for criticism and asks* (2) *For capacity of condenser and grid leak.* (3) *If the circuit will be suitable for* **PCGG.**

(1) The circuit is a variation of the Armstrong regenerative, and we do not think this variation at all likely to work. We should strongly prefer the normal type of circuit as used in this country. We do not think the circuit shown would give **PCGG**, and cannot say whether a grid condenser would be of any use, but we do not think it at all likely.

"**B.H.M.**" **(Ilford)** *asks for a design for a loud speaker. (2) If it is possible to receive* **PCGG** *with one valve.*

(1) See article February 19th, 1921. (2) Yes, but the results are not loud and would be greatly improved by additional amplification. Reaction must be used in any case.

"**R.C.**" **(Godalming)** *asks if, for an amateur making up his own three-valve set for telephony, it is better to have L.F. amplification or H.F.*

The best general arrangement is to have one stage of H.F., followed by detection and then one stage of L.F. Two stages of L.F., followed by a detector is also good, but we do not recommend entirely L.F. except where simplicity of operation is specially desired.

"**J.R.R.**" **(Manchester)** *asks advice about an aerial.*

Your arrangement with tapping No. 2 appears to be the best that can be done, and should give quite good results with a two or three valve amplifier. The part 1 to 2 may be retained, but we should rather prefer to do away with it.

"**AUTODYNER**" **(Methil)** *asks (1) If a circuit is O.K. (2) If an aerial of No. 18 bare fuse wire will be satisfactory. (3) If certain coils will oscillate. (4) If the proportions of the parts are all right.*

(1) Circuit O.K. except that it would be better to couple the reaction coil with the closed circuit rather than with the loading coil. (2) This is electrically O.K. but mechanically very poor. The wire is not strong enough for the purpose. (3) Yes, if the rest of your coils are of fairly thick wire. (4) Yes, but we doubt if you will get strong enough signals to work a loud speaker.

"**C.L.B.**" **(Nottingham)** *asks (1) For a circuit to add two H.F. valves to a two-valve amplifier. (2) For windings for H.F. transformer for 180 metres.*

(1) The H.F. arrangement should be as in Fig. 5, page 813, March 18th issue. (2) We are unable to give exact windings, as these should be finally determined by experiment; but you will probably find windings of about 2" long of No. 34 wire on a former 1½" in diameter, the windings being separated by one or two layers of shellac paper, would be about the right value.

"**E.J.W.**" **(Manchester)** *asks (1) For a constructional textbook on receiving circuits. (2) The wavelength range of the circuit in Fig. 8, page 719, and that of Fig. 13, page 727. (3) If these sets would receive American high-power stations.*

(1) We are afraid there is no suitable book in existence, but you would obtain useful information from articles in past numbers. (2) The wave range of these sets depends on size of coils used. The type of Fig. 8 is suitable for all wavelengths, and that of Fig. 13 for all wavelengths above 1,000 metres. The latter set should, however, give greater amplification at long wavelengths. (3) Yes, under favourable conditions, but we should prefer the second set.

"**A.R.**" **(Egham)** *refers to Fig. 13, page 726, February 18th, and asks if a single slide coil would be suitable for tuning. (2) Dimensions of the coil for* (a) *1,500, and* (b) *for 3,000 metres. (3) For capacity across the transformer. (4) Which two of the three valves shown give* **PCGG.**

(1) Yes, but we do not like the method shown of shorting part of the coil not in use. (2) Parallel condenser is not necessary for such small wavelengths. For 1,500 metres, coil might be 8" × 5" of No. 20, and for 3,000 metres 9" × 6" of No. 22. (3) About 0·001 mfd. (4) We do not know which the author used; probably all three. His statement that two were used, is probably a misprint.

"**L.J.V.K.**" **(Rugby)** *asks (1) Why a set will not oscillate on short wavelengths. (2) If a choke instead of an anode resistance would be an improvement. (3) If the set would give radiation troubles. (4) If certain windings should give* **2 MT.**

(1) The probable reason is that you have H.R. 'phones without a condenser in series with your reaction coil. Addition of the condenser will probably be sufficient to make your set oscillate. (2) Not appreciably. (3) Radiation is always fairly considerable from a single circuit oscillating set. (4) Yes, but we should much prefer single layer coils of larger size to the pile wound coils shown.

"**W.S.**" **(Chorlton-cum-Hardy)** *has a coupler 6" × 7½" of No. 24, and 5" × 6½" of No. 28. He asks (1) If the coupler will work. (2) If so, to what wavelengths. (3) If 4" × 9" of No. 22 and 3" × 6" of No. 30 is suitable for concerts. (4) How to make a loud speaker.*

(1) Yes. (2) Up to about 3,000 metres. (3) Yes. (4) See an article in the issue of February 19th, 1921.

"**E.H.M.**" **(Bexley)** *refers to Fig. 1, page 430, October 1st issue, and asks (1) If S.1 and S.2 are inductances or resistances. (2) For a two-valve winding employing the same principles. (3) If either of two arrangements sketched would be suitable. (4) If S.1 and S.2 are resistances, what value they should have.*

(1) Either resistances or inductances would do. Resistances would give you a bigger range of wavelengths. We should advise earthing the middle part of the frame to the negative of the L.T. battery. (2) and (3) We do not think this could be very satisfactorily done for C.W., but for spark your second arrangement would be satisfactory if you added a crystal in series with the telephones. You might add reaction coils in the plate of each valve coupling back to the frame circuit, but we doubt if this would be very effective. (4) 20,000 to 50,000 ohms each.

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