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EXPERT VIEWS ON THE H.T. QUESTION

No. 251 [No. 10 Vol. XIV]

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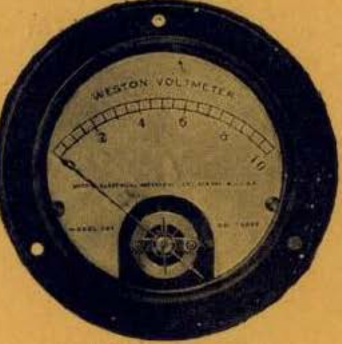

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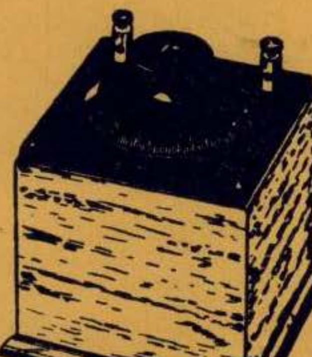

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Under the Supervision of W. JAMES.

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THE EDITOR will be glad to consider articles and illustrations dealing with subjects within the scope of the Journal. Illustrations should preferably be confined to photographs and rough drawings. The greatest care will be taken to return all illustrations and manuscripts not required for publication if these are accompanied by stamps to pay return postage. All manuscripts and illustrations are sent at the Author's risk and the Editor cannot accept responsibility for their safe custody or return. Contributions should be addressed to the Editor, "The Wireless World and Radio Review," 12 and 13, Henrietta Street, Strand, London, W.C.2.

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The WIRELESS WORLD AND RADIO REVIEW

THE QUESTION OF THE H.T. BATTERY.

By THE EDITOR.

WE never anticipated that the necessity would arise for devoting an editorial page to a discussion of the subject which we now have in mind, but so much is being published in other journals at the moment on the subject of dispensing with the separate battery for providing plate potential in wireless receiving circuits that we feel it is necessary to comment on the matter even at the risk of it being suggested that we are offering an insult to the intelligence of our readers.

One would have thought that any wireless journal which can claim to be conducted by a technical staff would either have refused to recognise in the proposition a subject of sufficient importance to warrant devoting space and consideration to it, or that at the most the subject would have been referred to as an experiment to be tried out then dismissed.

Still less would we have expected to see a kind of rivalry set up between journals in an effort to present to their readers ideas which some of the authors at any rate have been compelled to discredit from the point of view of efficiency, even whilst their policy appears to be to encourage the reader to adopt them, as is evidenced by articles describing the construction of permanent receivers embodying these principles.

Although our daily post-bag is largely composed of technical questions, yet so far we have not received one single enquiry with regard to dispensing with H.T. batteries. So much then for the importance which the amateur attaches to the matter.

However, for the benefit of those who may be comparatively new to wireless or who are likely to be questioned by others on this subject, we propose to deal with the matter briefly and present points of view which may or may not be new to our readers, depending upon the extent and duration of their acquaintance with wireless.

As touching on the novelty of the idea, without going outside the columns of *The Wireless World and Radio Review* and taking only one reference to a practical circuit, we refer the reader to the issue of August 15th, 1923, wherein a practical receiver was described under the title of " An Armstrong Super Receiver—Operated with Two Dry Cells." Editorial comment on this article stated " The author having thoroughly mastered the operation of the Armstrong super, proceeds to make the outfit easily portable by abandoning heavy accumulators and high voltage H.T. battery and substituting two dry cells." For further information the reader is referred to that issue, though before passing on we may quote one paragraph from the text :—

" So I contend that if fair results can be obtained under conditions which more nearly approach those met with when using an ordinary regenerative receiver, success is more likely to be assured later when higher voltages, and perhaps more correct operating conditions, are used,

We have yet to see published, in spite of the new claims made, a single-valve circuit which, employing only two dry cells as distinct from batteries of cells, will give this performance, yet those who care to refer back to that issue will see that no extraordinary claims were made for the arrangement. It was not described as a new invention, nor did the fact that the valve operated and gave this satisfactory performance with so small a potential on the plate, arouse any special interest amongst the editorial staff. It was recognised that no new principle was involved. Sets were constructed by our readers to the details given and in not a few instances they took the trouble to write expressing their satisfaction with results obtained.

In reviewing this subject, the point which must not be lost sight of is the fact that with extremely limited plate potential results can be obtained even though the potential is not more than that which can be derived from the filament heating battery, but in proportion as the source of this potential is reduced, so the ability of the valve to function as an amplifier is reduced and whilst the arrangement may present some possibilities as a H.F. amplifier or amplifier of very weak signals, its value is at a discount the moment it becomes a question of amplifying strong signals or attempting to operate any but the most sensitive types of electro-magnetic apparatus.

From the point of view of economy too, the question calls for even less consideration and dismisses in our opinion once and for all the value of such an arrangement from a practical point of view.

The cost of the high tension battery with the ordinary receiving set can be put down as at the outside 10s. for six months in exchange for which you get weaker signals and inability to operate a loud speaker, apart altogether from considerations of distortion which will occur due to operating the valve on an unsuitable portion of its characteristic curve.

If it is a question of the use of a 4-electrode valve in place of a 3-electrode, then it is universally recognised that by a rearrangement of the circuit, a 4-electrode valve will give greater amplification than a 3-electrode; that in fact is the purpose for which the second grid was introduced.

It may be mentioned that a commercial receiver designed for shipboard use employing a single four-electrode valve is claimed to give an amplification equal to three ordinary valves. Those who care to study the question of the employment of four-electrode valves in receiving circuits may be referred to an article by Dr. G. W. O. Howe appearing in *Radio Review*, Vol. II, No. 7, July, 1921, wherein the effect of various potentials applied to the grids is discussed.

Finally, lest anyone may suggest that we are biased in our views, we append hereto the opinions of eminent authorities on this subject.

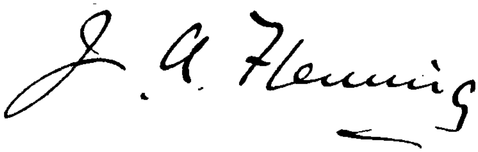
Senatore G. Marconi, G.C.V.O., LL.D., D.Sc.

In my opinion there is no novelty in the proposal to dispense with the separate plate battery in thermionic valve receiving circuits. That results can be obtained with a minimum of plate potential has long been known to wireless engineers; but since the valve, working under such conditions, is a comparatively inefficient instrument, these circuits do not call for serious consideration.

Dr. J. A. Fleming, F.R.S.

Although I should be extremely sorry to write anything which might appear to be unappreciative of valve invention, or to throw cold water on possible improvements, yet it is sometimes necessary to utter a word of warning against a too hasty enthusiasm with respect to inventions hailed as revolutionising. We all know only too well the trouble with regard to the H.T. battery in valve receivers. It is a continual expense and bother, and any invention which did remove the necessity for it, whilst retaining present efficiency, would be indeed a boon.

It is essential, however, to bear in mind that the function of the H.T. or plate battery is to supply the power which the valve controls, and that without this source of power there could be no amplification or relay action but merely rectification of the small power drawn from the aerial. It is this relay action of the valve or of valves in cascade which creates the modern ultra-sensitive receiver. Hence, if it is proposed to get rid of the H.T. battery and to employ some type of transformer or other device to keep the valve anode at a high positive potential we should at once ask, whence comes the power for amplification? Is it drawn from the filament battery and if not, where from? Apart from this relay action the three-electrode valve is no better than a simple two-electrode or rectifying valve and there can be no real magnification of signal-making power.

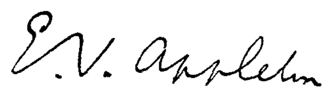


Dr. E. V. Appleton, M.A.

I cannot see that so-called " High tensionless Receivers " embody any new principle. The use of the filament volts drop to provide the anode potential for a receiving valve (no separate anode battery being required) is well known and has been described at least once before ("Periodic Trigger Reception," Appleton and Thompson, *Journ. I.E.E.*, Vol. 62, No. 326, February, 1924).* Similarly, the recognition of the action of the second grid in tetrode valves in reducing the anode voltage necessary for correct functioning is as old as the tetrode valve itself.

It should be pointed out that the lower the filament voltage on a valve the more difficult it is to work without separate anode battery, so that, with the low voltage dull-emitter valves used by many listeners, such working will be very difficult, if not impossible. In any case it is obvious that the result, particularly from the point of view of amplification, cannot possibly be as good as when a small separate anode battery is used.

It is unfortunate that the science of wireless should be so often the subject of sensational newspaper reporting as has, I believe, been the case in connection with this circuit. No other science suffers to the same extent in this respect. In most cases the word "invention" applies more appropriately to the extravagant claims made in connection with the device than to the device itself.



Dr. R. L. Smith-Rose.

Like most wireless " novelties " which occasionally get boomed in the press, the double-grid valve and the use of either this or the usual single-grid valve with only a 6-volt anode potential, do not come as news to the experienced wireless worker. In the way of double-grid valves one is reminded of the introduction of these on the continent some years ago, and the devices with elaborate names described in American journals, while even a triple-grid was proposed, and its theory worked some five years ago. Used under the correct conditions these valves possibly give a factor of operation which is sufficient to compensate for the somewhat more complicated circuit arrangements, but in view of the demand for the reduction of the H.T. battery it is interesting to point out that one prominent make of four-electrode valve in this country is specified to require an anode potential of from 24 to 100 volts.

In common with the writer, many workers must have used for several years thermionic valve apparatus with no anode potential other than that supplied by the filament battery, this being a convenient arrangement for certain work where only a small output is required. One outcome of this arrangement has been that the full advantage of the dull-emitter type of valve has not been realised since the 6-volt accumulator has usually been retained in order to supply the anode potential, although less than 2 volts are required for the filament supply. It is desirable, however, to realise the limitations of such circuit arrangements, and as a particular example, the case of an audio-

* The following is an extract from " Periodic Trigger Reception," Appleton and Thompson, Journal I.E.E., Vol. 62, No. 326, February, 1924.

" As a matter of practical interest, and in view of the fact that the signals hitherto received had been excessively loud, the system was tried with low values of anode voltage on the oscillator triode. With the anode connected to the positive end of the filament battery and the anode battery omitted, weak signals were received with the grid at about − 1·7 volts. With a further 2 volts on the anode the " backlash " region was about 0·3 volt, but it was found that in the middle of this region a small self-oscillation started, there being a further sudden increase of amplitude when the positive end of the region was reached. This necessitated the moving of the working point to the left of the centre of the backlash region, otherwise the signal was heard as a heterodyne whistle interrupted at the quenching frequency. In certain cases a state of absolute silence occurred at resonance, most probably due to the forcing of the feeble receiver oscillations by the incoming signal.† With the same connections and the anode at + 6 volts a nice loud signal was obtained and the effects enumerated above ceased to give trouble."

† Appleton: " The Automatic Synchronisation of Triode Oscillators," *Proceedings of the Cambridge Philosophical Society*, 1922, vol. 21, p. 231.

frequency amplifier with no H.T. supply may be discussed. Recent progress in such amplifiers has been in the direction of high amplification and ample power output with uniformity of these factors over the whole range of audible frequencies. To attain this end it is now accepted practice to employ a much greater H.T. voltage than is necessary for the mere operation of the valve as an amplifier. In enthusiasm over the present novelty there is danger of taking a retrograde step in this respect, and the result may do much damage to the reputation of wireless broadcast and general reception.

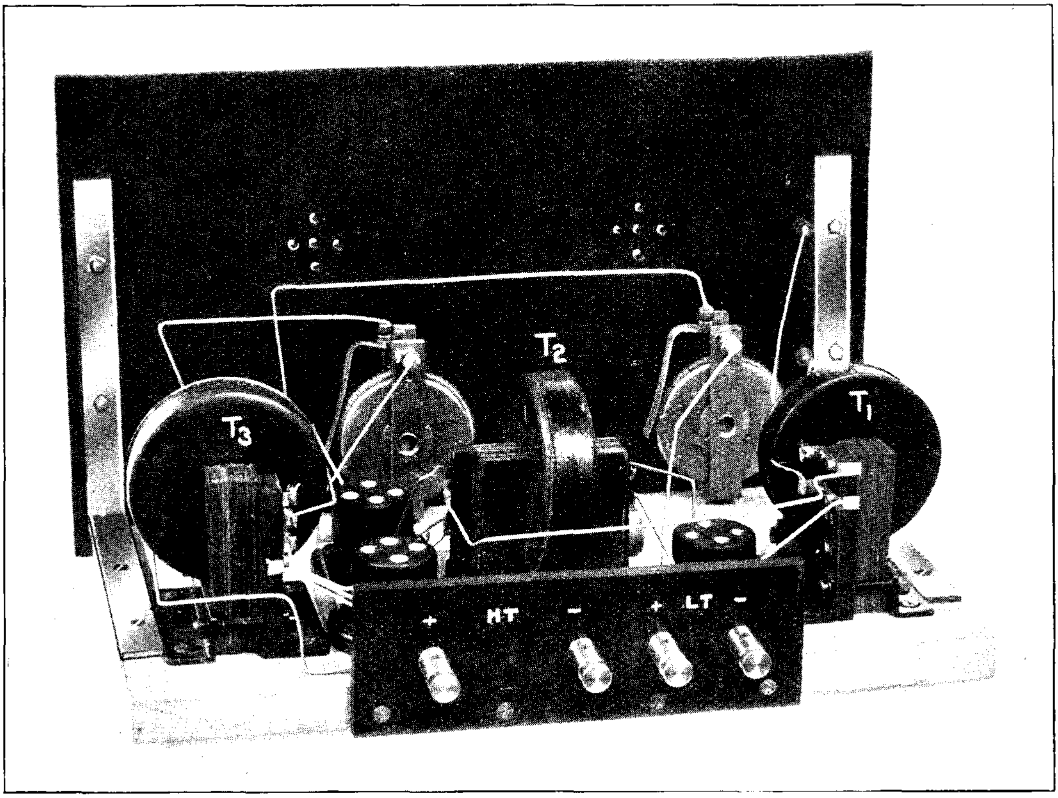
While one cannot prophesy how the future design of valves will affect the result, it is at present extremely difficult to satisfy the conditions for really efficient amplification with a total battery E.M.F. of six volts. If the grid of a valve be given a positive potential of six volts, the anode must be at a lower potential, since even 120 ohm telephones will drop an appreciable fraction of a volt, and 4,000 ohm telephones will reduce the anode potential to about three volts. In such a case the characteristic of anode-volts against anode-current is very curved at the operating point, and incidentally the curve is concave instead of as usual, convex to the anode-voltage axis. This curvature of the characteristic will give rise to amplitude distortion in receiving speech. It is next evident that if a steady negative potential be given to the second grid, the effect of the positive potential of the first grid will be partially neutralised. Unless, however, a negative potential of at least two volts can be given to the grid to which the alternating potentials are applied, the operation of the previous inter-valve transformer will be seriously impaired and distortion will also arise due to the asymmetrical conductivity of the grid-filament path. It is obvious, of course, that the resistance-capacity coupling, with all the perfection claimed for it, cannot be used, for with a steady E.M.F. of only six volts it is impossible to pass a milliampere or so through an anode resistance of the order of 50,000 ohms.

Concerning the amplification obtainable, one valve whose static characteristics were studied under these " H.-T.-less " conditions, gave a voltage factor of 2·3, whereas the corresponding figure for an R-type valve used under the correct conditions is between 8 and 10. The effective internal impedance of the anode-filament path of the valve, however, was only 14,000 ohms, a value which is advantageously lower than that for an ordinary " R " valve (25,000-40,000 ohms). Unless, therefore, valves can be arranged to give a greater amplification than the above, it will be necessary to use more stages to obtain a satisfactory overall amplification, and the elimination of the H.T. battery will then be a doubtful economy.

It is hoped that this brief discussion will be of some use in enabling experimenters to decide whether and in what circumstances it is desirable to use these arrangements for amplification purposes. The writer would finally like to suggest that those in a position to do so should make *quantitative* measurements, as he is firmly convinced that the present use of purely subjective observations as a basis for discussing the relative merits of apparatus is responsible for much existing confusion, and for a great deal of disappointment on the part of the less experienced experimenter.

Philip R. Coursey, B.Sc., F.Inst.P., A.M.I.E.E.

In the early days of wireless discovery thermionic valves were used as simple rectifiers without any external source of " high-tension," and this being so a valve receiver without H.T. is no startling novelty. The modern three-electrode valve, however, when used as an amplifier operates in a very different manner, as its output energy must necessarily be derived from some source, which ordinarily is the H.T. battery—and hence, unless some alternative source is provided, it is unreasonable to expect the same output of signal energy in the plate circuit. This other source can be the filament accumulator, provided that the valve is so constructed as to have a very low impedance, and consequently to draw a larger current at a small voltage in place of the usual milliampere or so at say 60 volts. One cannot obtain signal energy in the telephones from nowhere, and it is consequently unreasonable to expect to do so.



Back view showing arrangement of parts, of amplifier, wiring, and connection strip.

PUSH-PULL SPEECH AMPLIFIER.

A special transformer coupled speech frequency amplifier designed to eliminate distortion, and employing ordinary receiving valves.

By W. JAMES.

IT is not always an easy matter to obtain distortionless speech frequency amplification. We may distinguish between amplitude and frequency distortion. The operation of the amplifier may be considered to be determined by (1) the valve, (2) the coupling, and (3) the operating characteristics of the valve and coupling.

(1) Study of a valve's static characteristic curves show (*a*) the relation between grid potential and anode current is not linear; (*b*) current flows in the grid circuit when the grid becomes positive; (*c*) for each value of anode voltage there is one value of grid potential which fixes the operating point at the centre of the grid-anode characteristic; (*d*) there is a limit to the voltage which may be applied usefully to the grid circuit.

(*a*) The grid voltage-anode current characteristic may be straightened out for a portion of its range by the use of a suitable impedance in the anode circuit. The value of the impedance required depends principally upon the impedance of the valve.

When resistance capacity coupling is employed, the characteristic may be made straight over a considerable portion of its range if the coupling resistance has a value two or three times the impedance of the valve. With choke or transformer coupling the impedance connected in the anode circuit should have a value of two or three times the impedance of the valve at the lowest frequencies contained in the signal to be amplified.

(*b*) Grid current may be prevented by providing the grid with a negative bias of

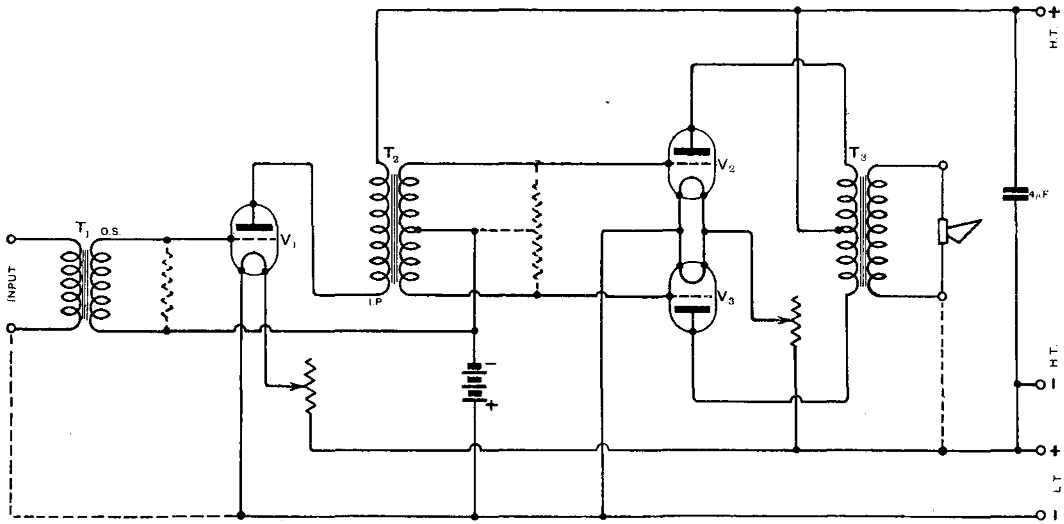


Fig. 1. Schematic connections of amplifier without the jacks. When the amplifier is connected to a crystal receiver, one input terminal should be connected to —L.T. and earth. With some transformers the quality may be improved by connecting grid leaks of about 0·5 megohm across the secondary windings as shown in dotted lines.

such magnitude that the grid cannot become positive during any portion of a signal.

(*c*) Adjustment of the grid bias should be followed by an adjustment of anode voltage. If the normal grid voltage fixes the operating point to the left of the centre of the grid potential-anode current characteristic, the negative peaks of the signal may be cut off. The normal anode current is also less than it should be. If, on the other hand, the anode voltage is higher than a certain value, the positive peaks of the grid voltage produce no effect on the anode current, and the normal anode current is too high.

It is most important that the value of the anode voltage is so chosen that the operating point is fixed at the centre of the straight portion of the characteristic. With this adjustment the best use is made of the valve and anode battery.

(*d*) The maximum signal voltage which can be applied usefully to the grid circuit is that which employs the whole of the straight portion of the grid voltage-anode current characteristic. Some types of receiving valve are easily overloaded.

If good volume from a loud speaker is required, it is usually necessary to employ (in the last stage certainly) valves taking an anode current of, say, 8 to 10 milliamperes when the grid bias is about 5 volts negative*

(2) We may employ (*a*) resistance capacity; (*b*) choke capacity, or (*c*) transformer inter-valve coupling.

(*a*) and (*b*) A resistance capacity or a choke capacity coupled amplifier may be

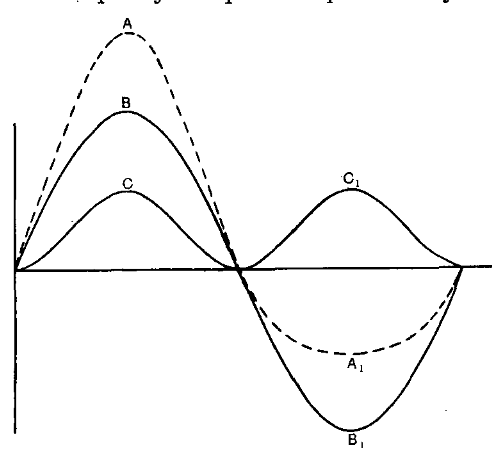


Fig. 2.

constructed to give good quality, but they are uneconomical, and therefore not suitable for the majority of amateurs.

* For example, the B.T.H. "B4" valve, or the M.O. "D.E.5" valve.

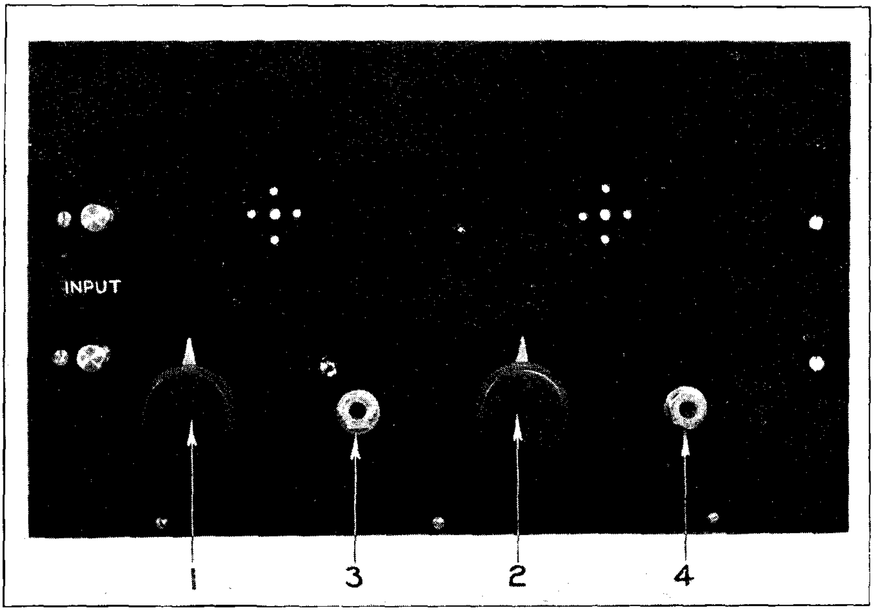


Fig. 3. Front view of amplifier. 1, filament resistance of valve V_1; 2, filament resistance of valves V_2 and V_3; 3, Elwell jack, type S.C.; 4, Elwell jack, type S.F.

To secure an amplification per stage which is a reasonable proportion of the voltage amplification factor of the valve (and to straighten the characteristic curve) it is necessary with resistance coupling to use a value of anode resistance two or three times the impedance of the valve, and with choke coupling to employ a choke whose impedance at the lowest speech frequencies is about two or three times that of the valve.

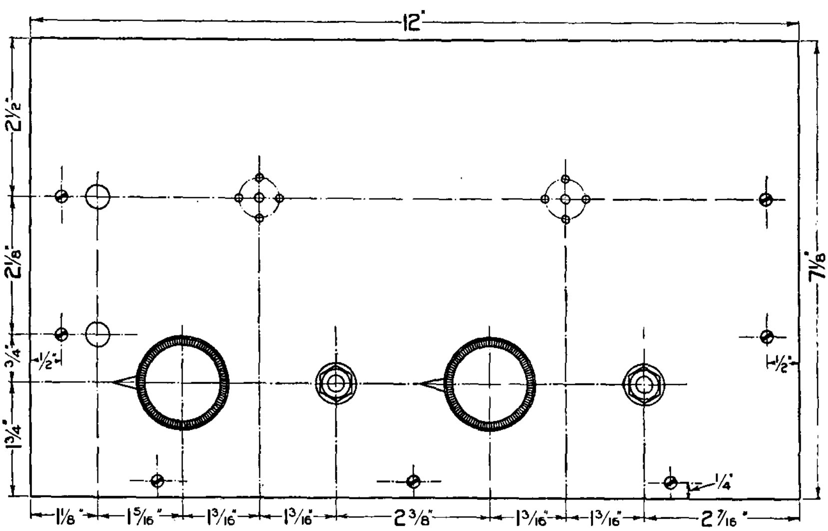


Fig. 4. Lay-out of front panel, one-third full size.

(c) With transformer intervalve coupling, the voltage set up in the anode circuit may be stepped up and applied to the grid of the next valve. There is a limit to the voltage step-up obtainable, due to the difficulties in the construction of suitable transformers, but the efficiency of a transformer-coupled stage of amplification may with careful design approach three times that obtainable when resistance or choke couplings are used.

It is more difficult to design a transformer-coupled speech amplifier, because the primary winding of the transformer is required to have approximately the same characteristics as the choke in a choke-coupled amplifier, and to obtain a step-up which is worth while, a ratio of secondary to primary turns of 2-4 to 1 is usually employed. The inductance of the windings depends upon the number of turns of wire and the dimensions and quality of the iron core. If a small core is employed, a large number of turns are required in the winding, resulting in a transformer having a large internal capacity, with the core working at a high flux density. A good transformer should therefore have a good quality core of ample dimensions and a large number of turns.

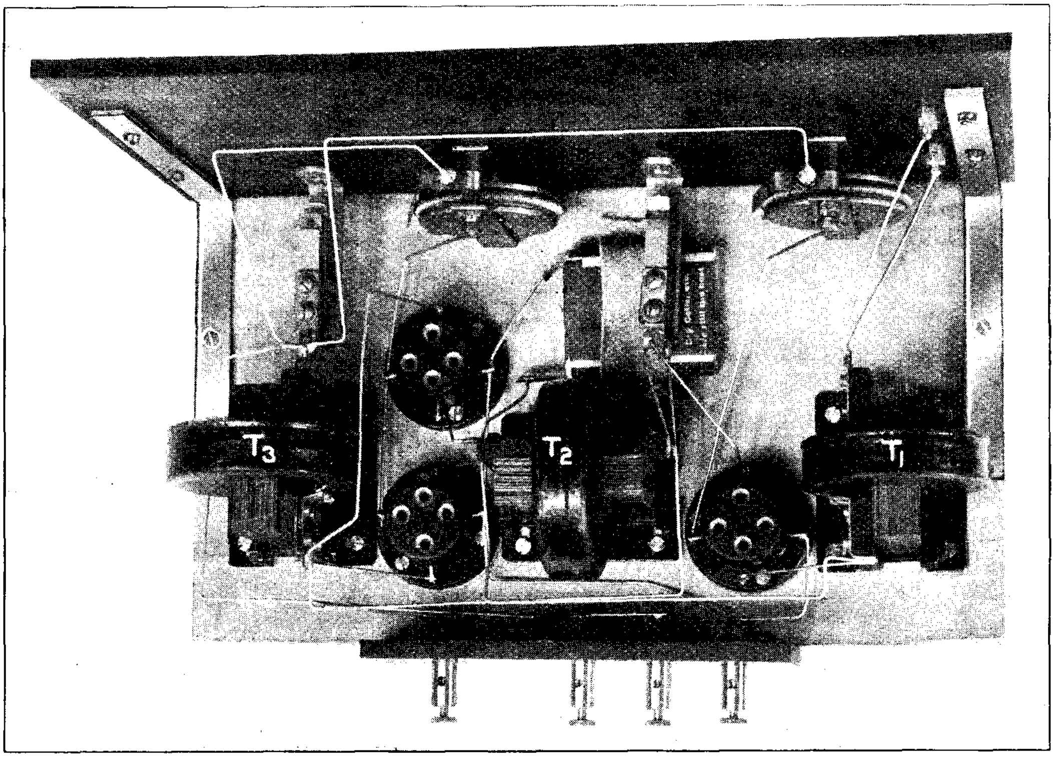


Fig. 5. View looking down on amplifier. T_1 "Pye" No. 1 intervalve transformer. T_2, Special Pye transformer with centre tap on secondary winding; T_3, special Pye transformer with centre tap on primary winding and secondary winding wound to suit a high resistance loud speaker.

(3) To prevent frequency distortion, the constants of the apparatus employed as the intervalve coupling should be designed so that the total impedance of the anode circuit is constant for all speech frequencies.

A resistance-coupled amplifier which will amplify without distortion may easily be arranged. With choke coupling a flat frequency characteristic may be obtained by carefully designing the winding to prevent the choke having a resonance frequency within the band of speech frequencies.

Unfortunately a number of transformers on the market are unsuitable for use in a speech amplifier, because they are constructed with too little iron and too few turns of wire. Also, special (power) valves are expensive and require an anode battery of large capacity. Many prefer to employ the same type of valve throughout the receiver, in order that a common filament battery may be used. One would therefore expect to find frequency and amplitude distortion as the result of using poor transformers and valves of small capacity. We may, however, use a special arrangement of transformers and valves as shown in Fig. 1.

The crystal or valve detector of the receiver is connected to the terminals of the primary winding of transformer T_1 (marked "input,") and the secondary winding of T_1 is joined between the grid and the negative terminal of the grid bias battery. Transformers T_2 and T_3 are specially constructed, T_2 having a centre tap on the secondary and T_3 a centre tap on the primary winding. The output from valve V_1 passes through the primary winding of transformer T_2 and sets up voltages in the secondary, the outer ends of which are connected to the grids of valves V_2 and V_3, and the mid-point to the negative terminal of the grid bias battery. The anodes of valves V_2 and V_3 are joined to opposite ends of the primary winding of transformer T_3, and positive H.T. is connected to the centre point. The secondary winding of T_3 is designed to work with a high resistance loud speaker.

It will be seen that the secondary voltage of transformer T_2 is divided between two valves, V_2 and V_3, and therefore these valves need not be so large as would be necessary if the total voltage of the secondary was applied to a single valve.

Referring to transformer T_3, the normal anode current of V_2 flows from the anode battery through the top half of the transformer, and the current for V_3, flows through the bottom half. The two currents are in opposite directions, hence the resultant magnetic field due to the current flowing through the primary winding is zero. When a voltage is set up in the secondary winding of T_2, the voltage of the grid of valve V_2 is, say, reduced while the voltage of the grid of V_3 is increased; thus, the anode current through V_2 is reduced, while the current through V_3 is increased. The two currents therefore combine to produce a current in the secondary winding which flows through the loud-speaker. When two valves and transformers are coupled in this manner, the arrangement is called a push-pull amplifier.

The way in which distortion due to a low

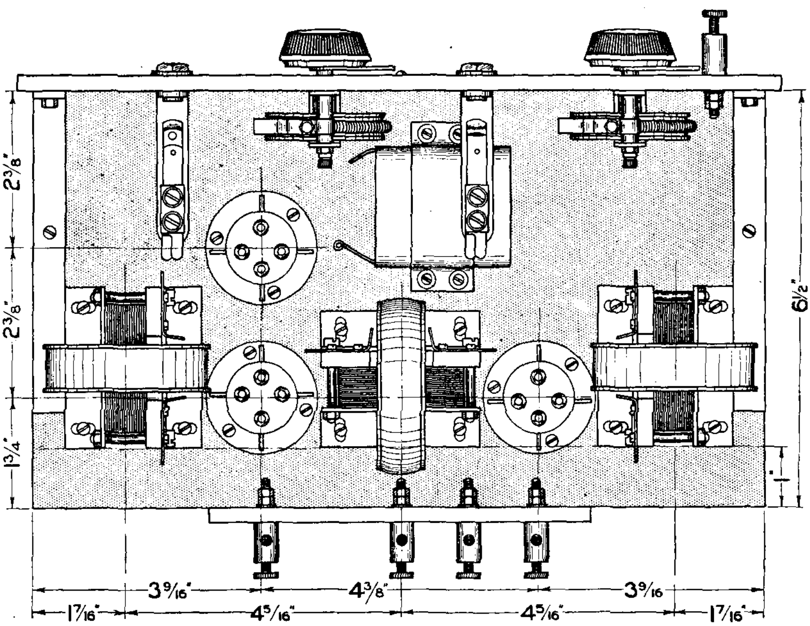


Fig. 6. Lay-out of components mounted on the baseboard, one-third full size.

impedance output circuit is prevented may be shown with the aid of Fig. 2. If a sine wave voltage is applied to the grid circuit of V_2, V_3, the output current in V_2 is distorted. It may have the shape of curve AA_1. In passing through the transformer it is resolved into the fundamental BB_1 and the harmonic CC_1. The output current from V_3 which flows in the other half of the primary winding is the same as that of V_2, but since the grid potentials are 180° out of phase, the currents B,B_1 are 180° out of phase, while the harmonics C,C_1 are in phase. The anode currents connected to valve V_1, and (2) is connected to valves V_2 and V_3; (3) and (4) are Elwell jacks, types S.C. and S.F. When the plug joined to the loud speaker is put into jack 3, the loud speaker is connected in the anode circuit of V_1, in place of the primary winding of T_2, and the filament circuit of valves V_2 and V_3 is broken by the upper springs of jack 4. Inserting the plug in jack 4 connects all the filament circuits and joins the loud speaker across the secondary winding of T_3.

The filament resistance to be employed depends on the type of valves used in the

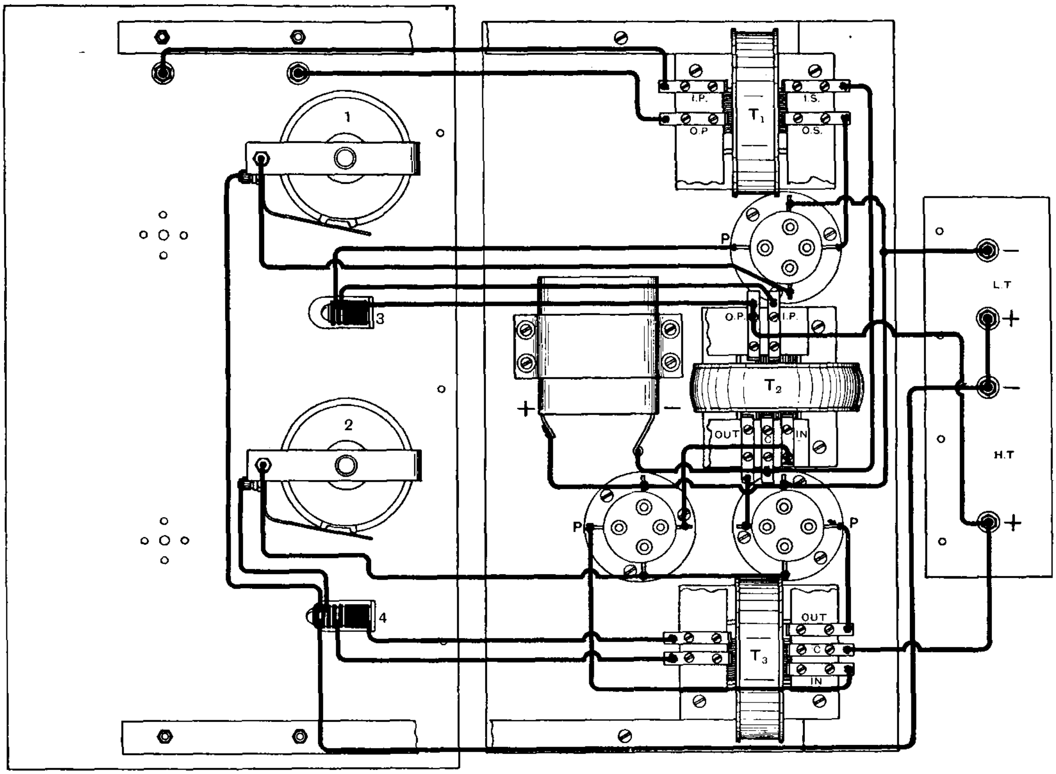


Fig. 7. Wiring diagram. The panel, baseboard and connection strip are drawn as though they lie in the same plane, one-third full size.

B,B_1 therefore combine, while the harmonic currents $C\ C_1$ act in opposition and neutralise each other.*

The speech amplifier described below has three valves and three transformers, giving one stage of ordinary amplification and one stage push-pull. Fig. 3 is a front view of the amplifier. The filament resistance (1) is amplifier. A 4 ohm resistance (such as the Igranic resistance in the amplifier described) is suitable for use with valves requiring a 6-volt battery. For example, the M.O., R.5, D.E.5, or B.T.H. B4.

The arrangement of the components on the front panel is shown in Fig. 4, which is one-third full size. An ebonite panel 12 × $7\frac{1}{8}$ × $\frac{1}{4}$ in. was used.

Fig. 5 is a view looking on the amplifier from above. T_1 is a Pye No. 1 intervalve

* See "The Thermionic Vacuum Tube," by H. J. Van der Bijl.

transformer. Transformer T_2 has a centre tap on the secondary winding, and T_3 has a centre tap on the primary winding. Transformers T_2 and T_3 were kindly made up for me by Messrs. W. G. Pye & Co., Granta Works, Montague Road, Cambridge, and they will supply sets of transformers to readers who may require them, at about the price of ordinary transformers.

The transformers, valve holders, 4½-volt grid bias battery and connection strip are secured to a wooden baseboard as indicated in Fig. 6, which shows the position of the parts.

It was found convenient to wire the components on the baseboard first, with the front panel removed. The remaining connections to the jacks, filament resistances and input terminals are easily wired when the panel is screwed to the baseboard. The wiring is particularly simple, as shown in Fig. 7.

The amplifier is connected to a crystal detector by connecting the input terminals of the amplifier with the telephone terminals of the crystal detector. It will be found an advantage to earth the negative terminal of the accumulator, as shown by the dotted connection between one input terminal and the accumulator in Fig. 1. If a valve detector is used, the input terminals of the amplifier are connected to the telephone terminals of the valve detector. A common low tension battery may be used, but it is advisable to employ a separate anode battery for the amplifier. If D.E.3 (60*m*A) valves are employed, an H.T. voltage of 90 to 100 is satisfactory when the grid bias is obtained from three dry cells. With valves of the R.5 type, the anode voltage may be increased to 120. Valves V_2 and V_3 should of course be as nearly alike as possible, although I have not found it necessary to specially select these valves; provided they are of the same type, results are satisfactory.

If transformers of a different type to those employed in the amplifier described are used, it may be found necessary to shunt the secondary windings with grid leaks of about 0·5 megohms, to reduce resonance effects and improve the quality, and to connect one side of the loud speaker with the filament battery, as indicated in Fig. 1.

The volume obtained from the amplifier is considerably more than that obtainable from an ordinary two-valve amplifier, and the quality is very good indeed. The amplification is not quite so much as one would obtain from a well designed three-valve transformer coupled amplifier of the ordinary type. However, with the push-pull amplifier one may employ smaller and therefore less expensive valves, and it will be found that the quality is excellent. In addition, since the loud speaker is connected to the secondary winding of a transformer, there is no need to employ a filter circuit for the purpose of preventing the normal anode current passing through the loud speaker.

A few firms in this country, and in America, supply receivers which contain a push-pull amplifier.

A NEW VALVE HOLDER.

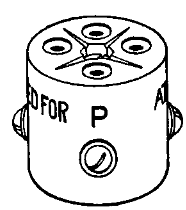
A valve holder of new design which has many unique merits has recently been placed on the market by the Athol Engineering Company of Manchester.

A special claim is that it possesses very low distributed capacity and extremely high insulation resistance, which is only to be expected as the body of the holder is constructed from high grade electrical porcelain.

The four sockets are suspended in holes by screws which are also used for making connection. It may be mounted on a non-insulating base by a single screw fixing and for this purpose a 4 BA screw is run right through the centre.

An interesting feature is that the sockets can be removed from the porcelain mounting piece and remounted facing in the reverse direction, which in view of the fact that the fixing screws are not centrally placed, will cause the sockets to protrude some ¼ in. above the porcelain. When assembled in this manner it may be mounted on the underside of an instrument panel, so that the brass sockets come flush with the ebonite top, passing through clearance holes in the ebonite.

Other suggested methods of mounting include the fitting of brass brackets on to the panel and



arranging for them to engage into one or opposite screws which are provided for the purpose of making connection.

The valve holder is particularly well constructed and its price is moderate, and we have no hesitation in recommending it to our readers.

CRYSTAL DETECTORS IN THEORY AND PRACTICE—III

THE CHEMISTRY AND MINERALOGY OF CRYSTALS.

By JAMES STRACHAN, F.Inst.P.

THE electrical conductivity of the "earth" depends mainly upon its water or moisture content. More than three-fourths of the mineral matter composing the earth's crust is of a non-conducting or very badly conducting nature. The main rock masses of mountains and lower strata are silicates and carbonates, both of which are good insulators, their degree of conductivity being measured largely by their porosity and water content. We may regard the earth's crust then as composed largely of insulating substances rendered conductive on its surface and to some depth by meteoric waters. In addition to the latter, however, we have many underground streams of water and lodes of metalliferous ores, which, associated together, probably form a network of underground conductors.

A crystal, to be a good rectifier, must conduct electricity to some extent and it is from this comparatively limited field of metallic ores that we have taken our crystals for detectors. Further it is found that of many hundreds of mineral species containing metals, comparatively few possess the necessary properties of conduction and rectification.

The silicates, carbonates, halides and phosphates of the common metals are useless for this purpose. The majority of the crystalline oxides conduct only in very thin films and the number of oxide crystal rectifiers is few. The substances from which we have made our most efficient crystal rectifiers are those which resemble the metals themselves in physical and electrical properties. The largest class of substances of this nature is the sulphides, *i.e.*, compounds of metals with sulphur, but even in this class the number of rectifiers is few, although more numerous than in the case of the oxides. In addition to the minerals occurring in nature we must also consider synthetic or artificial minerals, and chemical compounds and elements produced in the laboratory from mineral sources. I have already indicated that among the numerous metallic minerals and crystals that conduct electricity we may trace a gradual sequence from compounds possessing true metallic conduction without rectification to others having a higher electrical resistance and possessing good powers of rectification. Between the two extremes we find crystals which require an applied potential to function properly, when some of them become fairly efficient rectifiers and others behave so indifferently as to be of theoretical interest only. In such cases the applied direct current potential may be anything from 2 to 20 or more volts according to the resistance of the substance.

Table I gives three typical examples of compounds which gave metallic conduction *without* rectification (audible in telephones) to H.F. oscillations.

TABLE I.

Mineral Species.	Formula.	Chemical Nomenclature.
Niccolite ..	Ni As. ..	Nickel arsenide.
Dyscrasite	Ag_3 Sb. ..	Silver antimonide.
Breithauptite.	Ni Sb. ..	Nickel antimonide.

The minerals contained in Table II are typical examples of crystals which even with very strong oscillations gave no sign of rectification until an applied D.C. potential was employed. The degree of contact was extremely sensitive and the slightest movement gave metallic conduction. Reception, at best, weak.

TABLE II.

Mineral Species.	Formula.	Chemical Nomenclature, etc.
Pyrrotite..	Fe_nS_n+1 ..	Iron Sulphide (magnetic pyrites).
Gersdorffite	Ni As-Ni S_2	Nickel arsenide-sulphide (nickel glance).
Smaltite ..	Co As_2 ..	Cobalt arsenide.
Bismuthinite.	$Bi_2 S_3$ ..	Bismuth sulphide.

In Table III we come to a more numerous class of minerals which under strong oscillations gave faint rectification which was very much improved by the use of an applied D.C. potential, when reception became fairly clear but rather weak.

TABLE III.

Mineral Species.	Formula.	Chemical Nomenclature, etc.
Tetrahedrite	$4\ Cu_2S\text{-}Sb_2S_3$	Sulphide of copper and antimony.
Bornite ..	$Cu_3\ Fe\ S_3$ ..	Sulphide of copper and iron.
Franklinite	$(FeMnZn)O\text{-}(FeMn)_2O_3$	Oxide of iron manganese and zinc.
Mispickel..	Fe As S ..	Iron sulpharsenide.
Manganite	$Mn_2O_3\text{-}H_2O$	Hydrated oxides of manganese.
Psilomelane	$Mn_2O_3\text{-}H_2O$	Hydrated oxides of manganese.
Pyrolusite	MnO_2 ..	Manganese dioxide.
Grünlingite	$Bi_4\ Te\ S_3$ ..	Bismuth sulphide and telluride.

Following on the above, the next group of crystals (Table IV) gave faint but clear reception under strong oscillations and with an applied potential reception was quite good. As with the foregoing minerals, the degree of contact required very fine adjustment, a very slight pressure giving rise to metallic conduction. This group comprises useful rectifiers when used with an applied D.C. potential.

The next group (Table V) comprises a much more useful series, all of which gave good reception under strong oscillations without an applied potential. Silicon, carborundum and tellurium, which do not occur in nature, are

TABLE IV.

Mineral Species.	Formula.	Chemical Nomenclature, etc.
Molybdenite	Mo S_2 ..	Molybdenum sulphide.
Ilmenite ..	$FeO{\cdot}TiO_2$ ..	Oxide of iron and titanium.
Magnetite	$Fe_3\ O_4$ ..	Magnetic oxide of iron.
Copper Pyrites.	$Cu_2\ S{\cdot}Fe_2\ S_3$	Sulphide of copper and iron.
Graphite ..	C	Carbon.
Stromeyerite.	$Cu_2\ S{\cdot}Ag_2\ S$	Sulphide of copper and silver.
Covellite ..	Cu S ..	Sulphide of copper.
Tennantite	$4\ Cu_2\ S{\cdot}As_2\ S_3$	Sulphide of copper and arsenic.
Stannite ..	$Cu_2\ S{\cdot}FeS{\cdot}Sn\ S_2$.	Iron of copper and tin sulphide (tin pyrites).

for convenience included in this series. An applied D.C. potential improves reception with the majority of these crystals.

TABLE V.

Mineral Species.	Formula.	Chemical Nomenclature, etc.
Zincite ..	(Zn Mn) O	Oxide of Zinc and manganese.
Cassiterite	Sn O_2 ..	Tin dioxide (tinstone).
Iron Pyrites	Fe S_2 ..	Iron disulphide.
Galena ..	Pb S ..	Lead sulphide.
Jamesonite	$2\ PbS{\cdot}Sb_2S_3$	Sulphide of lead and antimony.
Bournonite	$3(Pb\ Cu_2)S{\cdot}Sb_2\ S_3$	Sulphide of lead, copper and antimony
Frieslebenite.	$5(Ph\ Ag_2)S{\cdot}2\ Sh_2\ S_3$.	Sulphide of lead, silver and antimony
Altaite ..	Pb Te ..	Lead telluride.
Nagyagite	(Ph Au) Te	Telluride of lead and gold.
Silicon ..	Si	Fused silicon.
Tellurium	Te ..	Pure metallic crystals.
Carborundum.	Si C ..	Silicon carbide.

A small group of crystals, including Argentite (silver sulphide, Ag_2S.) and Pyrargyrite (sulphide of silver and antimony, $3\ Ag_2\ S.Sb_2S_3$), exhibited electrolytic conduction with very faint rectification under strong oscillations and applied potential, but these are quite useless as rectifiers.

The large majority of metallic oxides and sulphides examined gave negative results, being practically insulating substances or giving very slight conduction under comparatively high potentials, viz., 40-50 volts, without rectification.

The natural crystalline sulphides of zinc, manganese, mercury, arsenic and antimony, which seemed likely substances, proved to be quite useless.

From the chemical point of view we may classify rectifying substances as follows :—

I. ELEMENTS.
Carbon. Silicon. Tellurium.

II. COMPOUNDS.

A. *Oxides* Zinc (with manganese).
Tin.
Iron (magnetite).
Manganese
Cerium.
Titanium.
Zirconium or Thorium (hot).
Oxide films of copper, nickel, etc.

B. *Sulphides.*
(1) Galena Group—Lead sulphide and compound sulphides containing lead sulphide.
(2) Pyrites Group—Sulphides of iron and copper; compound sulphides of same with lead, tin, etc.

C. *Tellurides.*
Lead and compound tellurides.

D. A few binary compounds including one carbide and a few arsenides.

From the point of view of the theory just advanced by the writer, in which rectification is associated with the electrical properties of the substances and displacement of their atomic charges, it is interesting to compare the foregoing review of such substances with Table VI, showing the periodic classification of the more common elements.

From this it will be observed that practically all the elements and compounds of same, which have proved useful as rectifiers, belong to or are compounds of elements in groups IV and VI. In the case of group IV, every element mentioned possesses rectifying properties in itself or in one of its compounds.

The only notable exceptions are iron pyrites (bringing in the transition group VIII) and zincite, oxide of zinc with manganese, the latter being closely associated with iron. The principal rectifying substances therefore are elements, or compounds of same, drawn from the periodic groups, which are as in group IV not strongly electro-positive or electro-negative, and, as in group VI, electro-negative in character. This is very suggestive and, when we completely understand the nature of the electron movements in rectification, should enable us to select the proper combination of elements to give the best results. Working on lead sulphide as a basis very interesting results have been obtained from synthetic crystals by introducing varying percentages of other sulphides.

TABLE VI.

Groups.	Elements.	Electrical. state.
I ..	Hydrogen, sodium, potassium, copper, silver, gold	Electro-positive.
II ..	Magnesium, calcium, Barium, zinc, cadmium, mercury.	
III	Boron, aluminium.	
IV ..	Carbon, silicon, titanium, zirconium, cerium, thorium, tin, lead.	Inter-mediate.
V ..	Nitrogen, phosphorus, arsenic, antimony, bismuth.	
VI ..	Oxygen, sulphur, selenium, tellurium, chromium, molybdenum, tungsten.	Electro-negative.
VII	Fluorine, chlorine, bromine, iodine, manganese.	
VIII	Iron, nickel, cobalt, palladium, osmium, iridium, platinum.	Transition group.

Crystal Structure and Composition.

In studying the space lattice structure of rectifying crystals in connection with their electrical properties attention should be paid to the difference in structure in the case of dimorphous substances. Carbon in the form of diamond is non-conducting and non-rectifying, while in the form of graphite the electrical conduction is almost metallic and very good rectification may be obtained with an applied potential. Another dimorphous substance is oxide of titanium which exhibits rectifying properties in brookite (also in the compound oxide, ilmenite) but which appears to be non-conducting and certainly non-rectifying in rutile. In both cases there are marked differences in the crystal structure between rectifying and non-rectifying forms. Another interesting comparison may be made between crystals of the same form but possessing different internal structures. The best example of this kind lies in a comparison between blende (zinc sulphide) which is non-conducting, and galena (lead sulphide), which is a good rectifier. Another form of zinc sulphide, viz., würtzite, is also non-conducting and non-rectifying.

Crystals and Cold Valves.

It is interesting to note that the temperature at which thorium oxide becomes conducting and assumes rectifying properties, viz., a low red heat, is approximately that of the filament (containing thoria) in dull-emitter valves. The theory of the crystal detector suggested by my own experiments indicates that it may be possible to produce a cold valve, with two electrodes, one of the latter being composed of or coated with a rectifying substance. This opens up a new field of research which is, however, outside the scope of the subject at present under discussion.

Correspondence.

Molecular Construction of Crystals.

To the Editor of The Wireless World and Radio Review.

Sir,—In the article on crystal detectors in your last issue there occurs the statement: "any thermal effect at the contact would facilitate electrolytic conduction by increasing the mobility of the molecules and of their ionisation," with reference to electrolytic theories.

I should like to point out that in true crystals molecules do not exist. The whole structure is built up of individual atoms, and the crystal itself is really a large molecule. In this connection the results of Bragg's work on crystal structure might be studied with advantage; an instance is the structure of graphite crystals.

Molecules are most notably present in oxide films, but in this connection it is doubtful whether sufficient mobility is present for any conduction by ions to occur. In fact ions in solids do not exist.

I should also like to confirm the experience of reception on the crystal cup itself.

A. Roach.

London, W.C.1.

To the Editor of The Wireless World and Radio Review.

Sir,—In reply to Mr. Roach, crystals are certainly composed of molecules. Early experiments with X-ray spectra led to conclusions indicating individual atomic structure, but later work shows that this was premature. In the case of graphite the presence of 6-carbon-atom rings has been demonstrated and in other crystals the actual dimensions of the molecules have been measured.

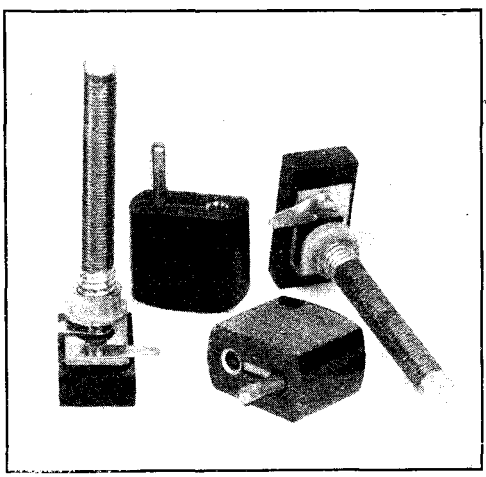
Silver sulphide conducts electrolytically at ordinary temperatures with slow ionisation which is increased by heating. As may be read from my second article on the subject, I do not advance this question in my own theory as it is a comparatively rare phenomenon.

I am pleased to observe that Mr. Roach can confirm reception on the crystal cup alone. Another correspondent has sent me particulars of interesting results obtained with a brass detector and also with finely powdered crystals which are quite in accordance with my own experiments.

Perhaps readers would kindly defer criticisms until the present series of articles—seven in number—is completed, as some points which have been raised are dealt with in subsequent articles.

J. Strachan.

Aberdeen.



Two useful products of Messrs. Burndept, Ltd. The interchangeable resistances with screw sockets permit of the use of any type of dull emitter valve without alteration of filament resistance. The short circuiting plugs are useful for taking the reaction inductance out of circuit.

THE DEVELOPMENT OF SIMULTANEOUS BROADCASTING.*

WIRELESS RELAY STATIONS.

By E. K. SANDEMAN, B.Sc.

Although it was not intended to extend the scope of this account to wireless relay stations since such work has, as far as the author is aware, been developed in England exclusively by the British Broadcasting Company, yet for the sake of completeness it is felt some reference should be made to this branch of the subject.

The general idea of a wireless relay station is not new, in fact it must have occurred to most people who have considered wireless matters, but this detracts not at all from the credit which is due to those engineers who have been responsible for the perfecting of a reliable system of relay working.

The essential principle is simply that the wavelength of the relay station must differ sufficiently from that of the relayed station to prevent the receiving apparatus at the relay station picking up its own signal, in which case the station would howl.

The general schematic is shown in Fig. 8. The apparatus converting the incoming wave to the new wavelength may take a number of forms. If the set is not highly selective and well shielded, and if λ_1 is not sufficiently removed from λ_2 it will be necessary to have the receiving loop aerial

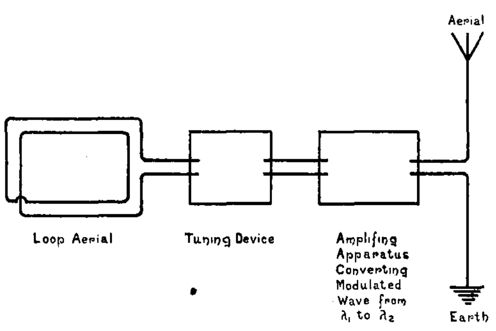


Fig. 8. *Layout of wireless relay set.*

* Concluded from page 260 of previous issue.

at some distance (say ¼ mile) from the transmitting aerial.

In this case it will be necessary to have the selective receiving set situated at the same location as the loop and reducing the incoming wave to audio frequency for transmission by a short land line to the transmitting set, which need embody no special features. By this means too, the directional nature of the loop may be made to assist in cutting out the local transmitter since a position may be found where the loop may be placed directional to the incoming wave (λ_1), and anti-directional to the local transmitted wave (λ_2).

A set which is suitable for this purpose and which gives high selectivity is the super-heterodyne or double detection; in this case, however, it will be necessary to see that λ_1 and λ_2 do not bear such relations to one another that $f_1 - f_2 = 2 f_3$.

Where f_1 = the frequency corresponding to λ_1
f_2 = the frequency corresponding to λ_2
f_3 = the frequency of the intermediate amplification stages.

This is, however, a side issue.

Provided that such a set as the above is suitably shielded and sufficient stages of tuned intermediate frequency are employed it should be unnecessary to degrade the energy to audio frequency for transmission, since by modulating the intermediate frequency directly with a carrier wave f_4 of such frequency that $f_3 + f_4 = f_2$

or

$$f_4 - f_3 = f_2$$

the necessary carrier and side bands may be obtained for retransmission.

The method chosen actually depends on the type of transmitting set which is to be employed. Most low power (of the order of 1 kilowatt) sets in England employ a method of modulation in which audio frequency at a power comparable with the power of output of the set is employed to modulate the carrier wave, little or no further amplification being employed. On large sets such as the 200 kilowatt radio telephone equipment installed by the A.T. & T. Company at Rocky Point, the modulation and selection of the side bands is all done on low power valves and the selected side band amplified on high frequency amplifiers. If such a method of control were employed in a transmitting station employed for relay working, it would probably be considered preferable to transfer the energy from one wavelength to another without descending to audio frequency at all.

Theoretical considerations present a third alternative which could probably only be employed after a large amount of experimental work to obtain selectivity and adequate shielding. This consists in receiving on a highly selective straight set employing a multiplicity of tuned circuits, in heterodyning the incoming wave with a frequency f_5 (such that $f_5 = f_2 - f_1$) and selecting the beat frequency f_2 with a high frequency amplifier tuned to f_2 ($\equiv \lambda_2$).

The relaying from America on the 100 metre wavelength emitted from **KDKA** is a feat of which the originators (Messrs. The Westinghouse Company) should be justly proud, as should also the British Broadcasting Company's engineers. The fact that energy on the 100 metre wavelength is received over here with less attenuation than on the higher wavelengths is still unexplained. It is of course true that an aerial may more easily be made efficient at the higher frequencies owing to the increase in radiation as the frequency increases, but this is not sufficient to account for the field strengths which are being received in England and the reduction in fading.

If we consider for a moment we can see that two distinct types of fading are to be expected. Firstly, since the received waves are subject to reflection from a hypothetical electron layer (or as has been recently suggested, a layer of frozen nitrogen crystals) and also from cloud masses, it is evident that the wave front reaching any particular observer will from time to time experience different degrees of attenuation before reaching him, owing to the different paths traversed. Further, a certain convergence of wave front may sometimes obtain, resulting in an increased signal strength. Both these effects are the first ones which occur to the mind and account for the periodical changes in intensity which occur.

There is, however, another effect which is well known to the student of sound and which is due to the formation of a system of nodes and antinodes in any space traversed by both incident and reflected waves. On a long wavelength, say a thousand metres, since these nodes and antinodes are of the order of half a wavelength apart, it is evident that a receiving aerial may be one moment at a node and the next moment at an antinode, as the configuration of the reflecting surface changes.

This would be expected to give rise to changes in signal strength occurring over much shorter periods.

It is evident also that fading due to this cause can hardly behave in the same way for waves whose nodes and antinodes occur at distances apart commensurate with the size of the receiving aerial, as it would in the case of much longer waves, though this hardly explains the phenomenon as experienced when receiving on a loop.

Further, it does not seem a great stretch of imagination to conceive that the reflecting surface in the upper atmosphere is not perfectly smooth but more or less broken, presenting a surface more or less like a ploughed field or an eiderdown. It is only necessary to suppose that these undulations or breaks are always of the same *order* of size (which is really not in the region of supposition, but of certainty if they occur at all) in order to show that certain wavelengths will be reflected in less degree than others.

For instance, if the breaks are o the order of 500 metres in size then the 500 metre wavelength will be less well reflected than any other, both longer and shorter wavelengths being reflected more completely. The frequency response or wavelength response characteristic for transatlantic transmission (or any other transmission), if we neglect the effect of nodes, thus depends chiefly on the attenuation at each frequency and the reflection at each frequency. It would appear that by taking wavelength response characteristics for differing distances the respective importance of each of these causes could be determined, if it were worth while.

Dr. W. H. Eccles has suggested that owing to the fact that a series condenser is employed with a normal aerial in order to make it oscillate below its fundamental wavelength for the 100 metre transmission the maximum radiation is at an angle above the horizontal so that the wave " gets a good start."

Further, owing to the wavelength being shorter compared to the length of the antenna, a certain amount of directivity results, in other words, an approximation to a beam results.

Some such explanation is undoubtedly necessary since the results obtained are due to a real increase in field strength and not merely to the absence of noise on this particular wavelength.

NOTE. In the first instalment of this article which appeared on May 21st, an error occurred on page 227. Instead of " the current ratio for 11 miles of standard cable is 1·115 " the wording should be " the current ratio for 10 miles of standard cable is $\epsilon^{1.09} = 2{\cdot}974$."

PATENTS AND ABSTRACTS.

Non-Inductive Resistances.

It is well known that a tuned circuit—say, for example, the tuned anode circuit of a high frequency amplifier—may be stabilised by inserting a resistance in the anode circuit. The resistance should be preferably non-inductive.

One method of constructing a non-inductive resistance may be explained by referring to Fig. 1.*

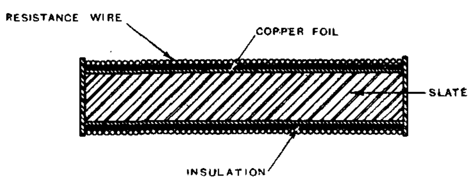


Fig. 1.

A former of slate or similar material has wrapped round it a layer of copper foil, the ends being soldered together, or alternatively a coating of copper may be deposited electrolytically. The copper coating is covered with a thin layer of insulating material, such as paraffin wax paper, and then the resistance coil is wound over the insulation. The copper foil being in the full field of the coil makes the inductance of the winding negligible, while the self-capacity of the winding remains fairly small.

A variable resistance of this sort could be made by tapping the coil or arranging a slider which could be moved along the coil.

* British Patent No. 213,675, by N. Ashbridge.

Variable High Resistance.

It is proposed to construct a variable grid leak by employing a multi-stud switch, to which is secured a disc or sheet of paper bearing a line of black lead, graphite, or other suitable material, as suggested in the sketches, Fig. 2.* When low resistances are required, the paper may be impregnated or treated throughout part of its area with suitable material. The disc or sheet of paper makes connection with the contact studs of the multiple-way switch by means of which the resistance included in a circuit may be controlled.

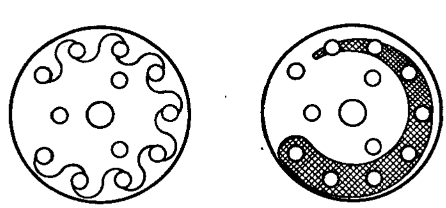


Fig. 2.

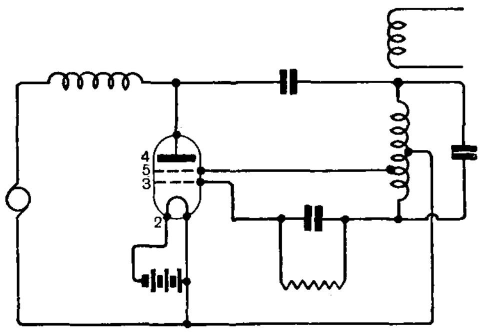
A Four-Electrode Valve for Producing Oscillations.

One of the principal losses in the operation of a three-electrode valve is that due to the space charge drop between filament and anode. This fall in potential between filament and anode may be greatly reduced

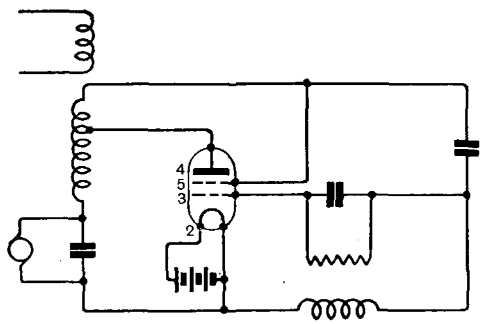
* British Patent No. 213,084, by A. H. Hunt.

by the use of a second grid interposed betw en the control grid and the anode.*

Referring to Figs. 3A and B, 2 is the filament, 3 the control grid, and 4 the anode. A second grid, 5, is placed between the control grid 3, and the anode 4.



A



B

Fig. 3.

An oscillatory circuit is connected to the valve, and the anode supply is fed through a choke in the usual way, to prevent the high frequency energy being short-circuited through the H.T. source. The grid 5 will oscillate in potential with the grid 3 and anode 4, and the amount of its swing can be so adjusted that it will become just enough positive to permit the maximum current to flow to the anode, and not so positive as to permit it or grid 3 to receive secondary electrons emitted from the anode.

In the arrangement of Fig. 3B, the extra grid 5, and the anode oscillate in potential together, but the potential of the extra grid is always sufficiently below that of the anode, while electrons are passing to the anode, to prevent secondary emission.

* British Patent No. 195,964; by the British Thomson-Houston Co.

Valve Holders.

The common type of holder for valves consists of a body of insulating material having metal sockets into which the pins which form the terminals of the valve electrodes are forced, thus completing the connections and holding the valve in position. The disadvantage of the ordinary type of valve holder is that it is necessary to insert all the valve pins at the same time, and it is possible to destroy a valve by placing the pins connected to the filament in contact with the wrong sockets.

A new arrangement* consists in constructing a valve holder as shown in Fig. 4, where G, F and P represent the usual sockets. The upper surface is stepped at S so as to form a platform on the socket B. This enables P to be easily seen, and in inserting the legs in the sockets, the anode

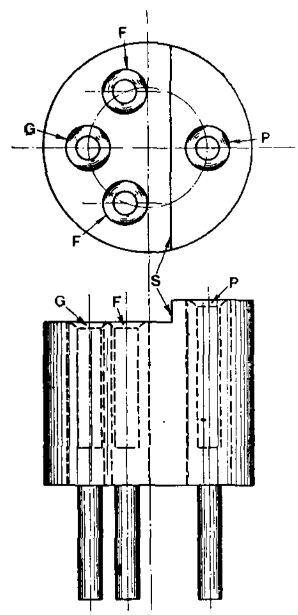


Fig. 4.

pin, which is distinctive by being separated at a greater distance than the others, is first inserted in P. A slight rotation of the valve about this leg brings the other legs automatically over their sockets.

* British Patent No. 213,383, by R. E. Beswick

NOTES & CLUB NEWS

It is proposed to introduce broadcast advertising in Berlin to defray programme expenses.

* * * *

Better broadcast reception is reported in the Edinburgh district. Improvements are still being carried out at **2 EH.**

* * * *

The three-masted ship "Pourquoi Pas" left Cherbourg on May 28th for a scientific weather research cruise off Iceland. Results will be transmitted by wireless twice daily.

* * * *

There are now 530 licensed broadcasting stations in the United States.

* * * *

Sunday, May 25th, witnessed the opening of a high power radio station at Belgrade, organised and controlled by a French company. The new station will be used for international communication.

* * * *

Mr. L. M. Baker (**2 FN**), of Ruddington, Notts, reports that he is now working with American and Canadian amateurs.

* * * *

At a public demonstration of broadcast reception recently held in Leningrad, a French concert was well received over a distance of 1,300 miles.

* * * *

The Eiffel Tower and Ecole Supérieure des P. T. T. broadcasting stations are carrying out simultaneous transmissions of the same programme, the former on 2,600 metres and the latter on 450.

* * * *

The Montreal (**CKAC**) broadcasting station, which opens this month, will cater specially for the requirements of French-Canadians. **CKAC** is extremely powerful and should be heard in Europe with comparative ease.

* * * *

A new wireless station has been erected at Tarawa, in the Gilbert Group of Pacific Islands, and is in communication with Ocean Island, 240 miles distant.

* * * *

Progress at Rugby.

Constructional work on the high power Imperial wireless station at Rugby is proceeding apace.

The aerial, which will be supported on twelve masts, each 820 ft. high, is about a mile and a half long and about half-a-mile wide.

Power will be obtained from a three-phase public supply. The power plant will consist of motor generators, arranged to give high tension and direct current output of one thousand kilowatts at any voltage which may be required between 4,000 and 18,000 volts. A high frequency generator will be laid up on banks of valves arranged in such a way as to deal with an output of from 200 to 500 kilowatts. An earth screen, 20 ft. in height, will be provided.

Efforts are being made to have the station ready for operation by the end of the present year.

2 QC.

The call sign of the powerful experimental station of the British Broadcasting Company at Hendon has been changed from **2 QC** to **6 BBC.**

Brussels Broadcasting.

The reduced wavelength of the "Radio Electrique" broadcasting station in Brussels is 265 metres. No reduction in power has taken place, as suggested in a recent issue.

Argentine Amateur's Success.

Senor Carlos Braggio, Argentine **CB 8,** whose signals, as reported in our last issue, were heard recently in this country by **2 OD** and **2 UV,** is stated to have communicated with New Zealand, maintaining touch for two hours. The distance covered is about 6,000 miles.

Mr. G. W. H. Tripp (**2 ASL**) of Chew Magna, Somerset, reports that he heard signals from the same station on Sunday, May 25th. A two-valve (o—v—1) receiver was used.

Swedish Amateur Transmissions.

Dr. Nilsson, owner of the Swedish transmitting station **SALD,** referred to in these columns last week, states that the Swedish Telegraph Department has decided that amateur stations shall in future have the prefix **SM.** Dr. Nilsson's call sign is now **SMZV.**

Reports are welcomed from British experimenters who hear his signals.

Photo: Palmer Illustrations.

A recent photograph of the Imperial wireless station at Rugby in course of erection. Twelve masts are employed, 820 feet high, and the aerial covers a distance of a mile and a half. The inset gives a good idea of the massive construction of the masts.

Velocity of Wireless Waves less than Light.

Captain T. J. See, Professor of Mathematics in the United States Navy, asserts that the velocity of strains in ether varies with wavelength. That this is the case is generally admitted and it explains how distortion occurs in modulating short waves for telephony, when an appreciable frequency change is apparent, accompanied by distortion at the receiver due to uneven speed of travel of the many frequencies constituting the modulated wave. Captain See agrees that the velocity of light is 186,000 miles a second, which is the recognised value and can be verified by numerous methods, but he states as a result of his investigations that ether strains on the wavelengths normally employed for wireless work have a velocity of 165,000 miles a second.

Woman and Wireless.

Under this alliterative title in a recent issue of *The Daily Graphic* the Countess de Armil discussed the scientific attractions of radio with more charm than technical accuracy.

"While listening-in," the Countess wrote, "I learned how the wireless valves produce the *electrones* which form the actual signals and how the grid-leaks and *condensers* help the valve in *rectifying sound as purely as possible*. Also, *how the transformers amplify the signals which are received by the detector valve*.

The italics are ours.

Japanese Wireless Press Service.

The Japanese Department of Communications has completed arrangements to facilitate a press service throughout Japan of news received by the Hiranogo Wireless Station, near Osako, from the United States, Germany and France.

Educational Broadcasting.

The systematic development of broadcasting to schools is expected to come into operation in September next. This decision is the result of the recommendations of the National Advisory Committee of the B.B.C., which is of the opinion that there is a useful place for broadcast educational talks. The committee includes Sir Benjamin S. Gott, Sir H. Walford Davies, and representatives of the Association of Educational Committees, the Directors of Education, and other influential bodies.

Tests from 5 HM.

5 HM, the experimental station of Mr. J. Fitton, 27B Milnrow Road, Rochdale, Lancs, is at present conducting extensive test transmissions of C.W. and telephony with choke control and absorption circuits, also single-valve transmissions employing grid modulation with power varying from 2 to 10 watts. Reports would be welcomed at the above address from amateurs receiving the transmissions outside a ten-mile radius of the station, and Mr. Fitton would be grateful for particulars concerning the location and the number of valves used in each case.

Transatlantic Wireless Telephony.

Wireless connection between the telephone systems of Great Britain and the United States is the possibility opened up by recommendations to the Postmaster-General of the Committee formed in 1923 to investigate Transatlantic wireless telephony.

The committee, which is under the chairmanship of Admiral of the Fleet Sir H. B. Jackson, recommends the installation of an experimental 200 k.W. telephony valve transmitting plant at the new Post Office Station at Rugby, of a similar type to that in use for the experiments in America, so as to enable "two-way" conversations to be carried out. It is hoped that these experiments will show that it is possible to connect telephone subscribers in London to subscribers in New York during favourable atmospheric conditions, particularly during the winter months.

What a Flewelling Will Do.

The reception of 103 amateurs on telephony since Christmas is reported by Mr. A. Acland, of Chatham. These results are commendable in view of the fact that only one valve was used, and that in many cases the stations were over 200 miles distant. Mr. Acland's set, embodying the Flewelling circuit, was constructed from details given in the *Wireless World and Radio Review*.

Poachers Still at Work.

Mr. J. E. Sheldrick, B.Sc. (**5 IG**), of "The Brambles," Third Avenue, Denville, Havant, Hants, has reason to suspect that his call sign is being appropriated by another transmitter.

Information leading to discovery of the offender will be welcomed.

Broadcasting in Manchester Parks.

Great success has marked the inauguration of a series of wireless concerts in the parks of Manchester.

Arranged by the Manchester *Evening Chronicle*, in conjunction with the Marconiphone Company, demonstrations are given in Whitworth, Heaton, and Peel Parks, and great appreciation is being shown by the public. Ten loud speakers are used, ranged round the circumference of the bandstands with, it is reported, very pleasing results.

Restrictions Removed in Australia.

Australian amateurs are rejoicing over the removal of the regulation under which receiving sets were sealed to work on one wavelength only.

The Postmaster-General recently called a conference in Sydney, attended by representatives of Australia, New Zealand and Fiji, and in addition to the decision referred to, it was agreed to issue a common licence for all owners of receiving sets at 40s. per annum for the broadcasting subscription, exclusive of 5s. per annum for the Government. During the discussion it was stated that in March there were 2,864 experimental licences in New South Wales.

Submarine Detector Service.

More volunteers are required for the submarine detector branch of the Navy. Ratings of the seamen, signal and wireless branches are eligible, and only those of superior ability and in possession of first-class hearing, will be accepted. The final aural test is carried out by the Commanding Officer at the Anti-Submarine School, Portland.

Jamaica Radio Regulations.

According to "Commerce Reports" there is practically an absolute prohibition at present against the erection and operation of radio equipment in Jamaica. The local government, however, is endeavouring to draw up a set of rules under which permits may be granted for the operation of receiving sets by private individuals.

Address Wanted.

We should be glad if Mr. H. P. Holden, of Bolton, Lancs, who recently contributed to the Calls Heard Section, would kindly forward his full address.

RADIO SOCIETY OF GREAT BRITAIN.

An Ordinary General Meeting of the Society was held at the Institution of Electrical Engineers on Wednesday, May 28th, Brig.-Gen. Sir Capel Holden, K.C.B., F.R.S. M.I.E.E., presiding. Prior to the reading and confirmation of the Minutes of the previous meeting, the Chairman explained with regret that owing to serious illness Dr. W. H. Eccles, F.R.S., the President, was prevented from attending.

Satisfaction was expressed that Dr. Eccles was making progress towards recovery.

A lecture on "Wireless in British Military Aircraft up to August, 1914," was delivered by Major H. P. T. Lefroy, and was followed by a brief discussion.

An Informal Meeting of the Transmitter and Relay Section will be held at the Institution of Electrical Engineers, Savoy Place, W.C.2, at 6 p.m. on Friday, June 6th, at which Captain A. G. St. Clair Finlay will give a lecture upon "Modulation Systems." Apparatus will be used to illustrate the lecture. Particular attention is drawn to the change of time.

An Informal Meeting will be held at the Institution of Electrical Engineers, at 6.30 p.m. on Wednesday, June 11th, at which Mr. A. H. Ninnis will give a talk on "General Observations on the Radio Situation, and the Development of Broadcasting in New Zealand."

The Max-Amp. Power Transformer.

Messrs. The Peto-Scott Co., Ltd., have drawn our attention to their advertisement on page xxvii of the May 28th issue of this journal, in which the price of the Max-Amp. Power Transformer is given as 30s. This is incorrect, the price of the instrument being 35s.

Larger Premises.

The Electrical Trades Supply Ltd., who have been established at Great Charles Street, Birmingham, for the last 24 years, have moved to larger and more commodious premises in the same street. There will be no change in the address or management.

Marconiphone Appointment.

Mr. L. Hermes, formerly Assistant Manager of the Wireless Department of the General Electric Co., Ltd., has now joined the Marconiphone Company, Limited (London Head Office) as Sales Manager.

CATALOGUES, ETC., RECEIVED.

"**S. A. Cutters**" (15 Red Lion Square, Holborn, W.C.). List of Wireless Equipment, loose-leafed for further additions.

Radi-Arc Electrical Co., Ltd. (Regency House, Warwick Street, W.1). Leaflet illustrating and describing the Liberty Crystal Radio Receiver, which is of particularly stable construction in circular stamped sheet case.

Gent & Co., Ltd. (Faraday Works, Leicester). Particulars of the "Tangent" Terminal, for ensuring instant and firm electrical contacts.

Hart, Collins, Ltd. (38A Bessborough Street, Westminster, S.W.1). Illustrated leaflet dealing with the "Tuninall" Single Valve Broadcast Receiver.

Marconi's Wireless Telegraph Co., Ltd. (Marconi House, Strand, W.C.2.). Leaflet No. 1022, illustrating and describing the Marconi Magnetic Drum Recorder for commercial telegraph reception.

Barnet and District Radio Society.*

Mr. G. A. V. Sowter, of the Radio Society of Highgate, paid a welcome return visit to the Barnet Society on Wednesday evening, May 21st, and interested a large gathering of members with his talk on a portable receiver of his own construction. The set fitted into a case of useful dimensions which allowed space for the storage of 'phones and batteries. The construction of the set was explained and it was shown how, by the alteration of connections to terminals, five different circuits could be obtained. Mr. Sowter answered numerous questions on the design of the set and later the audience were able to hear it in action.

The Barnet Urban District Council has written asking if the Society can lend its aid in providing wireless concerts during the summer evenings in the new recreation ground at Barnet.

Hon. Sec., J. Nokes, Sunnyside, Stapylton Road, Barnet.

The Hornsey and District Wireless Society.*

A cinematograph lecture of exceptional interest was delivered on May 19th by Mr. G. J. Westgate. A brief outline of the history of X-rays was given, from the time of Geissler, Crookes, Rontgen and others to the present day, including the production of the hot cathode tube by Coolidge in 1913. The film illustrated how valuable and indispensable X-ray apparatus had become to the modern surgery, particularly for the purpose of locating fractures and broken bones. Several slides were also shown illustrating modern high-power X-ray generators. One slide of particular interest represented the discharge from a million volt transformer, this slide being exhibited by the courtesy of the British representatives of the G.E.C. of America.

Two further films were shown, illustrating the manufacture of "Mazda" lamps at the works of the British Thomson-Houston Company.

Hon. Sec., H. Hyams, 188 Nelson Road, Hornsey, N.8.

Kensington Radio Society.*

At the May meeting, Mr. H. E. Hull gave a lecture on the various points to be aimed at in the erection of aerials when maximum efficiency is desired. The importance of reducing earth resistance and capacity effects from walls, etc., was also dealt with.

With reference to reaction and "body" capacity effects on tuning, many hints were given, particularly with regard to the screening of condensers and instruments.

The proposed "Sale and Exchange" has been postponed until Thursday, June 19th, at 8.30 p.m.

The Hon. Sec., J. Murchie, 33 Elm Bank Gardens, Barnes, S.W.13, will be pleased to answer any enquiries regarding the Society.

The Leeds Radio Society.*

On May 16th, Mr. A. F. Carter (Vice-President), delivered a lecture entitled "The Design and Construction of Valve Receiving Stations." Mr. Carter thoroughly analysed his subject, and paid particular attention to the design of a set which he had on view, employing an H.F. stage, rectifier and L.F. stage with regeneration. Two power amplifying stages could be used if desirable. During the lecture several experiments were carried out and finally numerous types of loud speakers were heard in turn.

On May 23rd the Hon. Secretary lectured upon "Methods of Rectification for Radio Frequent Currents." The chief methods examined were firstly, rectification attained by use of either of the bends on the anode current grid voltage characteristic, *i.e.*, "potentiometer rectification"; secondly, grid current rectification, and thirdly, cumulative grid condenser rectification. The latter method was advocated and the advantages of a variable grid condenser explained.

In view of the local interest in wireless that has been caused by the proposed erection of a relay station at Leeds, the Society is expecting a large influx of new members. Applications should be made without delay to the Hon. Secretary. It is not necessary to have a knowledge of wireless to become a member of this Society.

Hon. Sec., D. E. Pettigrew, 37 Mexborough Avenue, Leeds.

Tottenham Wireless Society.*

At a meeting held on Wednesday, May 21st, a lecturette on "Catwhiskers" was given by W. Elam, a member of the Junior Section of the Society.

Other short papers by members of the Junior Section were: "Experiments with Tuning Inductances," "Effect of Heat on the Resistance of Wires," "A Short History of Wireless," by A. Standingford, E. Wilson and J. Newman respectively.

The writers of the papers were congratulated on the high standard of their work, which testified to their keenness.

Mr. Tracey described the crystal receiver used by him for long distance telephony reception, and also related his experiments with variometers.

Mr. Holness mentioned some modifications of the Ultra-Flex circuit which he has designed.

Hon. Sec., A. G. Tucker, 42 Drayton Road, Tottenham, N.17.

West Bromwich Engineering Society (Radio Section).

"Radio Facts and Fancies" was the title of an interesting paper given to a large audience on Friday, May 16th, by Mr. E. Rawson, B.Sc., Vice-President. The lecturer dealt with numerous points in connection with broadcasting and radio in general, afterwards demonstrating an extremely interesting reflex circuit, by means of which **5 IT** was received on a loud speaker.

Hon. Sec., W. R. Evans, Technical School, West Bromwich.

St. Pancras Radio Society.

The Western Electric Co.'s "Audion Film" was shown at a meeting of the Society on April 24th. This film, which conveys the action of the thermionic valve in a clear and striking manner, was followed by a debate on the respective merits of resistance-capacity, and transformer L.F. amplification.

"What Valve Shall I Use?" was the title of an interesting and most instructive lecture given by Major W. I. G. Page, B.Sc., on April 1st. After briefly reviewing the theory of the valve with the aid of a cleverly arranged diagram, the lecturer proceeded to show why it was necessary to use certain types of valves for certain purposes in order to get the best results. He then dealt in detail with some 40 types of valves, explaining the properties of each and the purposes to which each was best adapted, strongly emphasising the need of low impedance valves for L.F. amplification. The valves were afterwards passed round for inspection. The lecturer concluded by measuring the impedance of a valve, and a table of valve constants which the lecturer had prepared was given to all who were present.

Hon. Sec., R. M. Atkins, 7 Eton Villas, N.W.3.

Radio Association of South Norwood and District.

Two interesting addresses were given by Messrs. Cullis and Fenney respectively on May 15th. Mr. Cullis gave useful details concerning a Flewelling receiver, containing an original modification making for increased efficiency. Mr. Fenney, **6 RH**, spoke on generating H.T. from a 6-volt accumulator.

Birmingham Wireless Club.

A profitable discussion evening was held at the Digbeth Institute on May 16th.

The Hon. Sec., H. G. Jennings, 133 Ladywood Road, Birmingham, will be pleased to answer enquiries concerning membership on receipt of a postcard.

Merthyr Radio and Scientific Society.

The Society held its first wireless and electrical exhibition on May 8th, 9th and 10th in the Parish Hall of St. David's Church, generously placed at the disposal of the Society by the Rector.

Many leading wireless manufacturers were represented, and visitors were able to examine an assortment of the latest receivers and component parts.

The exhibition was opened on the first day by His Worship the Mayor, on the second day by Mr. Howfield (President), and on the third by the Rector of Merthyr.

Among those present at the Exhibition were Messrs. W. A. Chamen and C. T. Allen, General Manager and Assistant Manager respectively of the South Wales Electric Power Company.

One of the most interesting features of the exhibition was a demonstration of X-ray work by Mr. E. L. Davies, B.Sc.

The exhibition was a complete success and it is hoped to hold one on a larger scale during the Autumn.

Hon. Sec., W. T. Rees, 84 Brecon Road, Merthyr Tydfil.

Forthcoming Events.

WEDNESDAY, JUNE 4th.

Golders Green Radio Society. At 8.30 p.m. At the Club House. Lantern Lecture: "Development and Manufacture of Thermionic Valves." By Mr. T. E. Goldup.

THURSDAY, JUNE 5th.

Hackney and District Radio Society. Lecture: "Test Room Experiences." By Mr. Shefford, of the General Radio Co.

Blackpool and Fylde Wireless Society. Lecture: "Wireless Uncertainties." By Mr. W. Diggle.

FRIDAY, JUNE 6th.

Radio Society of Great Britain (Transmitter and Relay Section). Informal Meeting. At 6 p.m. At the Institution of Electrical Engineers. A Discussion on "Modulation Systems" will be opened by Capt. St. Clair Finlay. Illustrated with apparatus.

Radio Society of Highgate. Lecture: "Accumulators." By Mr. W. Schofield, of the Hart Accumulator Co., Ltd.

TUESDAY, JUNE 10th.

Uxbridge and District Radio and Experimental Society. Lecture: "Wireless Gadgets made from the Junk Box." By Mr. W. Leno.

FAITHFUL REPRODUCTION BY BROADCAST.

By CAPT. P. P. ECKERSLEY, M.I.E.E.

(*Continued from page 254 of previous issue*).

DISCUSSION.

Admiral Sir Henry B. Jackson, opening the discussion, said :—

I certainly have no intention of opening discussion on this very practical problem by raising theoretical points. I should, however, like to congratulate Captain Eckersley on the results at the recent opening of the Wembley Exhibition. From all accounts it was a triumph for the British Broadcasting Company. Perhaps we have hardly appreciated the amount of work that it has been necessary to be put into this problem, which some people think is not very difficult, and is only a matter of a few troublesome adjustments. After the lecture we have heard to-night, however, we can clearly see what the difficulties are. The lecture has been of such a practical nature that I think every word must have appealed to us. To judge from my own listening—I have several sets of different sorts—that microphone is not quite perfect, but it is getting nearer. The loud speaker, too, is not quite a pleasure to hear, although a year ago it was very much worse. With good telephones and a good receiving set, then broadcasting is very nearly perfect.

Mr. P. R. Coursey.

I scarcely know what points in the lecture can be discussed properly now, as Captain Eckersley has dealt with the whole subject so fully that one really wants to sit down and think it over in detail. There is one thing, however, which particularly struck me, viz., that he lays more blame on the loud speaker, as a rule, as a source of distortion, than on the receiving set. That may be so in some cases but in the case of a good many sets it is not quite so true. A great many of the so-called low frequency amplifiers on the market to-day are *amplifiers*, but they are really no more than that, and when they are used for receiving speech I think they are, perhaps, more to blame than the loud speaker. Both contribute to distortion, but the bulk of the distortion may not necessarily be in the horn or the diaphragm.

One might, perhaps, if anything, wish for a little more detailed comparison of the different types of loud speakers. Captain Eckersley has been talking to us on the subject of reproducing broadcast transmissions, and the loud speaker, as he has said, is of great importance. Therefore, perhaps he may be able to amplify what he has already told us about the relative merits of different methods of reproducing sound. One might judge from his second diagram that the method utilising the same principle as is employed in the microphone itself, viz., the electromagnetic principle with a coil moving in a magnetic field, would from the theoretical point of view be much more perfect than any other method. Captain Eckersley has studied the subject throughout in such great detail that I would beg him to amplify his remarks in that connection.

Mr. J. H. Reeves.

My experience of trying to get good loud speaker results dates back to the time when, week by week, we used to look forward to a choice half hour from Writtle. The methods I was then employing appear to-day in four pages of *The Wireless World and Radio Review*, so that my contribution this evening will take up very little time. I am pleased to say, however, that I am now getting loud speaker results which are as good as I have heard anywhere, but there is one little point about the loud speaker which we actually accidentally discovered. I had a very expensive loud speaker, but the volume was poor and the quality bad. Mr. Child had heard of this, and he had just got out an apparatus by which he could re-magnetise a magnet, and he offered to treat mine. We took the loud speaker apart and found it was a disgraceful piece of mechanical imperfection. Neither of the pole pieces was true, and one was considerably nearer the diaphragm than the other. Mr. Child kindly put these pole pieces right for me, and I have never seen a man more delighted than he was when he subsequently heard the sounds out of that loud speaker. The mere perfection of the mechanical detail in the loud speaker converted it into one in which I should say the amplitude is two or three times what it was, and the quality improvement was wonderful.

Mr. Fogarty.

I should like to add my thanks to those of the previous speakers to Captain Eckersley for his interesting lecture. I certainly have learned a great deal that I did not know before. I am not sure whether it is relevant to the lecture, but I believe that Captain Eckersley is strongly of the opinion that as far as the low frequency amplifier is concerned it is best to dispense with the transformer and to utilise capacity and resistance methods. I should like to ask him if he believes that resistance capacity methods are better than the intervalve transformer, because I think a good many of us would be interested to know whether we may expect to get a great deal less distortion this way than with the method which we now so largely adopt.

Mr. R. E. H. Carpenter.

I should like to ask Captain Eckersley if he will deal a little with the question of detection. The detectors that we use at present are said to obey square laws, but I doubt whether, in fact, that is always the case. I think that one of the reasons why crystal detectors give more satisfactory detection than some valve detectors is due to this fact;

the crystal does not obey Ohm's law, and one result is that as the amplitude increases the damping effect of the crystal on the receiver circuit increases also. It follows that the ratio of amplitudes in the receiving circuit does not necessarily follow the ratio of amplitudes, on a time basis, that take place in the transmitter. That is to say, let us suppose that the transmitter at one moment is giving a particular amplitude ; the detector circuit has an amplitude of some very small fraction of this. If the amplitude in the transmitter circuit now doubles, the amplitude in the receiving circuit, which has a crystal connected across it, will not necessarily double because the effective resistance of the crystal is decreasing with increasing amplitude, and I think that fact offsets the square law to some extent. I think that is also a reason why grid currents, of which Captain Eckersley spoke so unkindly, are not always harmful. In using a valve detector, if the mean potential of the grid is slightly positive, the same sort of effect will come in there, *i.e.*, the increasing power absorption due to grid currents with increased amplitudes will, to some extent, tend to off-set the square law which the detector otherwise obeys. I would like, also, to oblige Captain Eckersley by telling him that on one point he is entirely wrong. He is quite wrong in suggesting that a lot of people will get up and tell him he is wrong, because he has dealt with the subject so lucidly that any man who gets up to heckle him would be very rash.

Lord Russell.

I have just whispered to my neighbour that probably in his reply to the questions that have been put Captain Eckersley will give amplification without distortion. (*Laughter.*) I have been interested in wireless just long enough to know that I know nothing about it. Possibly in five years time I shall begin to have a view on the subject, but I shall certainly not express one to-day.

Mr. P. G. A. H. Voigt.

Captain Eckersley has tried to make things so simple by putting everything down to amplitude that I think he has run off the rails a little. Like most other people, I have been thinking of the subject of the perfect loud speaker for a long time and I believe I have got a certain stage of perfection. It has not been published yet because it is not far enough advanced. Most people begin by considering the ear, but my own opinion is that in the transmission of sound the ear has got nothing to do with it, except at the finish. Imagine you have got a studio and that you have bored a hole in the wall, of the same diameter as the mouth of your loud speaker. You are listening in the next room through that hole ; you can put a fan in it if you like but so long as you have got a hole, sound is coming through it. What we have got to try to imitate is the exact way in which that sound comes through. Sound is an air vibration having amplitude, pressure, and velocity. I worked things out in my head—I am not good at maths, although I had to be once, and came to the conclusion that the maximum pressure varies directly as the maximum velocity and is in phase with it, and the relation is the same at all frequencies, but if you try to get the relation between amplitude and velocity it is not the same. At a lower frequency the velocity lasts a longer time and therefore the amplitude is greater, so that if you go an octave lower and keep the same velocity or pressure, you have double the amplitude. If you watch a man in a brass band hitting his drum, you can see the drum diaphragm move about half an inch. That means he is setting into motion a good many cubic inches of air, and that more or less seems to prove that at the lower frequencies you get a much bigger amplitude and a much bigger volume displaced through that hole. If you try to transmit that, your very low frequencies will use the whole carrier wave and the top frequencies will be washed out. Therefore I rather fancy that by leaving pressure out of it and getting electric current of equal amplitude for equal sound amplitudes your lowest frequencies are going to drown everything. If you "differentiate" it, as Captain Eckersley has said, so that as your frequency gets lower the electrical amplitude gets less for a given sound amplitude, you get the same state as if you have equal electric amplitudes for equal pressures. The pressure output of your loud speaker should then be proportional to your electrical input. As the horn is an unknown quantity I have, for preference, left that out. I have used a conical diaphragm but that resonates and I am making a diaphragm that I hope will not. It is not conical and it is not flat ; it is something else, and it does not work from the centre. The driving part has not got a reed in the ordinary sense with a natural frequency. Captain Eckersley has drawn some curves in which he has taken frequency as a base. Now what happens on a frequency curve ? The whole musical scale covers 8 to 11 octaves. If you have frequency as a basis, the highest octave, say 5,000 to 10,000 cycles, is going to occupy one half of your graph paper. If you use wavelength—sound wavelength—for a base, the lowest octave—between 30 and 60 cycles—occupies again half of your graph paper. But there is no need to waste all that paper and crowd all the useful octaves into the margin. The correct method is to have octaves as the base, but I suggest it would be convenient to use an apparent scale which has its mid point at 512 cycles. On the right-hand side of that mid-point the base would be the sound wavelength (that means that the highest frequencies would all be crowded into the margin because they are not very important, and the important frequencies from 512 to 1024 would occupy one quarter of your graph paper). Below 512 your base could be frequency. (Then you crowd your lowest frequencies into the left-hand margin and leave the 256 to 512 octave occupying one quarter of the page on the left side). Then you have a base in which frequencies of 256 to 1,012, *i.e.*, the octaves which are most useful, occupy half of your paper. The remainder is also on the paper but roughly in the proportion in which it is required. As for the one valve per mile, I do not agree with Captain Eckersley at all. If you live ten miles away and have ten valves, I should think the distortion would be something terrible, even if you have valves the size of a football and H.T. to match. With regard to grid current, perhaps it might be of interest if I mention an experiment. I was working with a loud speaker and tried to amplify further but found I could not do so without distortion, so I began to measure things. In the place of the telephone transformer I used an intervalve transformer. The peak voltage on the secondary was 50 volts and I applied that voltage to the grid filament in the usual way without grid bias. On the positive side the maximum voltage was 3 instead of 50. That is the reason for the distortion and it is the reason why most people who build up sets from books or who have not a suitable milliammeter in circuit do not know that they are distorting and are responsible for some of the results which have been indicated by Captain Eckersley. With regard to the hornless loud speaker, I tested quite recently a loud speaker of French origin—not a Lumiere—having a very large conical paper diaphragm, and I was very much astonished to find the efficiency was about half that of the big Brown loud speaker, so that those who say that the horn increases the volume by 150 times are a bit short of the mark. With regard to echo, it seems that people with loud speakers do not want any echo and those without loud speakers want it, and therefore I suppose the B.B.C. have to judge what to do for the best. With regard to detection, a crystal detector was once measured. It was put on to a 2-volt accumulator and the current was found to be only 1/20th of a milliampere. Then we changed the accumulator over and the needle did not move, but we found we should have reversed the milliammeter. (Laughter). When we did that we found the needle went right across the scale to 4 milliamperes, so that the rectification ratio was of the order of 80 to 1. After one stage of high frequency, the rectified voltage across the blocking condenser is of the order of 4 volts and if you have a rectification ratio of 80 to 1 there is not much room left for the square law. As long as you have got micro-volts to deal with you can have the square law but when you get within 20 miles of the B.B.C. with high frequency, it is a straight line law, and that is one of the reasons why a set with crystal detection is better than a set with a valve detector.

Mr. E. Cudden.

I think it would be much better if loud speakers were not curved or made with metal horns. It is often the endeavour to get the curved form which introduces distortion. I have got over the difficulty by using a gramophone attachment to a loud speaker and using a wooden gramophone horn 22 ins. long, which is straight. It has a rubber connection, and there is no distortion on account of curvature. Mr. Fogarty has asked Captain Eckersley a question with regard to the use of the capacity and resistance coupling in low frequency amplification. I have tried it and found it very satisfactory, and provided you increase the value of your H.T. to the proper potential, the amplification is very little less. Then the choke method is also satisfactory. With regard to rectification, a good many people use high frequency when near to **2 LO,** and there is a tendency to introduce distortion here. If you want the best results with a loud speaker, do not use H.F. when near a broadcast station. I do not use reaction or H.F., and I do not use an earth. I do not know how it is, but I get perfectly satisfactory results without one. I have got a 40 ft. lead to the loud speaker, and that seems to act as an efficient capacity earth. A resistance of 120,000 ohms is also satisfactory across the transformer secondary. The lecturer was sceptical about obtaining the best results from tuning on the secondary of the intervalve transformer, but I have found it very satisfactory and it is far better than putting the loud speaker across the terminals. If your capacity is more than 0·001 you will get distortion, but if not you can vary the tuning in the loud speaker and get a beautiful effect from music or speech. The only curious thing about it is that the best setting of the condenser is not nice for speech.

Mr. Robinson.

I am surprised that in connection with distortionless reception, no mention has been made of the push-pull effect. There is the push-pull amplifier and also the Western Electric double button microphone in which the same effect is made use of. I wonder if Captain Eckersley can expound somewhat the idea of push-pull amplification. I take it that the idea is to balance out the curved components of a valve system or eliminate the output currents which are proportional to the square of the input voltage instead of being a linear function. In any case, it would be interesting to know something about the push-pull amplification effect and the extent to which its use is justified. I would also like to have some information, if it is available, as to whether there are any methods for converting electrical energy into sound energy by any means other than the mechanically moving diaphragm. Is there any method of causing variations in air pressure directly by the action of an electrical current, an ionised gas stream or anything like that? It occurs to me that the ideal loud speaker made on such lines would dispense with mechanical distortion caused by mechanically moving parts. The thing which has come to mind is the Simon talking arc which I have given a trial, but I found the sound feeble owing to the low amplification I was using. I thought it might be of interest to see what I could do with such an arc, using a Bunsen flame very highly charged with sodium vapour and applying good beefy L.F. speech currents across the flame, and I obtained good speech in that way. There was a little distortion owing to the irregular discharge of the flame but at times the higher harmonics were exceptionally good, and I have not heard anything quite like it from any other loud speaker.

Captain Plugge.

I should like to ask the lecturer why he has decided on such a high-pitched note for the tuning signal of his stations. It appears to me that in order to provide means for sensitive tuning, a lower frequency, acoustically speaking, would be preferable. Another point arises out of the interesting lecture this evening. I think we all appreciate that most of the distortion, if not all, is to be found at the receiving end, and a good deal of the remarks to-night have been directed towards the loud speaker. Personally, I am very much in favour of the hornless loud speaker, and I am sorry to say that I do not think manufacturers in this country have devoted enough attention to this type of instrument as compared with Continental manufacturers. I brought back a loud speaker from Paris some six months ago—hornless—and having compared it with several good makes of horn loud speakers, I am satisfied that the hornless loud speaker, everything else being equal, gives better reproduction. It appears to me, since our lecterer to-night has pointed out the difficulties encountered when dealing with acoustics, that it is preferable to perform all the work possible in the electrical field, and do as little work as possible in the acoustic field. If a powerful signal is required at the receiving end, it is preferable to have a diaphragm large enough to produce such a signal, and amplify the current sufficiently before it reaches the loud speaker, leaving the sound vibrations untouched. The ear is a delicate organ which is hurt by any unnatural sound. If a horn is used, the mind is continuously conscious that some mechanical device is being employed. Therefore, I think that the future of perfect reproduction greatly lies in the development of the hornless loud speaker.

Mr. P. K. Turner.

I should like Captain Eckersley to deal a little further with the question of where the distortion lies in the receiver. Captain Eckersley has suggested that it is mainly in the loud speaker, but I am not quite sure that it is only in the loud speaker. Whereas I am sure that none of my present hearers ever have distortion in their sets, there are quite a number of people called broadcast listeners, and the percentage of distortion in their receivers is roughly 90 per cent. in the set and 10 per cent. in the loud speaker, because they do not get the chance to muck about with the loud speaker.

Setting aside the fact that resistance coupled amplification is better theoretically, it is quite possible to get, with transformer coupling, infinitely better results than are obtained by most sets in the hands of broadcast listeners that I have seen, and one of the main points in which we can help these people is in the valves they use. If one is going to get anything beyond the most moderate power for a small room, it is my fixed conviction that the ordinary "general purpose" valve is not sufficiently powerful for the job. It has not got a long enough straight part in its curve to deal with a loud speaker unless it is grossly over-run. Even the dull emitter valve cannot be made to do the work properly.

There is one point about the series rejector in use with telephones. A very handy method of doing this, which enables anybody to play about with it without purchasing special chokes, is to insert, in series with the high resistance telephones or loud speaker, the primary of an intervalve transformer, of which the secondary is shunted by the largest variable condenser which can be got. If you have a fairly heavily wound high ratio intervalve transformer you will usually find that you can successfully make that a rejector for this purpose. It is necessary, also, or advisable, to insert ohmic resistance in the circuit of the rejector to prevent it "rejecting" too powerfully.

I test a lot of transformers and loud speakers and valves and I find that there are at least a dozen loud speakers that give excellent results, but there is an enormous difference in transformers. A good transformer will give good results, which to the ordinary ear are hardly distinguishable from resistance amplification; but there are not many such.

Mr. Davis.

If we assume that rectification is proportional to the square of the amplitude, then we get strong signals out of proportion to weak ones. Does Captain Eckersley make any allowance for that in the regulation of the output?

Mr. Lawes.

It may interest some of you to know that the potential across a 400 microhenry coil with a series aerial condenser is about 6 volts at a distanc of three or four miles from **2 LO.** With regard to the use of a detector valve, a short while ago I tested one of the cheap Dutch soft valves, and was surprised to find a very considerable improvement in the quality of a loud speaker, coupled with increased loudness. I should like to say, also, in connection with Mr. Reeves' remark, that in my opinion the shape of the pole pieces of loud speakers has not received sufficient attention. Some time ago, in testing loud speakers for use on ships, I found that the shorter dimension of the area of the pole-face made a considerable difference to the loudness and quality. I therefore made a loud speaker with laminated Stalloy pole pieces, the size being about ¾ in. by ⅜ in. across. That is about three or four times the usual size. Lately I have constructed a loud speaker with similar poles, and I find the tone is much more mellow. Apparently the narrow pole pieces employed on some loud speakers produce local disturbance of the diaphragm, having a rather high frequency, and that may produce a difficulty. Lastly I should like to take up a point mentioned by Captain Eckersley when he spoke about the organ notes. Some time ago, when being shown over **2 LO,** one of the gentlemen there said that the lower organ notes on Sunday afternoons were present in the transmission. I have never been able to get them. Now, taking a 16-ft. organ pipe, this will have a wavelength of 32 ft. The frequency is therefore about 40 cycles. That nice little picture on the board begins, I think, at 200. I would like to know whether the lower notes are present in the transmission. (*Laughter.*)

The President.

I have been very greatly interested by this lecture because Captain Eckersley has dealt with the matter in a manner only possible on the part of those who have been deeply immersed in the subject for months. The subject has become so vast, and is so largely unexplored, that to the ordinary person it is practically a morass without any marked paths through it. That always happens where you have a new application of a variety of sciences, because where many sciences meet there are very rarely any individuals at hand who know all the necessary paths, and therefore a great deal of spade work has to be done in separating the various sciences and moulding them together in the appropriate manner. For example, Captain Eckersley has found that there are no books on acoustics. Of course, as a matter of fact, there are a great many scientific books on acoustics. I think he has to admit that there were some a yard thick—but he meant that they were so difficult for most people that it amounted to there being practically no books. Exactly the same difficulty occurred nearly 30 years ago in connection with electrical alternating currents. We had Maxwell's theory and Heaviside as the interpreter, and people of that day said that although books were in existence they were of no use because they could not read them. Before the books could be used they had to be interpreted. A tremendous amount of research was involved in interpreting Maxwell's and Heaviside's original work, and I have no doubt the same thing will happen in acoustics. There is information in these books, but it remains for people engaged in research work such as that which Captain Eckers'ey is doing, to translate those books into more general practical application, and that he is doing in a splendid manner. It is characteristic of him that he gives us a good deal of wisdom mingled with his humour, and I think he is right in saying that a great deal depends upon satisfying people in the art of suggestion. If you can give them some notes that suggest they are listening to a band, they believe they are listening to a band and are satisfied. (*Laughter.*) In other words, I think that in reproduction a good deal has to be left to the imagination. For instance, I believe that in a telephone conversation, 60 per cent. of the words would be unintelligible were there no context for the imagination to make use of for supplying the omissions and completing the meanings of the separate words. Possibly it is the same, and may always be the same with broadcasting, unless workers like Captain Eckersley can bring about true distortionless transmission and reception. I will now ask Mr. Coursey to take the chair as I have to leave for another engagement.

Mr. Percy W. Harris.

There are two small practical points I should like to mention. Captain Eckersley mentioned that we occasionally put condensers across our loud speakers, and he does not recommend us to do it as we introduce a resonance circuit. I have tried a very large number of loud speakers of varying quality, and I certainly agree with Mr. Turner that quite a large number give excellent results, but it does seem to me that many of those loud speakers are deliberately designed to be used with a condenser across them, for in many cases the absence of any shunting condenser across the terminals gives an unpleasant tone which is peculiar and noticeable in these loud speakers. Placing a small condenser across the terminals of the loud speaker remedies that defect. Perhaps Captain Eckersley can say whether it is the custom of the manufacturers of loud speakers to allow for the presence of a condenser across the terminals, because in the average set the condenser is there and apparently the manufacturers are allowing for their use. One speaker mentioned the use of metallic horns and suggested that they were part of the cause of distortion. I do not know whether that is the case. I am inclined to think that the metallic horn is frequently blamed for defects which are not in it, and I believe that so long as the lower portion of the horn is made of rigid metal we do not get much distortion. A gramophone which has recently been placed on the market—an improved model of a well-known existing machine —has a decidedly improved quality. Up to the present wooden horns have been used, but in the new model the horn is constructed of cast iron, very thick. If the metal of the loud speaker horn is thin all the way down to the small orifice (which is the case with some of the cheaper loud speakers), there are unpleasant resonance effects. I do not know whether others agree with me, but I consider that the introduction of wooden horns on loud speakers during the past year or two has not brought any improvement in quality. It certainly improves the appearance of some of them, but in testing one or two models which previously had metal horns and now have wooden horns, I really cannot find any difference.

Mr. G. G. Blake.

At one part of his lecture Captain Eckersley spoke of the microphone being treated with some weird kind of surgical dressings. It would be interesting to know if any other ingredients were used in addition to vaseline and cotton wool, and how they were applied.

Speaking of the acoustic properties of a room the author said that very little is known on the subject. When the architect is designing a room or hall he understands so little about acoustics that it is really greatly a matter of chance as to what properties it will possess when the building is completed.

I remember a lecture about a year ago, at the Royal Society of Arts, by Major Tucker, when he showed his hot wire microphone, and told us that by its aid he had been able to explore the interiors of buildings for their acoustic properties. He was able to go about a hall and detect nodes and loops of sound. In fact, the instrument was so sensitive that he could locate certain places in a hall where no sound could be heard.

We have therefore, I suppose, to take it that it is possible for a member of an audience to be just so located that one of his ears coincides with one of these dead spots. In such a position he would hear with one ear and not with the other.

If this instrument of Major Tucker's is made use of it seems to me that it should certainly be possible in the future to design rooms with better acoustic properties, or at any rate to know something of the sort of effects that are likely to be produced after the room is built.

One of the speakers has referred to the Simon's speaking arc as a loud speaker. About a year ago I carried out some experiments myself with a speaking arc as a loud speaker, and reproduced music and speech from **2 LO** moderately well. It seemed to me at the time that as the arc has no diaphragm and the speech reproduction is due to variations of the expansion of the air being heated by the arc there should be no undue resonance, and this might prove a very valuable way of obtaining good reproduction. My own results were not altogether satisfactory. I could hear quite well right across the room, but the speech sounded very woolly. I attributed this to the fact that I was using some old apparatus I had employed some years previously at the time Simon's arc was first introduced. Probably the apparatus was wrongly designed, and this may have accounted for the trouble. I certainly think that further experiments should be carried out with this arc in the hope of finding a solution in this way.

Captain Eckersley, replying to the discussion, said :—

Admiral Jackson said that the loud speaker was much better a year ago than now. I consider that a serious reflection upon **2 LO.** I do not think so. It may be that distortion balanced distortion when we used the carbon microphone. I have heard of receiving apparatus giving better results with faulty microphones when distortion is balancing another. For instance, the transformer amplifier and the loud speaker may balance distortions, and some manufacturers will not sell their loud speakers without their amplifier, because they have balanced one distortion against another.

Mr. Coursey raised an interesting question when he asked me about the relative merits of various principles for loud speakers. That is unfortunately a leading question, and, owing to my official position, I am sorry to say I dare not, if I could, answer it. I should be treading on too dangerous ground. It seems to me that it does not matter which way it is done. So long as you get the result, the principle does not matter.

Mr. Reeves referred to sloppy construction of loud speakers, and he has there raised a fundamentally important point. We have found, for instance, in relation to microphone construction, how important it is to leave no slackness in any intendedly rigid part.

As to the question put by Mr. Fogarty as to which is the best, resistance capacity, reactance capacity or transformer, I hold no brief for the resistance capacity, but like it because it is the fool's method, and therefore my own—(*Laughter*)—and as being the method which cannot go wrong, provided always, of course, that you use the right values. With a 50,000 ohm anode resistance and 0·2 or 0·3 μF intervalve condensers there should be no serious distortion.

With regard to transformers one must be very wary. There are certain ones in highly polished brass cases which look lovely, but they may not be so good as that dirty looking thing chucked away on the dust heap. This transformer question is an extraordinarily interesting one, because the transformers have got to be efficient from down to 30 a second—which we do not give you (*laughter*)—up to 10,000 a second. Most transformers are resonant and only amplify just those frequencies which are reamplified by 'phones or loud speaker.

By heavily shunting transformers you may cut out their resonance, but you may equally reduce their sensitivity to our equality with resistance capacity amplification.

Finally you do get down to a fairly effective device, and the important point is that you must use your transformer in the proper way. Again, it is no use taking *a* transformer and *a* valve. You must have *the* transformer and *the* valve. When a trader shows you a perfect curve, certified by a dozen people, ask him how they got the curve and with what valve, and how much they gave the certifier. (*Loud laughter.*) Reactance capacity is very good, but make the impedance of the inductance large.

The question of detection raised by Mr. Carpenter takes us into very deep waters, and frankly, how does a valve rectify ? I think the general theory is quite simple, but a great many factors complicate the situation In certain cases a valve may introduce more damping for greater amplitudes, as does the crystal.

I find some difficulty in following Mr. Voigt, because he approaches the subject from a different angle than I do. Unfortunately I have complicated this discussion by foolishly making the mistake of using the term equal amplitude when I meant equal audibility. I must apologise to all who were present at the lecture. The mistake has been corrected in the text printed here.

I wonder if one can neglect the higher frequencies, and again I would like to tackle this subject like a fool, and it may be a most foolish idea, but I think it may be that one can neglect the higher frequencies. I have been taken seriously about the one valve per mile, and I had better not say anything more about that. (*Loud laughter.*)

With regard to horns, raised by Mr. Cudden, a great many people have dealt with horns. I still am an exponent of the horn, because I do not think that you ought to do all your work by low frequency magnification, and then have an inefficient system. I do not agree, simply because it is not practicable. Our houses are wrecked fairly adequately now ; my drawing-room does not look very much like a drawing-room. It is a chaos of valves, condensers, wires, charging apparatus and so on, in the middle of which I sit whilst my wife complains. We must realise that the really efficient set must have a good low frequency amplifier and a really efficient loud speaker, rather than having a glut of valves and an inefficient loud speaker. Without the horn a loud speaker is usually inefficient ; the horn increases efficiency.

As to the material of which horns are made, I do not think it matters in the least. I think that as long as you have a horn which is not influenced too much by the vibrations of the moving parts, then you are on the right road.

Somebody mentioned that he was not using an earth. Very many sets work much better without an earth because they tend to oscillate easier, and so give apparently louder signals. Be very wary of doing without an earth, however.

Mr. Robinson raised the question of push-pull magnification. This is an extraordinarily efficient method of magnification, and has all sorts of valuable qualities. The Western Electric system with double buttons uses that method. The test of a microphone, however—and this is a point which has not been mentioned—is the ratio of its sensitivity to its spurious noise. The double button does not help here.

Mr. Robinson also mentioned freak microphones, and asked if we could use some other method. Of course, one dreams about things like that. One dreams about microphones which have no moving parts whatever ; one dreams of heat engines which have an efficiency of 100 per cent. ; one dreams of all sorts of things like that (*loud laughter*), but after all, the principle does not matter if you can get something which is practically perfect.

Captain Plugge asked why such a high pitched note is used by the B.B.C. for tuning. That is because the same apparatus is used for the time signal. That is why the high pitched biting note is used instead of something which is rather more mellow, and therefore difficult for purposes of the time signal.

I thoroughly agree with Captain Turner on the question of the last valve on the loud speaker amplifier. That valve has got to do work. It has got to push the diaphragm up and down, and in consequence it has got to have a certain number of watts coming into it, and these watts have got to be dissipated in the plate. Therefore you will, in my opinion, require a valve which has at least 20 volts sweep on the grid without affecting the straightness of the curve, and without running into grid current. I did not quite understand his point about bright and dull valves, but the dull emitter valve gives *me* exactly what the bright valve has given me and at much less cost. Therefore, I take off my hat to the dull emitter valve.

Mr. Lawes said he was shown round the **2 LO** studio, and was told by one of the staff there that the pedal notes of the organ were present, whereas my curves show a lamentable falling off in the bass. That gentleman will get the sack to-morrow. (*Laughter.*) My curves show that the pedal notes are present, but I admit not in their full ratio. The loud speaker, however, must do better before the lack is apparent.

Dr. Eccles spoke about our work, and I think he realises that we are aiming at perfection without fake.

Mr. Harris talked about condensers across loud speakers. I said I did not advise their use, as they may not give perfect integration as theory indicates.

That finishes my talk, and if it has been as interesting an evening to you as it has been to me, I am more than satisfied.

BROADCASTING.

REGULAR PROGRAMMES ARE BROADCAST FROM THE FOLLOWING EUROPEAN STATIONS :—

GREAT BRITAIN.

ABERDEEN, 2 BD, 495 metres; **BIRMINGHAM 5 IT,** 475 metres; **GLASGOW 5 SC,** 420 metres; **NEWCASTLE 2 NO,** 400 metres; **BOURNEMOUTH 6 BM,** 385 metres; **MANCHESTER 2 ZY,** 375 metres; **LONDON 2 LO,** 365 metres; **CARDIFF 5 WA,** 351 metres; **PLYMOUTH 5 PY** (Relay), 335 metres; **EDINBURGH 2 EH** (Relay), 325 metres; **SHEFFIELD** (Relay), 303 metres Tuesdays, Thursdays and Fridays, 1 p.m. to 2 p.m. (**2 LO** only). Regular daily programmes, 3.30 to 4.30 p.m., 5 to 10.30 p.m. Sundays, 3 to 5 p.m., 8.30 to 10.30 p.m.

FRANCE.

PARIS (Eiffel Tower), FL, 2,600 metres. 7.40 a.m. Weather Forecasts, 11.0 a.m. (Sunday); 12.0 noon, Market Report; 12.15 to 12.30 (Weekdays), Time Signal and Weather Forecast; 3.40 p.m., Financial Reports; 5.30 p.m., Bourse Closing Prices; 6.15 p.m., Concert; 8.0 p.m., Weather Report; 9.0 p.m. (Wednesday and Sunday), Concert; 10.10 p.m., Weather Forecast.

PARIS (Radiola), SFR, 1,780 metres. 12.30 p.m., Cotton Prices, News; 12.45 p.m., Concert; 1.30 p.m., Exchange Prices; 4.30 p.m., Financial Report; 5.0 p.m., Concert; 8.30 p.m., News and Concert.

PARIS (Ecole Superieure des Postes et Telegraphes), 450 metres. 3.45 p.m. (Wednesday), Talk on History; 8.0 p.m. (Tuesday), English Lesson; 8.30 p.m., Concert; 9.0 p.m., Relayed Concert or Play.

PARIS (Station du Petit Parisien), 340 metres. 8.30 p.m., Tests

BELGIUM.

BRUSSELS, BAV, 1,100 metres. At 2 p.m. and 6.50 p.m., Meteorological Forecast.

BRUSSELS ("Radio Electrique"), 265 metres. Daily, 5 p.m. and 8.30 p.m., Concert.

HOLLAND.

THE HAGUE, PCGG, 1,070 metres. 4 to 6 p.m. (Sunday), 9.40 to 11.40 p.m. (Monday and Thursday), Concerts.

THE HAGUE (Heussen Laboratory), PCUU, 1,050 metres. 10.40 to 11.40 a.m. (Sunday), Concert; 9.40 to 10.40 p.m., Concert; 8.45 to 9 p.m. (Thursday), Concert.

THE HAGUE (Velthuisen), PCKK, 1,050 metres, 9.40 to 10.40 p.m. (Friday), Concert.

HILVERSUM, 1,050 metres. 9.10 to 11.10 (Sunday), Concert and News.

IJMUIDEN (Middelraad), PCMM, 1,050 metres. Saturday, 9.10 to 10.40 p.m., Concert.

AMSTERDAM, PA 5, 1,050 metres (Irregular), 8.40 to 10.10 p.m., Concert.

AMSTERDAM (Vas Diaz), PCFF, 2,000 metres, 9 a.m. and 5 p.m., Share Market Report, Exchange Rates and News.

DENMARK.

LYNGBY, OXE, 2,400 metres. 8.30 to 9.45 p.m. (weekdays), 8 to 9 (Sunday), Concert.

SWEDEN.

STOCKHOLM (Telegrafverket), 440 metres. Monday, Wednesday and Saturday, 7 to 9 p.m. Sunday, 11 to 12 a.m.

STOCKHOLM (Radiobolaget), 470 metres, Tuesday and Thursday, 7 to 9 p.m. Sunday, 6 to 8 p.m.

GOTHENBURG (Nya Varvet), 700 metres. Wednesday, 7 to 8 p.m.

BODEN, 2,500 metres. 6.0 to 7.0 p.m., Concert.

GERMANY.

BERLIN (Koenigswusterhausen), LP, 2,370 metres (Sunday), 10.40 a.m. to 11.45 a.m., Orchestral Concert. 4,000 metres, 7 to 8 a.m., Music and Speech; 12.30 to 1.30 p.m., Music and Speech; 5.0 to 5.30 p.m., News.

EBERSWALDE, 2,930 metres. Daily, 1 to 2 p.m., Address and Concert; 6 to 7.30 p.m., Address and Concert; Thursday and Saturday, 7.20 p.m., Concert.

BERLIN (Vox Haus), 400 metres. 11 a.m., Stock Exchange; 1.55 p.m., Time Signals; 5.40 to 7 p.m., Concert; 7 to 8 p.m. (Sunday), Concert.

BERLIN (Telefunken), 425 metres. 7.30 to 8 p.m. and 8.45 to 9.30 p.m., Tests and Concert.

BERLIN (Funkstunde A.G.), 726 metres.

FRANKFURT AM MAIN, 460 metres. 7.30 to 10 p.m. Tests, Gramophone records.

LEIPZIG (Mitteldeutsche Rundfunk A.G.), 450 metres.

MUNCHEN (Die Deutsche Stunde in Bayern), 486 metres.

AUSTRIA.

VIENNA (Radio-Hekaphon), 600 metres.

CZECHO-SLOVAKIA.

PRAGUE, PRG, 1,800 metres. 8 a.m., 12 a.m. and 4 p.m., Meteorological Bulletin and News; 4,500 metres, 10 a.m., 3 p.m. and 10 p.m., Concert.

KBELY (near Prague), 1,150 metres. 7.15 p.m. and 10 p.m., Concert and News.

SWITZERLAND.

GENEVA, 1,100 metres (Weekdays). At 3.15 and 8 p.m., Concert or Lecture.

LAUSANNE, HB 2, 780 metres. Daily, 9.15 p.m., Concert and Address.

SPAIN.

MADRID, PTT, 400 to 700 metres. 6 to 8 p.m., Tests.

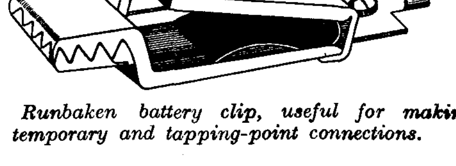
MADRID (Radio Iberica), 392 metres. Daily (except Thursdays and Sundays), 7 to 9 p.m. Thursdays and Sundays, 10 to 12 p.m., Concerts.

MADRID, 1,800 metres. Irregular.

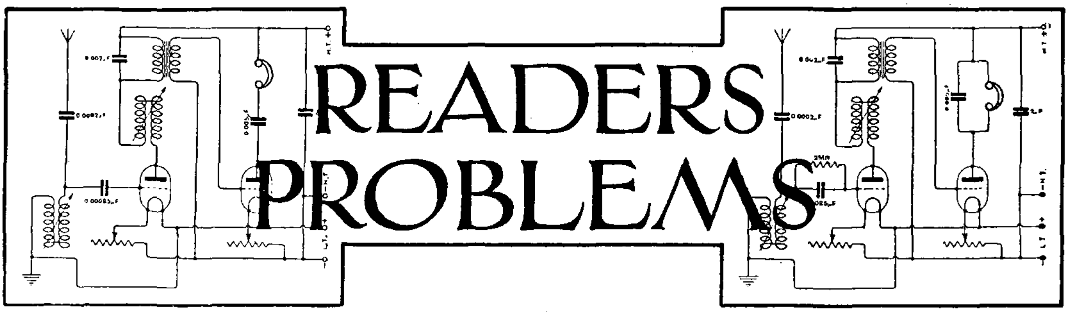
CARTAGENA, EBX, 1,200 metres, 12.0 to 12.30 p.m., 5.0 to 5.30 p.m., Lectures and Concerts.

ITALY.

ROME, ICD, 3,200 metres. Weekdays, 12 a.m. 1,800 metres, 4 p.m. and 8.30 p.m., Tests, Gramophone Records.



The Runbaken battery clip, useful for making temporary and tapping-point connections.



READERS PROBLEMS

*1. All questions are answered through the post. A selection of those of general interest is published. 2. Not more than four questions may be sent in at any one time. 3. Every question should be accompanied by a postal order for **1/-**, or **3/6** for four questions, and by a coupon taken from the current issue. 4. A free coupon appears in the first issue of each month, and if this is sent in together with coupons from the three previous issues, the reader is entitled to have one question answered free of charge.*

"*H.D.H.*" (*Boston*) **asks if there is any special method of connecting the fixed and moving vanes in variable condensers.**

It is always better to connect the moving plates of the condenser with a point of fixed potential; thus, the moving vanes of a condenser used to tune the A.T.I. should be connected to earth, while the moving vanes of an anode tuning condenser should be connected to + H.T.

"*B.M.G.*" (*Basingstoke*) **submits a diagram of a dual amplification circuit, and asks why the tuning of the receiver should be affected when the telephones or loud speaker are touched with the hand.**

We notice that in the diagram submitted the loud speaker is connected between the tuned anode coil and the plate of the valve. If you reverse the positions of these components, thus connecting one side of the loud speaker to +H.T., it is probable that your difficulties will disappear, since the positive side of the H.T. battery is a point of fixed potential. In the original circuit the high frequency potential of the loud speaker with respect to earth is continually changing, and any capacity between the loud speaker and earth will be shunted across the plate filament circuit of the valve.

"*W.W.*" (*Farnborough*) **sends particulars of a transformer coupled H.F. amplifier, and asks by what means the selectivity may be improved.**

The flatness of tuning in your existing H.F. transformers is due to the resistance introduced into the circuit by the use of No. 42 S.W.G. wire. The use of a tuning condenser would not improve the selectivity, and the only method of doing this would be to use a thicker gauge of wire, in order to reduce the ohmic resistance. An excellent H.F. transformer, having a very sharp resonance curve, could be constructed by coupling together two duolateral coils. For a wavelength of approximately 2,000 metres, two No. 600 Igranic coils would be suitable. The primary winding should be tuned by a variable condenser of not more than 0·0005μF capacity.

"*S.L.*" (*Birmingham*) **sends a description of his receiver, and asks if the use of a rejector circuit would enable him to eliminate the transmissions from 5 IT.**

Unless great care is taken in the construction and adjustment of the coils and condensers in the rejector circuit, this method of reducing interference will not be so effective as the use of a coupled aerial circuit. We recommend that you couple a reaction coil to the secondary tuning circuit. There will be no danger of causing interference through the use of this reaction coil, unless the coupling is made close enough to cause the set to oscillate. The use of reaction and a loosely coupled aerial circuit should give all the selectivity required, and we recommend that you use a rejector circuit only as a last resort.

"*H.J.J.*" (*Ilford*) **asks why buzzing noises should be heard on certain studs of the selector switch of his crystal receiver.**

The buzzing noises which you hear are probably due to a break in the wire between the switch stud and the tapping on the coil, or to a poor contact between the stud and the switch arm. The noises are usually caused by earth currents due to neighbouring electrical machinery, trams or lighting mains. If you listen carefully, you will no doubt be able to distinguish the characteristic hum of a dynamo commutator. This phenomenon is well known, and is often useful in indicating the location of a broken wire in a receiving set.

"*H.P.*" (*Lancashire*) **has built a resistance coupled L.F. amplifier which does not function properly until the valves have been switched on for about half a minute.**

We note that the coupling condensers which you are using have a capacity of 2μF, and that the grid leaks have a resistance of the order of 1 megohm. The time taken for the charge on the condenser to adjust itself to the redistribution of potential when the valve filaments are switched on is therefore comparatively long. The obvious remedy is to reduce the size of the coupling condensers. In practice the actual capacity of these condensers is not critical, and may lie between 0·01 and 0·1 μF. You may find it an advantage to use a lower resistance grid leak, say 0·5 megohms.

"*B.R.*" (*Petrograd*) **asks if the light rays emitted from the filament of a valve have any effect upon the valve characteristics and the functioning of the valve.**

The light rays of short wavelength in the ultra-violet region of the spectrum will cause electrons to be emitted, under the influence of the photo-electric effect, from the parts of the grid and plate upon which they fall. The number of electrons freed in this way constitutes only a very small fraction of the electron emission from the filament, and it is doubtful if their effect upon the characteristic of the valve could be detected.

"*H.G.W.*" (*Sheldon*) **refers to the circuit given on page 525 of the issue of January 23rd, 1924, and states that he cannot observe any change in signal strength when the detector valve is switched off.**

The effects which you observe seem to point to the fact that the radio frequency choke is not functioning properly. The self-capacity of this coil must be kept at an absolute minimum, since radio frequency currents will be passed by any stray capacities which may exist. If you intend to work chiefly on the B.B.C. band of wavelengths, you might find it an advantage to substitute a basket coil consisting of 300 turns of No. 36 D.S.C. for the cylindrical choke coil described in the original article. The minimum amount of insulating varnish or paraffin wax should be used in the construction of the coil, which for preference should be self-supporting.

"*A.M.W.*" (*London, S.E.*8) **submits a diagram of a single-valve transformer-coupled H.F. amplifier, and asks if we can suggest any reasons why it should not function properly.**

The connections of the circuit are correct, and assuming that the wiring of your instrument corresponds with the diagram, we can only suggest the following causes for failure: (1) That the reaction coil is reversed. (2) That the wiring of the H.F. transformer does not correspond with the wiring of the valve plug into which it is inserted; (3) That the tuning range of the H.F. transformer does not correspond with the tuning range of the A.T.I. If you give attention to these three points, we do not think you will have any difficulty in getting the amplifier to work.

"*H.G.T.*" (*Dundalk*) **asks if it is necessary to use insulated wire for the lead-in between the horizontal part of the aerial and the point where the aerial enters the house.**

There is no necessity to use insulated wire for the whole of the lead-in portion of the aerial. The insulation of the point where the aerial enters the house should, however, receive very careful attention, and it is important to ensure that the wire is bent in such a way that rain water will run off the wire before reaching the insulator. The lead-in wire must be kept well away from the wall of the building if efficiency is to be obtained. If the wire runs parallel with the wall for about 15 or 20 ft., the average distance from the wall should be between 5 and 10 ft.

"*C.V.W.*" (*Tamworth*) **wishes to include a milliammeter in his receiver circuit, and asks at what point in the circuit the meter should be connected.**

The correct place to connect a milliammeter is between the negative side of the H.T. battery and the L.T. battery. With regard to the range required for a four-valve receiver, allowing a reading of 2 milliamperes per valve, you will require an instrument measuring from 0 to 10 milliamperes. If power valves are used in any part of the receiver, it will be necessary to allow more than 2 milliamperes for these valves.

"*F.A.*" (*Wakefield*) **asks if it would be practicable to use plug-in type H.F. transformers in the Neutrodyne receiver.**

We are afraid that you will not be able to use a series of these transformers in order to cover a wider range of wavelength, because the balancing capacities will have to be changed each time the values of inductance and capacity in the grid and plate circuits are changed. The balancing of the stray capacities is a somewhat delicate matter, and would take quite a considerable time.

"*G.B.*" (*Staines*) **asks if there is any danger of damaging receiving valves when the receiver is adjusted to give loud and distorted music.**

There is no fear of damaging the valves when they are producing distorted speech and music. The only way in which they could be permanently damaged is by applying an excessive H.T. voltage and burning the filaments too brightly.

"*W.B.*" (*Wellington*) **asks if the bridge method of recording wireless signals can be recommended for amateur use.**

The bridge method is somewhat critical in operation, and we think that you would obtain better results by using the method suggested in the article entitled "The Automatic Recording of Wireless Signals," by E. R. Batten, in the issue of October 24th, 1923. If this method is used, it will be possible to connect the Siemens relay to the receiver by means of a telephone plug in the manner which you suggest.

"*H.B.*" (*Southampton*) **asks the reason for distortion and whistling noises which occur in his receiver.**

The distortion which you experience is due to the fact that your receiver is continually in a state of self-oscillation. When telephony is being correctly received, it should not be possible to hear the whistle caused by the carrier wave when the receiver is slightly detuned from the wavelength of the transmitting station. It is possible that you will have difficulty in preventing self-oscillation if both the aerial and reaction circuits are tuned. We therefore recommend that you use an untuned reaction coil having a natural wavelength less than that of the lowest wavelength which it is required to receive.

"*E.A.A.*" (*Edinburgh*) **asks if tables are published giving the diameters, in inches and millimetres, of the various numbers in the standard wire gauge.**

A complete list of the gauges of wire in common use is given on page 111 of "The Wireless Annual."

Calls Heard

Contributors to this section are requested to limit the number of calls sent in to those heard in the previous three weeks, these being of greater interest and value to transmitters than earlier records. The repetition of the same call sign in consecutive lists is not recommended. Contributors will also assist by kindly arranging reports in alphabetical order. Full address (not for publication) should be given to enable correspondence to be forwarded.

Mablethorpe, Lincolnshire.
2 AQ, 2 CA, 2 CT, 2 JU, 2 KG, 2 OQ, 2 VJ, 2 XC, 2 XD, 2 XG, 5 FH, 5 HA, 5 IK, 5 MT, 5 OC, 5 OT, 5 RQ, 5 UG, 5 UO, 5 WK, 6 AA, 6 NH, 6 NO, 6 TM, 6 ZX, 8 AAA, 8 AE3, 8 AQ, 8 CN, 8 CK, 8 DN, 8 GV, 8 JC, 8 MM, 8 ML, 8 QI, 8 R3, 8 RO, 0 BW, 0 MS, 0 PC, 0 PG, 0 RB, 0 XW, 0 ZW, PCRR. Miscellaneous: **9 AA, 9 BV, 7 BG, 8 XBH, W 2, 4 C2.** J. Marlow.

Stockton-on-Tees (March 29th and April 14th).
2 IB, 2 SH, 2 TA, 2 WJ, 2 XA, 5 AW, 5 BT, 5 BV, 5 DN, 5 JX, 5 MO, 5 SI, 6 AL, 6 UD, 8 BV, 8 CZ, 8 DN, 8 EB, 8 RO, 0 AG, 0 KV, 0 MR, 0 NY, 0 XQ, 0 ZN. J. W. Pallister.

Edinburgh (March 24th to April 14th).
British: **2 DR, 2 GG, 2 KF, 2 KW, 2 MM, 2 NM, 2 OD, 2 SZ, 2 TC, 2 UV, 2 WJ, 2 XAA, 2 XQ, 2 XY, 2 ZT, 5 BV, 5 DN, 5 FD, 5 HA, 5 IK, 5 KO, 5 MO, 5 NN, 5 NW, 5 PY, 5 QV, 5 SI, 5 SZ, 5 US, 6 BY, 6 CV, 6 DW, 6 TD, 6 UD, 6 WH, 6 XY.** U.S.A.: **1 AFN, 1 AKL, 1 AVJ, 1 AVW, 1 BDX, 1 VC, 1 XAB, 1 XAH, 1 XJ, 1 XZ, 2 AGB, 3 PZ, 4 XE, 8 BPN, 8 PL.** Canadian: **1 AF, 1 BQ, 1 BT, 1 DT, 1 EF, 2 BN, 3 MS, 9 BI.** French: **8 AB, 8 AE3, 8 AP, 8 AQ 8 BM, 8 BV, 8 CM, 8 DA, 8 DC, 8 DN, 8 DP, 8 ÉB, 8 JD, 8 RO.** Dutch: **0 AA, 0 AG, 0 NN, 0 NY, 0 ZN.** Swiss: **XY.** Belgian: **W2** Italian: **1 ER.** (o—v—1 or o—v—o) M. G. Scroggie.

Harrow.
2 AS, 2 ABR, 2 AKS, 2 BZ, 2 CA, 2 DY, 2 GO, 2 ID, 2 KG, 2 MK, 2 MO, 2 OM, 2 PX, 2 PY, 2 QC, 2 SF, 2 SO, 2 SZ, 2 UV, 2 VW, 2 VY, 2 WD, 2 XO, 2 XQ, 2 XZ, 2 YR, 2 ZA, 2 ZO, 2 ZY, 2 ZZ, 5 BT, 5 CB, 5 CF, 5 CP, 5 CV, 5 DK, 5 DT, 5 HY, 5 HW, 5 IO, 5 LN, 5 LP, 5 OB, 5 OP, 5 OX, 5 OY, 5 PU, 5 UL, 5 UO, 5 VR, 5 XT, 5 ZL, 6 BO, 6 DW, 6 IM, 6 IV, 6 KI, 6 OB, 6 PD, 6 QA, 6 VO, 6 WV, 6 WX, 6 ZX. (o—v—o). T. A. Studley.

Edgbaston, Birmingham. (April 15th to 29th)
2 AC, 2 AEX, 2 ADX, 2 AHH, 2 DU, 2 FQ, 2 GG, 2 HF, 2 HV, 2 HA, 2 JP, 2 KO, 2 KF, 2 KR, 2 KQ, 2 LV, 2 LT, 2 NV, 2 NP, 2 NM, 2 OX, 2 OP, 2 OM, 2 PV, 2 QR, 2 RQ, 2 SY, 2 SV, 2 SH, 2 TR, 2 VB, 2 WF, 2 WB, 2 WQ, 2 YC, 2 YZ, 2 YD, 5 BV, 5 FI, 5 IY, 5 KD, 5 KO, 5 PX, 5 NH, 5 RI, 5 WO, 5 YS, 5 YI, 5 YW, 6 AG, 6 HS, 6 KRG, 6 MJ, 6 PW, 6 MQ, 6 UU, 6 XH, 6 XX, 8 AB, 0 MX, 0 YS. (One to five valves.) G. C. Curtis (**5 VB.**)

Liverpool (April 1st to 30th).
2 AAN, 2 ABW, 2 AHT, 2 AKS, 2 AOI, 2 ARL, 2 II, 2 KW, 2 MG, 2 ZK, 2 ZU, 5 AY, 5 BF, 5 CK, 5 CR, 5 DC, 5 FD, 5 GB, 5 LB, 5 ML, 5 NX 5 OL, 5 QM, 5 RZ, 5 UO, 5 VK, 6 IL, 6 JQ, 6 KB, 6 KK, 6 LB, 6 LC, 6 NI, 6 OM, 6 OX, 6 RS, 6 SC, 6 SD, 6 SH, 6 TB, 8 CN, 8 ED, 8 FN, 8 HR, 8 JD, 8 ZM, 0 BA, 0 FN, 0 MN, 0 MR, 0 NN, 0 PC. F. W. Davies.

Edmonton, N. 18 (April 6th to 23rd). (On 185 metres approx.).
2 AP, 2 CW, 2 DR, 2 KA, 2 MC, 2 QR, 2 RB, 2 TF, 2 US, 2 XM, 2 ARX, 2 ASE, 5 MO, 5 SN, 5 ST, 5 SU, 5 UG, 5 US, 5 QM, 6 BT, 6 QR, 6 XG, 6 ZR, 7 EC, 7 ZM, 8 AU, 8 BM, 8 CA, 8 CD, 8 CH, 8 DA, 8 DO, 8 DP, 8 IP, 8 LD, 8 LM, 8 RO, 8 SP, 8 ZM, 8 AE3, 9 AA, 0 AAL, 0 CAL, 0 ST, 1 TU.
(o—v—1.) J. O. J. Hudson.

Woldingham, Surrey (April 1st to 21st).
2 BZ, 2 CA, 2 KC, 2 KF, 2 KT, 2 NM, 2 OV, 2 QC, 2 TQ, 2 VW, 2 XO, 2 XP, 2 XR, 5 AC, 5 BV, 5 DT, 5 FL, 5 IO, 5 OX, 5 PZ, 5 RZ, 5 UL, 5 UO, 5 WN, 5 XN, 6 IM, 6 IO, 6 NS, 6 OJ, 6 PD, 6 PL. (Single valve.) C. Spencer White.

Islington, London, N.1 (March 9th to 30th).
2 ABR, 2 ABZ, 2 ACU, 2 AU, 2 GO, 2 IF, 2 JU, 2 JX, 2 KD, 2 KF, 2 KT, 2 LH, 2 NM, 2 OM, 2 OS, 2 PW, 2 PX, 2 PY, 2 QC, 2 SH, 2 TA, 2 VW, 2 VY, 2 WE, 2 XAA, 2 XO, 2 YT, 5 AC, 5 AS, 5 AW, 5 BB, 5 BF, 5 BT, 5 BV, 5 CF, 5 CP, 5 CV, 5 DT, 5 IO, 5 JJ, 5 KC, 5 LN, 5 LP, 5 LZ, 5 NN, 5 OF, 5 OT, 5 OX, 5 OY, 5 PD, 5 PF, 5 PZ, 5 QV, 5 RZ, 5 SI, 5 TR, 5 UL, 5 WV, 5 XE, 5 XT, 5 ZO, 6 AT, 6 BJ, 6 BV, 6 BY, 6 DJ, 6 DW, 6 FG, 6 IM, 6 IV, 6 JT, 6 KI, 6 MH, 6 PD, 6 QA, 6 QB, 6 QV, 6 RY, 6 SO, 6 SY, 6 TM, 6 UF, 6 VO, 6 VR, 6 XG, 6 XX. Foreign: **0 AA, 0 BA, 0 DX, 0 KX, 0 NN.** American: **1 XAH, 1 XAM, 2 XI.** Belgian: **P2.** Dutch: **PCII, PCTT.** French: **8 AAA, 8 CN, 8 DX, 8 ÉB, 8 ÉM,** Unknown: **1 KF.** (1—v—o or 1—v—1.) Clemence Bradley.

Forest Gate, London, E.7 (April 6th to 26th).
British: **2 AD, 2 AU, 2 CF, 2 DR, 2 JX, 2 KF, 2 KT, 2 NA, 2 NM, 2 OD, 2 PC, 2 PW, 2 PX, 2 SH, 2 VJ, 2 VW, 2 WJ, 2 WY, 2 XD, 2 XQ, 2 XR, 2 XT, 2 XX, 2 YQ, 2 BBN, 5 AW, 5 CS, 5 DN, 5 FS, 5 IK, 5 KO, 5 LF, 5 LH, 5 LZ, 5 MO, 5 NN, 5 OT, 5 SI, 5 TR, 5 UL, 5 US, 5 VX, 5 XS.** French: **8 AAA, 8 AB, 8 AG, 8 AP, 8 AU, 8 BA, 8 BF, 8 BL, 8 BM, 8 BP, 8 BV, 8 CF, 8 CN, 8 CT, 8 CZ, 8 DA, 8 DN, 8 DP, 8 EB, 8 ÉD, 8 ÉM, 8 JC, 8 IP, 8 ML, 8 PX, 8 RO, 8 SSU, 8 WV.** Italian: **ACD, 1 ER.** Dutch: **0 AA, 0 GX, 0 MR, 0 NV, 0 WS, 0 XP, 0 ZN, P2, PCRR.** Belgian: **4 C2, W.2** Spanish: **9 AA.** Unknown: **4 AA.** American: **1 AJA, 1 AJP, 1 BC, 1 BLB, 1 BSD, 1 CAK, 1 DZ, 1 XJ, 1 XW, 1 XZ, 1 XAC, 1 XAH, 1 XAM, 1 XAP, 2 CLA, 2 CXN, 2 JD, 2 XAN, 3 BG, 3 CK, 3 CCJ, 3 CDN, 3 MB, 3 PZ, 3 XAQ, 3 XAR, 5 MI, 5 XAT, 8 AOL, 8 BPN, 8 FL, 8 XAB, 9 XAX.** Canadian: **1 AR, 1 BQ, 1 DD, 1 DJ, 1 DT, 1 EF, 2 BE, 2 BG, 2 BN, 2 CG, 3 ADN, 9 BL.** (o—v—o or o—v—1.) W. J. Tarring.

Northampton. (Telephony).
2 AFL, 2 BO, 2 BZ, 2 DU, 2 GG, 2 HF, 2 IL, 2 JR, 2 KO, 2 KV, 2 LX, 2 NP, 2 NV, 2 OM, 2 QC, 2 QR, 2 SY, 2 TV, 2 WM, 2 XG, 2 XH, 2 YX, 5 CP, 5 FI, 5 IO, 5 KD, 5 KW, 5 OK, 5 OY, 5 YS, 6 IM, 6 MJ, 6 ZX. (Telegraphy.) **2 DR, 2 IB, 2 JP, 2 LH, 2 LZ, 2 NA, 2 NM, 2 SU, 2 TO, 2 UV, 2 WJ, 2 WY, 2 XY, 5 AU, 5 AW, 5 CS, 5 GL, 5 HN, 5 IK, 5 ML, 5 MO, 5 RQ, 5 SI, 5 SN, 5 SU, 5 SZ, 5 VA, 5 WV, 6 HU, 6 RY, 6 TD, 6 TM, 6 UD, 0 BA, 0 MR, 0 XO, 0 XQ, 0 ZN, 1 CF, 4 TU, 4 C2, 7 ZM, 8 AG, 8 AM, 8 AQ, 8 BA, 8 BP, 8 CH, 8 CN, 8 CT, 8 CZ, 8 DA, 8 DI, 8 DO, 8 DP, 8 DX, 8 DY, 8 ÉM, 8 ÉO, 8 HR, 8 JC, 8 JD, 8 JP, 8 ML, 8 PX, 8 RO, 8 RV, 8 SSU, 8 XM, 9 AA, W2, P2, PCRR.** (1—v—o.) W. F. B. Shaw.

London, S.E.27.
2 AIH, 2 AKS, 2 ARX, 2 GG, 2 GO, 2 LH, 2 MP, 2 G, 2 OG, 2 VY, 2 YT, 5 AW, 5 DG, 5 NH, 5 LN, 5 ST, 6 BU, 6 BY, 6 CH, 6 FG, 6 GY, 6 IP, 6 OB, 6 GA, 6 TD, 6 XX, 7 BG, 8 CK, 8 DC, 8 DD, 8 DN, 8 DO, 8 IO, 8 JC, 8 JD, 8 ML, 8 RL, 8 RO, 8 ZM, 8 ZY, 0 NN, 0 BA, 0 BR, 0 MR, 2 XAA, 2 XAO, W2, 9 AB, 1 XAM. (o—v—o.) L. F. Aldous.

Finchley, London, N.3 (28th March to 18th April).
2 ABR, 2 ABZ, 2 DR, 2 JU, 2 KF, 2 KX, 2 LH, 2 NF, 2 NM, 2 OG, 2 QC, 2 SF, 2 TA, 2 TO, 2 UY, 2 WJ, 2 WY, 2 XA, 2 XG, 2 XY, 2 YQ, 2 ZT, 5 AS, 5 AW, 5 BA, 5 BT, 5 CS, 5 GF, 5 GL, 5 HN, 5 IK, 5 KO, 5 LZ, 5 MO, 5 NN, 5 SI, 5 SO, 5 XC, 5 XK, 6 BO, 6 BY, 6 CV, 6 EA, 6 FD, 6 IM, 6 QO, 6 RY, 6 TU, 6 TM, 6 VP, 6 XG, 6 XT, 6 XX. French: **8 AE, 8 AE3, 8 AG, 8 BM, 8 BP, 8 BV, 8 CN, 8 CZ, 8 DI, 8 DN, 8 DP, 8 DY, 8 EI, 8 EM, 8 GV, 8 JC, 8 JD, 8 RO, 8 SSU, 8 TY.** Dutch: **0 AA, 0 BA, 0 HA, 0 MS, 0 NN, 0 XO, 0 XQ, 0 ZN, P2.** Italian: **1 CF, 1 ER.** (Single valve.) W. F. & L. R. M. Adams.

Northampton (March 29th to April 30th). (Telephony).
2 AFL, 2 AIP, 2 DU, 2 DY, 2 GG, 2 HF, 2 IL, 2 KO, 2 KV, 2 LX, 2 MZ, 2 NP, 2 NV, 2 OM, 2 OX, 2 PV, 2 QC, 2 QR, 2 SF, 2 ST, 2 SY, 2 TN, 2 TV, 2 VQ, 2 VY, 2 WD, 2 WM, 2 XG, 2 XO, 2 XZ, 2 YV, 2 YX, 5 BP, 5 DY, 5 FI, 5 KD, 5 KW, 5 YI, 5 YS, 6 GX, 6 IM, 6 MJ, 6 QO, 6 QV, 6 ZX. Morse: **2 JP, 2 PL, 2 RB, 2 SZ, 2 TO, 2 WY, 2 XY, 5 BV, 5 FV, 5 IK, 5 JJ, 5 KO, 5 MO, 5 NH, 5 OC, 5 OT, 5 SZ, 5 VP, 5 YW, 6 AL, 6 GY, 6 HU, 6 IV, 6 KN, 6 RY, 6 TD, 6 TM, 6 UD, 6 VP, 1 CF, 0 MR, 0 PC, 0 ZN, 4 ZZ, 7 EC, 8 AG, 8 AU, 8 BA, 8 BP, 8 CN, 8 DY, 8 JC, 8 JD, 8 RL, 8 RM, 8 SSU, 9 AA, W2.** (1—v—o.) P. H. B. Trasler.

Rock Ferry, Cheshire (Sunday, April 20th).
2 II, 2 AAM, 2 ADP, 2 AHT, 5 BF, 5 DC, 5 HC, 5 HG, 5 LD, 5 LT, 5 NX, 5 OT, 5 VK, 6 IF, 6 IP, 6 LC, 6 LF, 6 LT, 6 RC, 6 RF. (1—v—2). R. H. H.

London, S.E.
2 AH, 2 AU, 2 CA, 2 DR, 2 ACU, 2 FA, 2 KF, 2 KOA, 2 JU, 2 PU, 2 VJ, 2 VY, 2 XAA, 2 XG, 2 XP, 2 YQ, 2 ZK, 2 ZO, 2 ZT, 5 OC, 5 DN, 5 CS, 5 IK, 5 IO, 5 KO, 5 OXT, 5 VP, 5 SZ, 5 WN, 6 BR, 6 BT, 6 CV, 6 DA, 6 GG, 6 IV, 6 NF, 6 NS, 6 ON, 6 TM, 6 VP, 6 VR, 6 XG, 0 NN, 0 NY, W 2, 7 EC, 7 ZM, 8 CC, 8 CN, 8 DX, 8 EU, 8 DO. (o—v—1.) A. G. Nihcro.

Marstrand, near Gothenbourg, Sweden (15th March to 15th April).
2 AS, 2 AW, 2 DF, 2 DR, 2 LH, 2 OQ, 2 SH, 2 TO, 2 VR, 2 WD, 2 WK, 2 XG, 2 XY, 2 YT, 2 YZ, 5 AW, 5 CC, 5 FD, 5 FS, 5 GL, 5 GX, 5 KO, 5 KW, 5 MO, 5 NH, 5 OC, 5 OT, 5 SI, 5 SZ, 5 UP, 5 YV, 6 BJ, 6 BY, 6 NF, 6 TD, 6 VP, 6 WP, 6 XQ, 7 EC, 7 CM, 7 ZM, 8 AE, 8 BP, 8 CH, 8 CN, 8 DT, 8 DY, 8 ÉI, 8 ÉY, 8 GG, 8 JC, 8 MM, 8 QA, 8 RV, 8 SSU, 8 ZM, 0 BA, 0 BX, 0 KX, 0 MR, 0 NN, 0 PO, 0 RO, 0 ST, PC 33, P 2, W 2, 1 TH. (o—v—o.) Folke G. Jonsson.

Rome.
2 SH, 2 TE, 2 YT, 2 WJ, 2 NM, 2 PC, 5 FS, 5 KO, 8 AB, 8 AÉ, 8 AP, 8 BF, 8 BV, 8 CF, 8 CT, 8 CZ, 8 DA, 8 DC, 8 DF, 8 DN, 8 DU, 8 DD, 8 ÉB 8 ÉN, 8 CH, 8 JC, 8 LMT, 8 BBB, 8 CK, P 2, 0 KX, 0 AA, 0 NY, PCTT, 1 ER, 3 MB, ACD. Ascanio Niutta.

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CRYSTALS WHICH OSCILLATE & AMPLIFY

THE WIRELESS WORLD AND RADIO REVIEW

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Under the Supervision of W. JAMES.

CONTENTS

THE EDITOR will be glad to consider articles and illustrations dealing with subjects within the scope of the Journal. Illustrations should preferably be confined to photographs and rough drawings. The greatest care will be taken to return all illustrations and manuscripts not required for publication if these are accompanied by stamps to pay return postage. All manuscripts and illustrations are sent at the Author's risk and the Editor cannot accept responsibility for their safe custody or return. Contributions should be addressed to the Editor, " The Wireless World and Radio Review," 12 and 13, Henrietta Street, Strand, London, W.C.2.

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The WIRELESS WORLD AND RADIO REVIEW

OSCILLATING AND AMPLIFYING CRYSTALS

By Hugh S. Pocock, *Editor.*

It is an interesting fact that whilst many of the phenomena met with in the course of development of wireless telegraphy and telephony have been satisfactorily explained by theories put forward and confirmed time and again in experimental and research work, yet one of the earliest phenomena observed has so far defied a complete explanation.

We refer to the theory of the operation of the crystal detector and contact detectors in general. A great deal of work has been done in the way of investigating their properties and as much has been written on the subject, and yet no satisfactory theory has been advanced so far which will explain all the phenomena met with.

The glamour of the valve and the possibilities which its development introduced, certainly appears to have side-tracked research work on crystal detectors, but we believe that the time has now come when the crystal detector must again claim a great deal of attention and important developments seem likely to take place in the very near future. An article contributed by M. I. Podliasky in a recent issue of *Radio Electricité* revives interest in this subject.

New developments may always be looked for where no definite theories have been established, for without a clear view of the operation of a device to form some guide and basis for research, there must exist a vast unexplored field. Consequently, whilst one would hesitate to place any confidence in new ideas put forward which were contrary to established theories, yet here in the case of the crystal we have no excuse for being sceptical of new discoveries.

Amongst certain investigators there has for some little while past been what may almost be described as a presentiment that great possibilities still remain unexplored in the properties of crystal detectors, and we may refer in particular to articles now appearing in *The Wireless World and Radio Review*, contributed by Mr. James Strachan.

We believe that the first recorded observation on the production of oscillations by means of a crystal contact was made by Dr. W. H. Eccles. In May, 1910, he showed before the Physical Society of London a galena detector generating oscillations in an oscillatory circuit.

Comparatively recently a Russian engineer, M. Lossev, has been successful in obtaining really interesting results in connection with the production of oscillations and also obtaining amplification in the reception of wireless signals utilising crystals. Reference to his work is made by M. Podliasky in the article referred to above.

"Necessity," it is said, "is the mother of invention," and perhaps it may be that whilst in other countries the valve has been so universally adopted and so easy to obtain that other methods of reception and amplification have been ignored, the difficulties which no doubt existed in obtaining valves and other apparatus in Russia during recent years may have stimulated research in other directions leading to these results.

For obtaining these results, M. Podliasky appears to favour the employment of zincite-carbon or zincite-steel contacts, considering that these combinations lend themselves more readily than others tried to the production of relatively strong oscillations. There is no complication in the apparatus employed, the mounting of the crystal and its contact can be identical with the ordinary arrangement and where a carbon contact is used it has been proposed to employ the filament of an old carbon filament lamp. For the steel contact a fine steel wire may be used.

The zincite crystals must be properly selected, but according to *Radio Electricité*, even poor crystals can be converted into good ones by fusing the crystal in an arc and either breaking the crystal afterwards, so as to expose the clean surface, or by scraping off the bad conducting surface produced externally. In fusing the crystal manganese dioxide should be present.

In order to test a batch of crystals it is necessary that their characteristic curves should be taken and a crystal capable of producing oscillations will be recognised by the fact that at a critical potential a negative resistance kink in the characteristic curve will be observed. It may be necessary to search over the surface of the crystal for good points, but when once a point is found it is likely to be comparatively stable in its action.

In Fig. 1 we reproduce an illustration which accompanied the article above referred to, and from this it will be seen that two circuits are provided, a low frequency circuit L_2 C_1 which will give an audible note in the telephones when oscillations are produced, and a high frequency circuit L_1, C_2, to which the crystal can be switched over after satisfactory

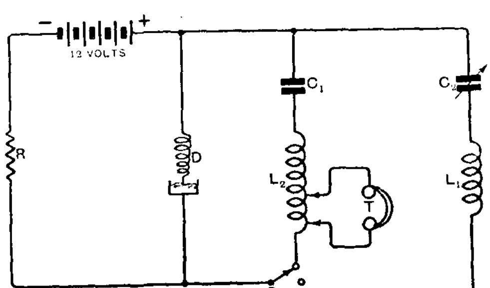


Fig. 1. An arrangement where a low frequency circuit is provided to test for oscillations.

oscillations have been started. This high frequency circuit can be tuned to the desired wavelength.

A dry battery of 40 volts is provided, and the potential applied to the crystal contact will be found to be between 5 and 30 volts, for obtaining good results, and it is mentioned that the internal resistance of the dry battery should not be too high.

The resistance R is of about 1,000 ohms, and the values for the capacities and inductances of the two circuits are given as follows :—L_2 = 0·1 henry. C_1 = 0·2 mfds. C_2 = 0·01 mfds. L_1 = 5 microhenries.

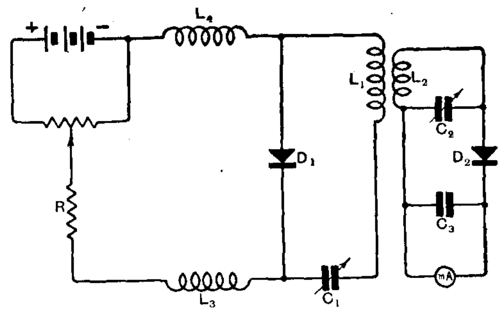


Fig. 2. Another circuit for reception of very short waves.

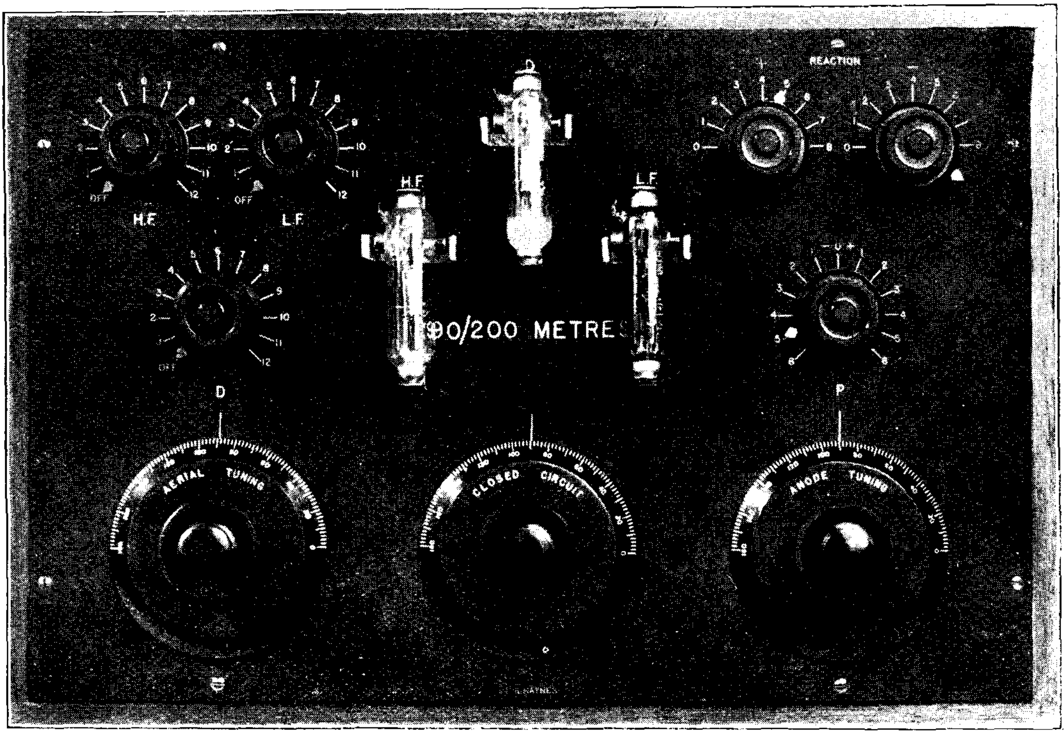
A low resistance telephone of about 300 ohms is used in this circuit. By switching to the circuit L_2, C_1, and by varying the potential and resistance value, audible oscillations can be heard in the telephones.

Fig. 2 shows another circuit with which it is claimed reception is possible on a wavelength of as low as 25 metres. Particulars of this circuit arrangement are as follows :—

The resistance R was 2,300 ohms ; the inductance coil L_1 of the circuit consisted of seven spirals of copper wire, 2 mm. diameter, wound as a solenoid of 5½ centimetres radius. The air dielectric condenser C_1 had a maximum value of 0·0003 mfds., L_3 and L_4 were choke coils consisting of 0·1 mm. wire, single layer, wound as a solenoid, their purpose being to prevent the passage of high frequency oscillations to the circuit containing the batteries and the resistance.

A wavemeter consisted of a coil L_2 (a single spiral of wire 2·2 mm. diameter, wound on a radius of 5·5 centimetres) and an air condenser C_2 of 0·006 mfds. A galena detector D_2 enabled readings of the maximum strength to be made by means of a galvanometer (micro-ammeter reading 100 microamperes). The galvanometer was shunted by a condenser C_3 of 0·0003 mfds.

We hope to be able to provide some further information regarding the employment of crystals in this way and in the meantime we should welcome reports of results obtained by our readers.



The long range short wave Receiver.

SHORT WAVE RECEIVER.

DESIGN FOR A LONG RANGE SET COVERING A WAVE BAND 90/200 METRES.

With the increasing interest taken in short wave work considerable attention is being given by experimenters to the construction of efficient receiving sets operating on wavelengths below 200 metres. The receiver described here has been developed essentially to meet this demand and contains much information that may be helpful when contemplating the construction of a short-wave set.

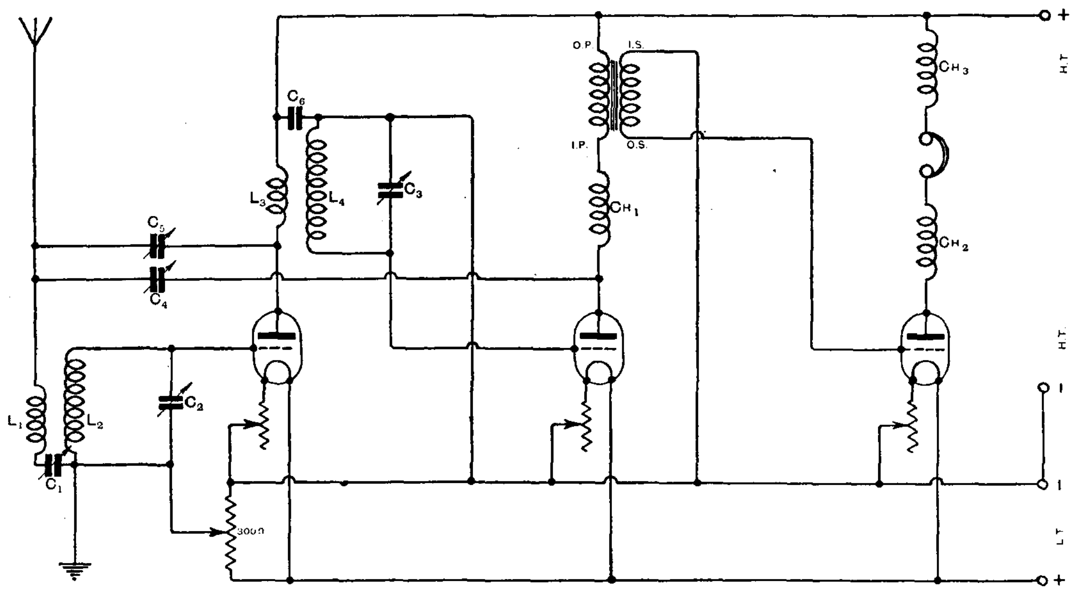
OWING primarily, no doubt, to the very successful transatlantic working on wavelengths of about 100 metres, and secondly by reason of the Postmaster-General's recent concession permitting experimental transmissions to be made on 115 to 130 metres, interest has been aroused in efficient receivers operating on these wavelengths.

Of the arrangements at present in use for reception on 100 metres, the most popular is probably a single circuit tuner with detector valve and reaction coil, followed, possibly, by a single-stage low frequency amplifier. There is, of course, the supersonic heterodyne receiver which is, perhaps, the best system for reception on these wavelengths, but it is doubtful if many experimenters care to undertake the construction of such an instrument in view of the large number of component parts required.

Difficulty encountered in the reception of short wavelengths can be almost summed up in the one word—capacity. It presents itself in the mounting of the electrodes of the valve, in the leading out wires in the pinch of the valve and is fairly liberally distributed throughout the connecting wires and the inductances, producing paths of low impedance which give rise to oscillation, damp out the received oscillations and self-oscillation, and drop the potentials applied to the valve grids. The reactance of a condenser (measured in ohms) is inversely proportional to its capacity and to the frequency, thus representing a very low value at the high oscillation frequency of wavelengths of 100 metres.

covering on insulated wire, when used for spacing the turns of an inductance, produces a self-capacity several times that given by an air spaced coil. The insulation on a wire in acting as a dielectric gives rise to losses, and these losses increase with frequency and so again, on short wavelengths where the frequency is high, it becomes necessary to use air dielectric inductances, air producing lower losses than other dielectrics. A minimum quantity of dielectric material should be allowed to be in the vicinity of the turns, the coils being as far as possible self supporting.

Another loss which increases with frequency



Short wave receiving circuit. Capacity reaction is employed, C_5 being arranged to stimulate oscillation and C_4 to suppress it.

The effect of distributed capacity in the tuning circuit should also be noted. The higher the self-capacity of the tuning inductances the more limited will be the wave range produced by a given tuning condenser. Hence it is most important to aim at an absolute minimum of distributed capacity in the inductance windings. This can only be achieved by increasing the spacing between the turns to a distance equal to about the diameter of the wire and also doing away with the insulated covering and employing air spacing. The

is the high frequency resistance, and consequently the wire employed should be of liberal gauge and have an enamel covering to preserve the surface of the wire in a clean bright condition. Constructional details of the inductances are given later.

Proceeding to the circuit, it will be noticed from the diagram that a series tuned aerial circuit C_1, L_1, is employed moderately tightly coupled to a tuned closed circuit C_2, L_2. To limit the number of tuning adjustments it was at first thought possible to tune the aerial and closed circuits by the closed circuit condenser alone, but it was found with the entire aerial coil coupled to the closed circuit that self-oscillation disappeared at a setting when the wavelength was approximately the fundamental of the aerial. It became necessary, therefore, to break up the aerial circuit either by adding an external inductance or a series condenser, the latter being adopted as it gives sharper and more critical tuning, oscillation is more easily produced and controlled, and signal strength is greater.

It has also been stated with regard to transmission that the elevation of the emitted wave is dependent upon the ratio of inductance to capacity in the series tuned aerial circuit. If this is the case it is an important factor, for the vertical component will govern the location of the point of reflection from the Heaviside layer and hence particular ratios of inductance to capacity should be adopted for communication over given distances. Assuming this argument to be correct, the effect should not be overlooked in the receiving circuit where, no doubt, the same properties exist.

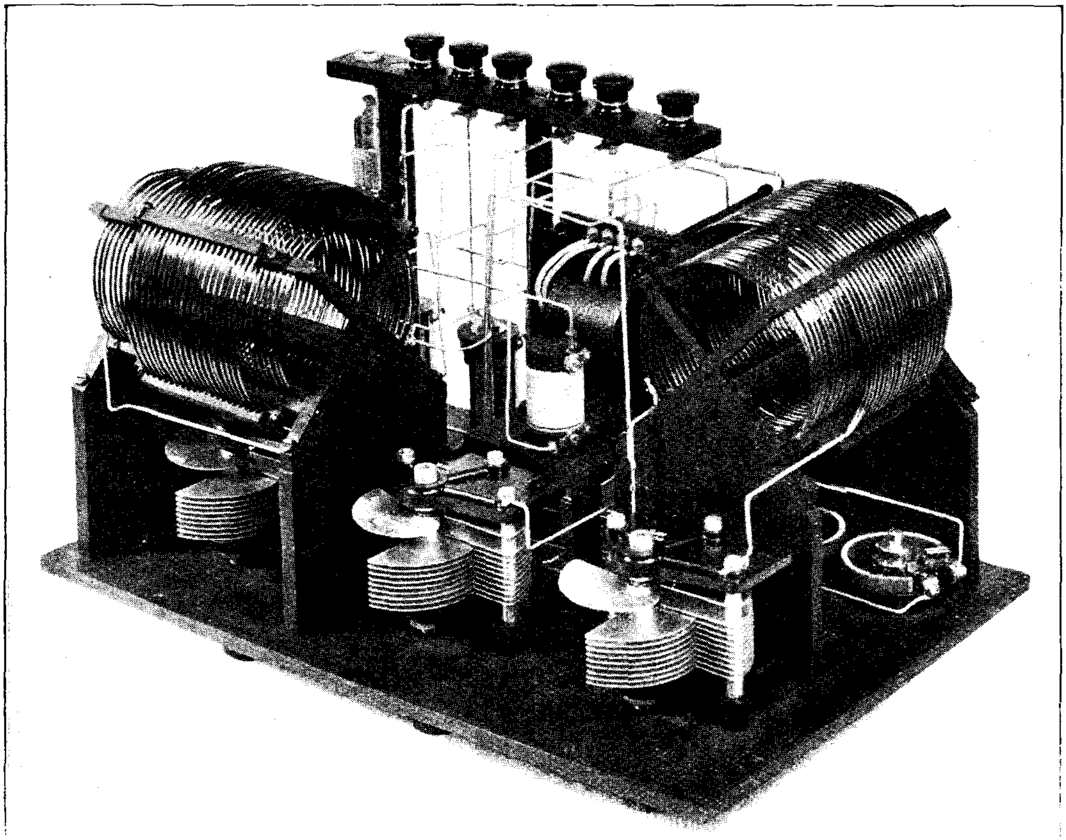
The aerial tuning condenser C_1 is connected on the earth side of the inductance L_1, an arrangement which is not permissible with single circuit tuners, but possible here as it is not short circuited by the capacity to earth of the filament heating battery and other apparatus on the circuit. It is connected on the earth side so that its moving plates may be at earth potential and " hand effects," such as are sometimes produced when tuning, obviated. The tuned closed circuit is also earth connected so as to create a definite earth potential point throughout the set and to eliminate " hand effects " when operating the closed circuit and transformer tuning condensers, C_2 and C_3, which have their moving plates connected to points in the circuit, which are at a low high-frequency potential.

It is desirable to stimulate some degree of oscillation in the aerial circuit to compensate for the damping produced by radiation, resistance and capacity and the feed-back condenser C_5 is introduced for this purpose. To accomplish this it is necessary to arrange the relative direction of winding of the inductances L_1 and L_2 correctly and as one coil is placed over the other the direction of winding must run on continuously from one coil to the other. In building the inductances the windings are thus made in opposite directions, or in other words, one resembles a left-hand threaded screw and the other a right-hand thread.

A tuned high-frequency amplifier is used, and although it is difficult to obtain successful high frequency amplification on short wavelengths, the introduction of a tuned oscillator in the plate circuit of the first valve will produce some degree of amplification if the component apparatus is carefully constructed, as it brings about the very desirable condition of stimulating oscillation and giving oscillation control that can be easily manipulated. The inductances L_3 and L_4, like L_1 and L_2, are wound in opposite directions to produce a continuous winding when joined together at one end. Bearing in mind the connections of a simple oscillating circuit it is easy to see that if a small degree of capacity feed-back is arranged between the plate of the detector valve and the plate end of inductance L_3, that oscillation will be set up by the detector valve in the circuits L_3, L_4, C_3. On wavelengths of 100 metres, it was found that this condenser did not bring about the desired effect because, apparently, of the very high capacity leakage across the intervalve transformer, but the introduction of the low-capacity fine wire choke coil Ch_1, easily brought about oscillation. The object of this condenser C_5, however, is not to cause oscillation but to prevent it, and to achieve this it is only necessary to link it across between the plate of the detector valve and the aerial, where the oscillations are in opposite phase to those occurring at the plate of the H.F. valve. The H.T. bridging condenser C_6 is connected in circuit to form a junction between the primary and secondary windings of the transformer L_3, L_4, so that the path of the oscillating currents is not carried around the distributed H.T. leads.

By employing an H.F. transformer, rectification can be carried out by a valve of the " Q " or " QX " types without grid condenser and leak, and with a negative grid potential.

A matter often overlooked when connecting up a receiving circuit is that the filament heating and H.T. batteries when standing on the bench produce an almost earthed point in the circuit, as do also the telephone receivers when placed in contact with the head. Whether or not telephone receivers are operated through a transformer, the conditions still exist and if not forming an actual low insulation leakage path, they at least form a route to earth of almost negligible impedance to the oscillations, owing to the high capacity of the windings. Again, this effect, though unimportant when receiving on wavelengths of 300 or 400 metres, cannot be overlooked on 100 metres. This path to earth thus created is, of course, additional to that normally provided and it will readily be appreciated how serious damping of the received oscillations will occur when the two paths tune to wavelengths widely different, as will be the case when so few turns are included in the aerial tuning circuit of the receiver such as are required on these short wavelengths. It is necessary in consequence to connect up the batteries with short leads—sufficiently short to prevent them acting as a tuned counterpoise—and insulate the batteries from earth by standing them on a sheet of ebonite or glass resting on four insulators to give liberal spacing from earth. As to the telephones (telephone or intervalve transformer), it is necessary to connect efficient choke coils having low capacity, Ch_2 and Ch_3, on either side of them.



Underside view of panel showing the low loss H.F. transformers of special design for short wave work.

(Constructional details will appear in the next issue.)

THE EARLY HISTORY OF TELEVISION.

The problem of television, which has recently caught the public imagination, is by no means new. In this article the author adduces interesting historical facts concerning early attempts to transmit pictures and images by electrical apparatus.

By James Strachan, F.Inst.P.

The first steps in television may be said to date from the earliest attempts at transmission of drawings by telegraph, since the principle underlying both is identical, the difference lying in the speed of operation of the synchronous system. The transmission of diagrams by the electric telegraph appears to have been accomplished first by the Abbé Caselli in 1862, and was in actual practice between Amiens and Paris between 1865-1869. Caselli is reported to have spent ten years in working out his apparatus, which appears to have been a modification of the chemical recorder, an iron stylus marking on paper sensitised with cyanide of potash.

The discovery in 1873 of the electrical sensitivity of selenium to light immediately stimulated the scientific imagination, and during the next ten years the claims of various investigators raised hopes that the problem of television was within measurable distance of perfect solution. Looking back over the past fifty years it appears almost incredible that the year 1877, which saw the advent of Graham Bell's telephone, also witnessed the invention of the "telectroscope," the first practical attempt at the solution of the problem of television. We now have wireless telephony, but television has not advanced appreciably in practice.

The first mention of the "telectroscope," which was invented by M. Senlecq, of Ardres, appeared in this country in *The English Mechanic* (Vol. XXVIII, page 509, January, 1879), when a preliminary description of the apparatus was published. From this brief notice it appears that Senlecq's apparatus was a lineal descendant of Caselli's. The image to be transmitted was projected on the glass of a camera obscura and traced out by a selenium point in the transmitting circuit, the variations in the current reproducing the effects of light and shade at the receiving end by electro-magnetic means.

The published description of Senlecq's "telectroscope" was immediately followed by claims for similar inventions by numerous investigators, who appear to have been working on the problem at the same time, including Messrs. Ayrton and Perry and Brown (in England), and Messrs. Sawyer, Sargent, Carey, McTighe and Graham Bell (in America).

Senlecq appears to have developed the primitive idea of the moving selenium point into a more complicated multiple cell apparatus for direct vision, and a detailed description of this may be found, with illustrations of the apparatus, in *The English Mechanic* (Vol. XXXII, pages 534-5, February, 1881). A single line wire was used, the electrical impulses being derived from a slide pulling under the influence of gravity and making contact during the fall with connections to the multiple-cell on which the picture was projected. Reproduction at the receiving end was accomplished by means of synchronous clockwork, and the incandescence of fine platinum wires, occupying similar positions to the selenium cells in the transmitter. The clockwork scheme looks impracticable, but it is stated vivid but fugitive pictures were obtained leaving an impression of the transmitted light and shade on the retina of the eye.

On February 7th, 1879, a Mr. Redmond, of Dublin, wrote a letter to *The English Mechanic* (Vol. XXVIII, page 540) one month later than the first published description of Senlecq's first apparatus, stating that he had been experimenting on this subject for three months with some success, and that he had adopted the principle of the copying telegraph, but that he had failed to obtain synchronous movement of sufficient rapidity.

In 1880, Graham Bell deposited with the Smithsonian Institution a sealed description of an invention for "seeing by telegraph."

This announcement in the press was followed by a letter from Messrs. Ayrton and Perry describing some of their own experiments, and those of Prof. Kerr. In both a multiple line wire was proposed with the usual multiple cell transmitter. In Ayrton and Perry's receiver each selenium cell of the transmitter had its counterpart in a magnetic needle which, by moving, closed or opened an aperture through which light passed, thus constituting a kind of mosaic of easily operated light shutters. Prof. Kerr's receiver consisted of a similar mosaic of electro-magnets with silvered ends illuminated by a polarised beam of light and observed through an analysing prism. The action of this receiver depended upon the rotation of the plane of polarisation by the current passing through the electro-magnets. This was followed by a letter from a Mr. Middleton, of St. John's College, Cambridge, who described his apparatus before the Cambridge Philosophical Society on March 8th, 1880. He departed entirely from the use of selenium and used a multiple-cell transmitter of thermo-electric couples which generated heat in similarly situated thermo-couples at the receiving end, the radiant heat being rendered visible by reflection from the polished surfaces of the thermo-couples "after the fashion of a Japanese mirror." Previous to Graham Bell's announcement, patents for television had been taken out in America by Messrs. Connelly and McTighe of Pittsburg and Dr. Hicks of Bethlehem, Penn. The latter termed his invention a "diaphote." Further particulars of the foregoing may be found in an article entitled "Seeing by Telegraph" (*The English Mechanic*, Vol. XXXI, pages 177-8, April, 1880). A full description of Carey's apparatus as it appeared in *The Scientific American* is reprinted, with illustrations, in the same volume of *The English Mechanic* on pages 345-6. This is a multiple-wire apparatus with the usual selenium-cell transmitter and incandescent receiver with carbon or platinum elements.* The subsequent description of Senlecq's improved apparatus in the following volume, *loc. cit.*, is much more ingenious.

In March, 1881, Shelford Bidwell (who had experimented with selenium perhaps more than any of his contemporaries) delivered his classical lecture on "Selenium and its Applications to the Photophone and Telephotography" at the Royal Institution in London. It should be noted in passing that "telephotography" is used in quite another sense at the present day. This lecture was fully reported with illustrations in *The English Mechanic* (Vol. XXXIII, pages 158-9, pages 180-1.).

*Referred to by Mr. Campbell Swinton in his paper on "The Possibilities of Television."

In the year 1882 the correspondence in *The English Mechanic* referred to by Mr. Ll. B. Atkinson in the discussion on Mr. Swinton's paper on "The Possibilities of Television," appears in two letters, the first signed "W.L." and the second "Ll. B. A." (Vol. XXXV, page 151 and page 194). In the apparatus suggested by "W.L." the transmitter is Senlecq's and the Nicol prism receiver which he claimed as a novelty had already been anticipated in a more practical form by Kerr.

Thereafter the pages of scientific journalism are singularly silent for many years on the subject of television, leaving us in 1882 with almost as much accomplished as at the present day.

In conclusion the present writer desires to draw the attention of readers to the valuable historical record of the development of the telegraph, the telephone and the microphone to be found in these early volumes of *The English Mechanic*, and which cannot be found elsewhere in so complete a form. For example there is a note that in 1877 Prof. Loomis, of New York, transmitted morse signals over a distance of twelve miles through the upper reaches of the atmosphere by means of kites flown with copper wires to the same height at the receiving and transmitting stations, without other connections except these aerial wires and earth. I cannot find a reference to this elsewhere, but it may be found in American literature.

With regard to the subject of television these historical notes bring out clearly that the earliest experimenter, Senlecq, had a very clear conception of what was required, viz., a single line wire with synchronous apparatus. The majority of subsequent inventions suggest the impracticable multiple wire system. Further, it appears to the writer that in the light of present-day knowledge the thermo-electric system suggested by Middleton is worth careful re-investigation. In the thermionic valve we now have means of amplifying minute thermo-electric currents, while we have also a much more extensive knowledge of thermo-electrics and more sensitive thermo-couples available. The late Silvanus Thompson has also shown us how in the case of "magic" Japanese mirrors microscopically minute differences of level in the metal may produce distinct images by reflection. A brass mirror on which a design was slightly etched by acid, even after twenty minutes polishing to remove the design, still showed the latter by reflection.† By this means, as suggested by Middleton, we have a simple and sensitive method of changing radiant heat into an image visible by reflected light by the varying expansion of a suitably constructed metallic mirror. The apparatus suggested by Middleton comprised the cumbrous and impracticable multiple wire system. From the modern point of view this would be replaced by the synchronous movement of mirrors at each end and transmission of the amplified currents by wireless. From the point of view of physical theory some such modification of Middleton's apparatus could be arranged to accomplish all that we might expect from Mr. Campbell Swinton's invention, and appears more within the sphere of practical politics.

† *Vide* "Light Visible and Invisible," pp. 50–54.

VALVE TESTS.

THE B.T.H. AND EDISWAN "R" TYPES.

THE "R" valve demands no introduction. Developed during the war, and first known as the French valve, it was manufactured on a large scale, and many present-day enthusiasts gained their first acquaintance with the "magic bottle" under war conditions, when the number of different types then obtainable was very small.

To these enthusiasts a note on the "R" type may seem redundant, but this week our notes are penned for the more recent newcomers to the realms and mysteries of wireless.

The "R" frequently referred to as the "twelve-and-sixpenny," is one of the cheapest valves on the market, and must in consequence have a large following. It is, moreover, as we shall see, a good all-round valve, which merits its popularity.

All the leading valve manufacturers have an "R" type in their catalogues, but this week space permits us to deal with only two, the B.T.H. and the Ediswan products. There is a great similarity in regard to the filament characteristics of all the various makers' valves which may be due to the fact that during the war all the leading manufacturers were working to the same Government specification. In all cases, the filaments are rated at 4 volts, and Fig. 1 shows the case of the B.T.H. sample we tested. At normal filament volts the current is 0·65

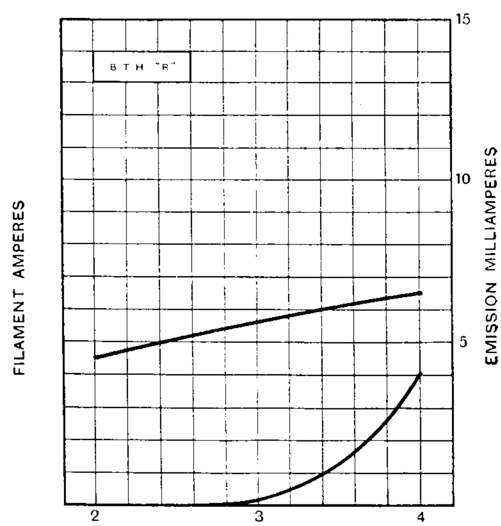


Fig. 1.

ampere, producing an emission of 4 milliamperes. The usual plate current-grid volts characteristics are given in Fig. 2,

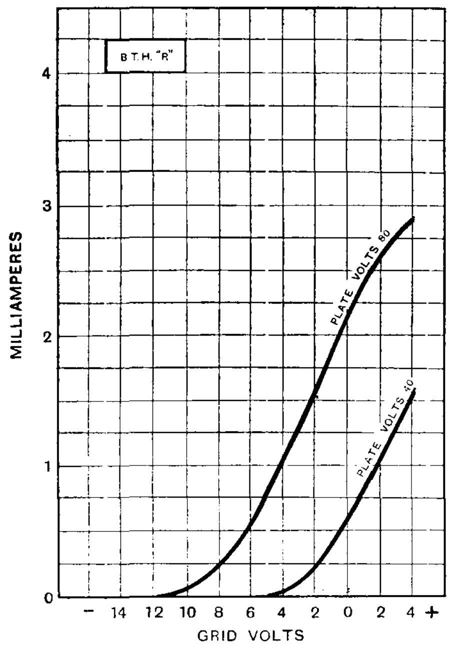


Fig. 2.

the 80-volt curve giving promise of good low frequency amplification when a negative bias of about 3 is applied to the grid. The magnification of this is rather lower than is the case with most valves of the class, and works out at slightly less than 6½ to 1

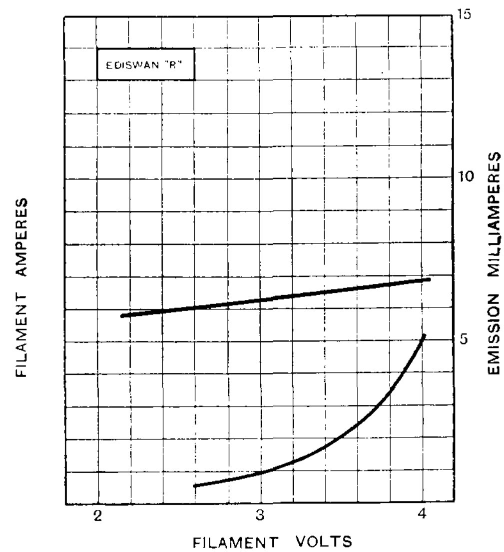


Fig. 4.

with an impedance of 24,000 ohms when the plate potential is 80 (Fig. 3).

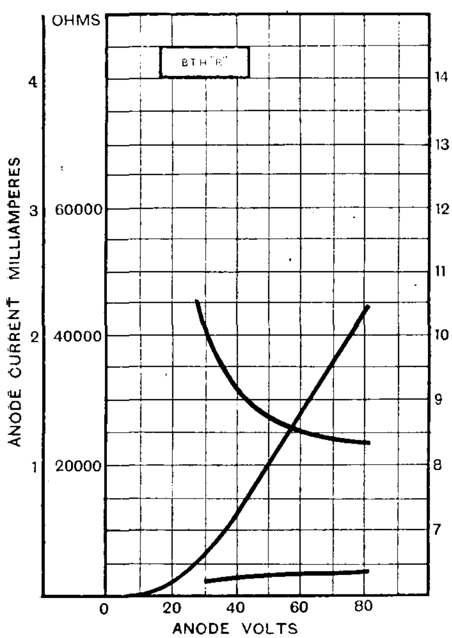


Fig. 3.

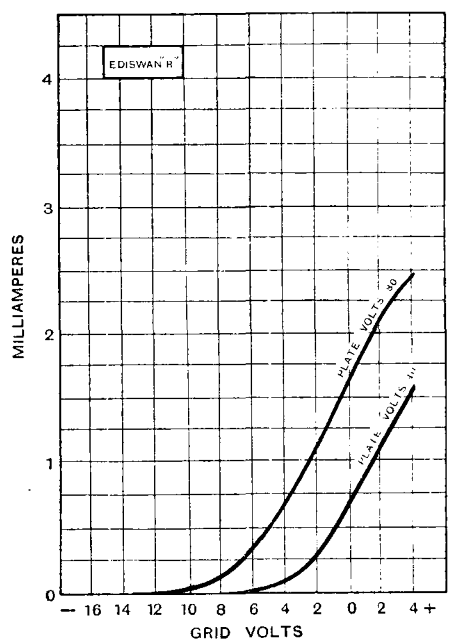


Fig. 5.

On our standard* circuit the B.T.H. "R4" gave quite satisfactory results in whatever capacity it was operating. As a detector or high frequency amplifier, 30 volts high tension seems to be quite sufficient, and when operating on the low frequency side, 60 volts on the plate gave good signal strength. At this value of plate potential we found it advisable to apply a steady voltage of −2 to the grid.

The characteristics of the Ediswan valve are given by Figs. 4, 5 and 6, and with the exception of the filament, they are seen to differ quite considerably from those previously discussed, and illustrated in Figs. 2 and 3. Fig. 5, for example, which gives the plate current as a function of grid voltage, immediately suggests a higher magnification factor. This assumption is proved to be correct as is seen from Fig. 6, where it is shown to be about 9·3 for the higher plate voltages. The plate impedance is correspondingly higher as is suggested by curve B, Fig. 6, and proved by curve C, same figure.

Under circuit conditions we found this make also quite satisfactory, particularly as a high frequency amplifier, which, in view of its somewhat higher magnification factor, was to be expected.

40 volts H.T. was used when the valve was working as a high frequency amplifier or detector, and 80 to 100 for low frequency work. Under the latter conditions a grid bias of −3 to −4 was employed.

Both the foregoing are good all-round valves and suitably adjusted will give perfectly satisfactory results in any receiving circuit.

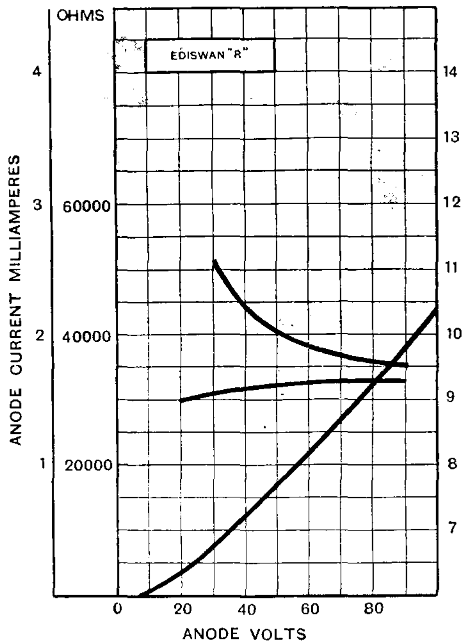


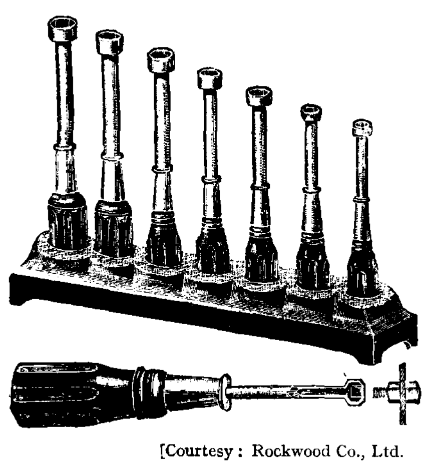
Fig. 6.

Next week we shall deal with the remaining types of this class.

* Our standard circuit is a straightforward one comprising H.F., Detector, L.F.

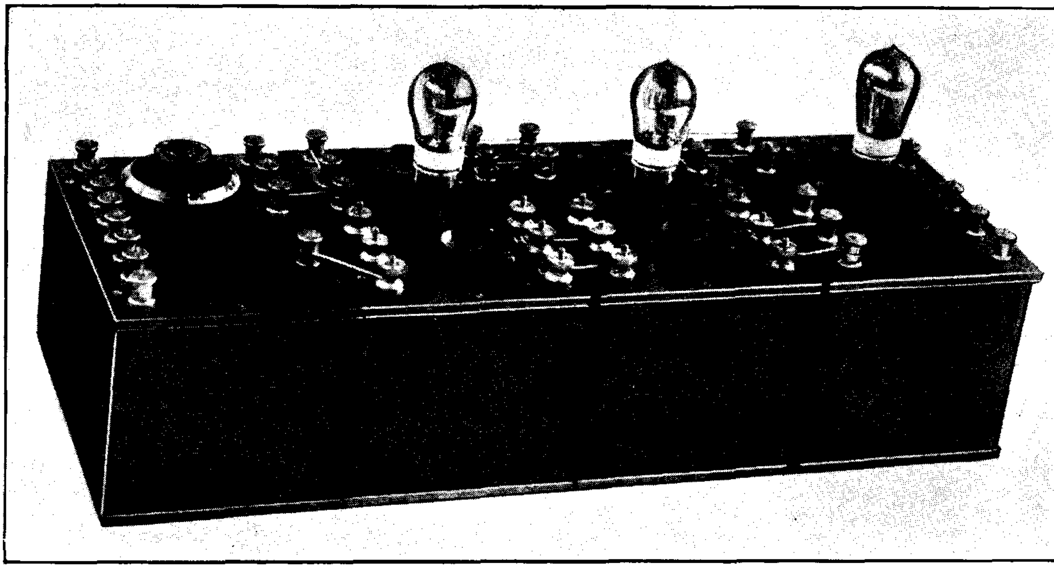
USEFUL WRENCHES.

The only correct method of tightening up small nuts in wireless instrument making is by the use of hollow box spanners, yet how often one finds the amateur instrument maker endeavouring to turn nuts on the back of the panel, and possibly in some inaccessible spot, by means of pliers. In using pliers it is impossible to judge the degree of tightness given to a small brass nut and, in consequence, the thread may easily become stripped, whilst damage to the faces of the nut is almost certain to occur. The wrenches shown in the accompanying illustration should prove most useful to instrument-making work.



[Courtesy: Rockwood Co., Ltd.

A range of box spanners for various nuts.



Unit set of very simple design suitable for school construction and use.

WIRELESS IN SCHOOLS.

The reception of broadcasting, and an elementary study of radiotelephony in schools provide recreation for the scholars as well as encouraging scientific study. The article describes the installation of a loud speaker set in a London school with a minimum of expenditure.

By G. F. AYLARD and J. A. EDEN, B.Sc.,

of the Barnsbury Central School, London, N.

SHORTLY after the British Broadcasting Company definitely announced that they were going to transmit lectures of an educational value for schools, we decided to see what could be done in the way of receiving. Previously we had constructed nothing more ambitious than crystal sets, the school being situated less than ten miles from **2 LO** and such sets being the limit of the ordinary boy's means. We had to cater for some five hundred boys and girls of ages from eleven to sixteen.

Our first problem was finance! The local education authority severely limited their expenditure to ten shillings towards the licence. Beginning from that we took stock of the situation and decided that our requirements were a large loud speaker, a detector and two stages of low frequency amplification, with the possibility of a power valve in the second stage, together with the necessary accumulator and H.T. battery. With no definite funds available the cost appeared to be somewhat alarming. However, inquiry amongst the boys showed a vast amount of enthusiasm and a readiness to provide the sum of one shilling in instalments from varying amounts of pocket money. Thus we made a start.

It was quickly apparent that something must be shown for money received if we were to push the matter to a really successful conclusion, hence we decided to build in units as funds permitted. The first part was a variable condenser bought unassembled and built up amidst much excitement among the select few members of the Radio Society. That brought in a fresh influx of members with subscriptions and so we progressed. Each part, on being obtained, was carefully demonstrated and its use explained, and in a surprisingly short time we had our tuning, detecting and one note amplifying units complete.

In order that our experience of the difficulties met and how they were overcome may be of use to others, we chronicle them here.

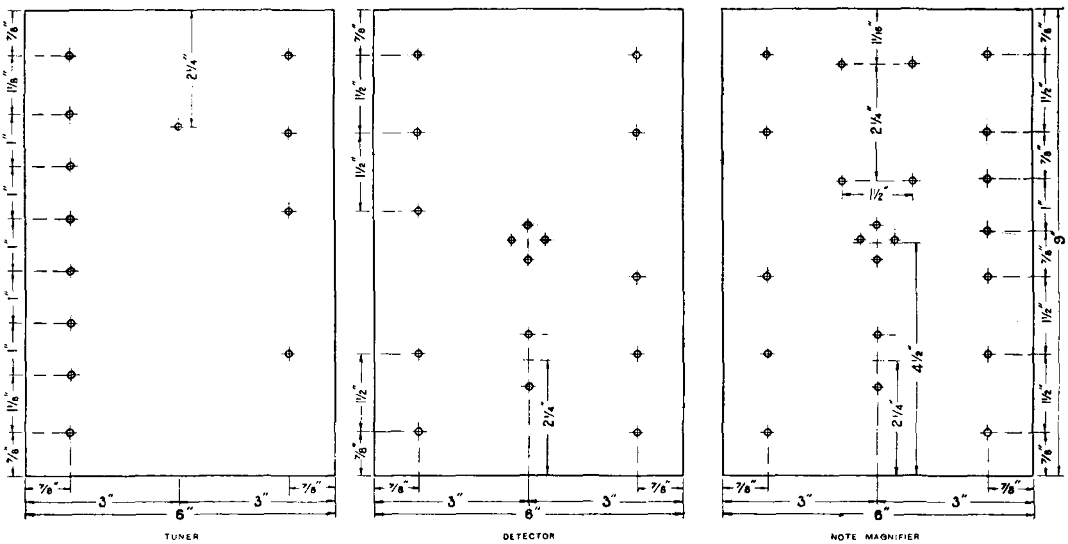
Our first aim was to obtain true reproduction. This we have found in the course of our tests to be most essential. At first we had difficulty with the announcer's voice blasting out in most distracting fashion, whilst musical items came through remarkably well. This we at once saw must be overcome as lectures and talks were to be broadcast.

Another point we had in mind was that the set must be both robust and reliable. Owing to the situation of the aerial, a certain amount of moving about was inevitable. The question of reliability needs no stressing when dealing with five hundred children and a critical staff.

A straight circuit built up on the unit system was found to lend itself admirably to our purpose from other points of view than the one already indicated. The separate units lend themselves extremely well to science room demonstrations, the need and function of a tuner, the valve used as a detector and as a note magnifier. Each panel is complete in itself. Further, the work was collective and well within the scope of the boys.

Provision has been made to provide a further unit on the high frequency side and for the introduction of reaction. After providing the loud speaker, a 6-volt 100 ampere hour accumulator and 120-volt high tension battery, the following requisites were necessary :—

4 pieces of ebonite, 9 ins. by 6 ins., by ¼-in.
1 variable condenser, 0·0005 capacity.
3 filament resistances. (Igranic).
3 R.5 valves.
2 L.F. transformers. (Ferranti).
3 fixed condensers of 0·0002, 0·001 and 0·0025 mfds. The method of making these is detailed later.
1 2-mfd. fixed condenser for connecting across the H.T. battery. (Mansbridge).
1 grid leak, 2 to 3 megohms. (Dubilier).
1 Duolateral coil (35 or 50.)
48 2 B.A. terminals.
4 telephone terminals.
12 valve sockets.
1 resistance, 100,000 ohms.



Details for drilling the panels.

The four panels (two L.F's.) were marked out and drilled, as shown in the drilling diagram. These were carefully rubbed down with carborundum cloth to remove the outer skin from both sides and polished with a piece of soft rag and pumice powder.

All the terminals were first cleaned by being boiled in strong soda solution, thoroughly rinsed in water and then dipped into strong nitric acid for an instant, again washed, and then dried and lacquered. All the parts were separately suspended on short lengths of brass wire during this treatment and not handled directly.

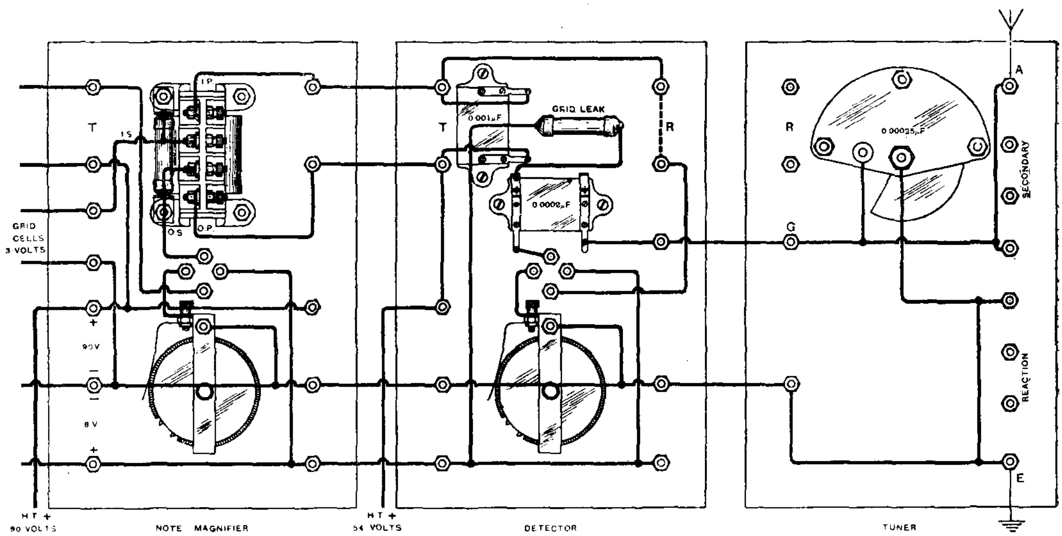
The tuning unit was first assembled and wired as shown in wiring diagram.

It should be noted here that the wiring in the photograph shows terminals for the introduction of reaction, but this was found to be unnecessary for our own station.

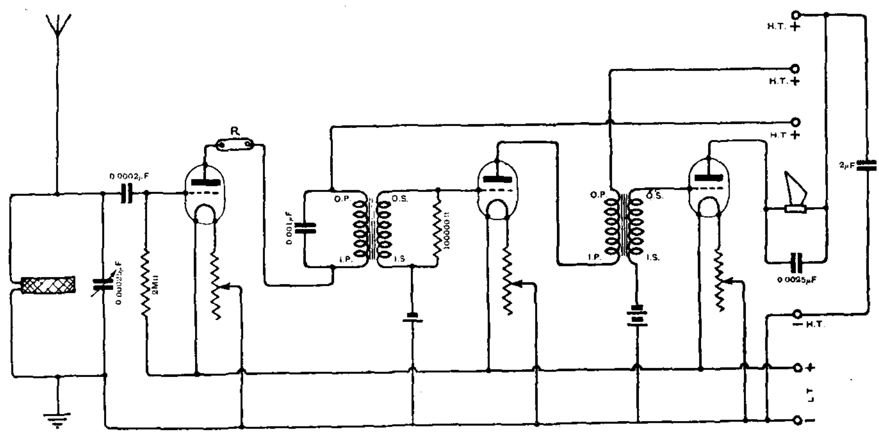
In the detector unit, the grid leak was connected between the grid and L.T. + to allow the H.F. unit to be added later and the 0·001 mfd. condenser, which is usually connected across the primary of the transformer, was left across the output terminal of the detector unit.

Proceeding to the third unit assembled, the points to note here are (1) the fixing of the 100,000 ohms high resistance across the secondary circuit of the transformer. It was found that when the two note magnifiers were in use that this was necessary to reduce resonance effects. (2) The rheostat is in the positive lead of the filament, thus allowing the negative grid bias to be maintained at a constant value by means of grid cells.

The last unit differs from the third to the extent that the resistance across the secondary of the transformer is omitted and the 0·0025 mfd. fixed condenser is inserted across the output terminals for the loud speaker.



Arrangement of the components and wiring.



Circuit diagram of simple three-valve receiver suitable for operating a loud speaker at distances up to 10 miles from a broadcasting station. Reaction is not made use of.

The fixed condensers were constructed of the same size outwardly. We describe here the making of the 0·001 mfd. and indicate the variations necessary for the others. Two pieces of ebonite were cut, 1 in. by 2 ins. by ¼-in., and rubbed down. Two holes to take 4 B.A. screws were drilled centrally in top piece, 1¾ ins. apart. Five pieces of copper foil, ½ in. wide by 1½ ins. long, and six pieces of mica 0·002 ins. in thickness, 1 in. wide and 1½ ins. long, were cut. The condenser was built up with one inch of the copper foil overlapping, a trace of shellac varnish holding the plates together, and this was allowed to dry under pressure. When quite dry the copper with the mica dielectric now securely held together was arranged between the ebonite plates and gripped in the vice whilst a 5 B.A. drill was run through the holes to pierce the copper foil. Two 4 B.A. one-inch cheese-headed brass screws were inserted and screwed up tight with a nut on top. A little molten paraffin wax was run along the edges to seal the condenser in. For the 0·0002 mfd. condenser only two pieces of copper foil and three pieces of mica were required, whilst the 0·0025 mfd. condenser required eleven pieces of copper foil and twelve pieces of mica. Alternatively the latter can be made out of six pieces of foil 1 in. wide and seven pieces of mica.

When the set was finally assembled and tried out it was found that results were greatly improved by applying separate plate voltages to each valve. This was done by removing the connecting links in the H.T. circuit and using separate plugs and spade terminals on pieces of flex, to connect the detector and first L.F. valves to various plus voltages.

A further important point is the grid bias. This was applied by a separate dry battery with plug connectors at every 1·5 volts. Again tests were carried out and we found that it was necessary to apply 3 volts to the first note magnifier and 4·5 volts to the second. The important point to remember if distortion is to be reduced to a minimum is that the correct voltage must be applied to the valve. The trial and error method had to be employed as the necessary instruments for working out the characteristic curves of the valves were not available.

Our aerial is about 90 ft. long, the free end being some 80 ft. high and the lead-in end 20, whilst the earth is good. Our results are thoroughly satisfactory and, if the lectures to come are as good as the two we have already received, we shall have both an efficient and economical set, for, up to date, we have spent less than eighteen pounds.

Radio added to the "three R's." Scholars at the Barnsbury Central School, London, N., listening to one of the special transmissions for schools broadcast from **2 LO**. *The apparatus was entirely constructed by senior boys.*

PATENTS AND ABSTRACTS

A Selective Amplifier.

It is well known that atmospheric discharges affect the wave collecting device, whether it is a frame aerial or an open aerial, and set up oscillations in the aerial circuit. For the reception of C.W. signals, a local heterodyne is generally utilised, and with proper tuning the signal which is required is heard as a note, but the atmospherics are heard as noises. When the atmospherics are not numerous, the operator easily distinguishes between the noises and the note of the signal, but when the atmospherics are numerous, it is difficult to distinguish the signal. It has therefore been proposed to construct a receiving system which will limit the amplitude of the atmospherics, and to utilise selective circuits which are bad circuits for all the currents which have not the note of resonance of these circuits, while they are sufficiently damped not to vibrate under the action of the atmospherics.*

It is therefore proposed to use one or more very damped amplifying circuits, and one or more circuits connected as a selective series, with a sufficient number of three-electrode valves, each of these circuits being tuned to the final period of the detected signals, or upon a multiple or sub-multiple of this period. It is known that a series of amplifying stages may produce sustained oscillations. The sustained oscillations occur in the resonant circuits of the valves when

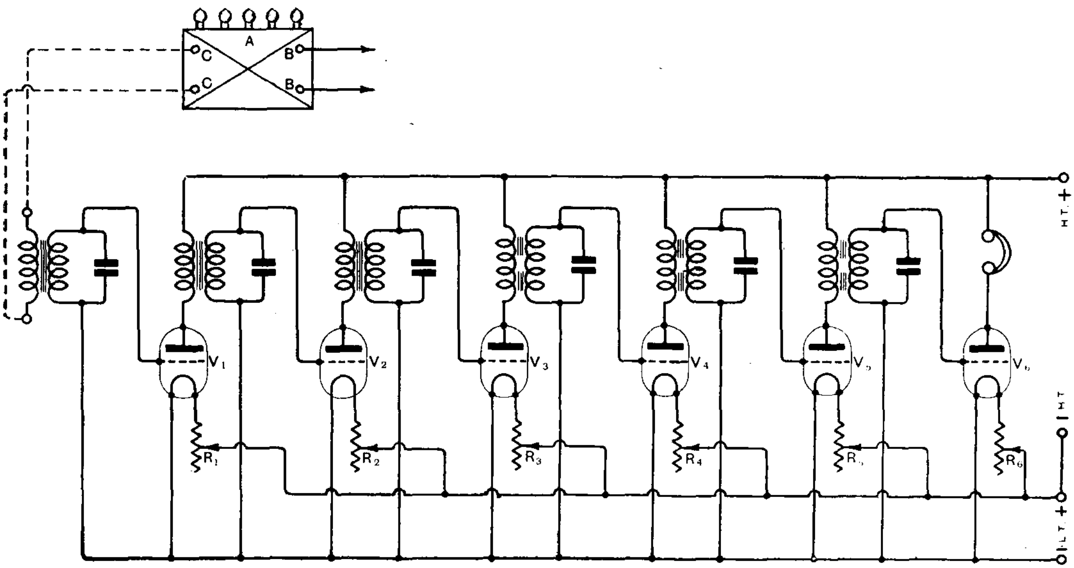


Fig. 1.

* British Patent No. 203,678; by Marrec, Ltd.

the heating of these valves is suitable, and when the resonant circuits are tuned precisely to the note of the signal to be received. The heating of the valves is suitably decreased, so that when no signals are received, the sustained oscillations do not take place. The local sustained oscillations are then produced only under the action of the desired signals, and only while these last. In other words, the heating is regulated so that the smallest possible current of similar period to that of the natural period may suffice to produce the sustained local oscillations. In this manner a reproduction of the selected signals is obtained, of relatively great intensity.

To fulfil these conditions, the arrangement sketched in Fig. 1 may be used. A receiving amplifier, A, is connected at BB to the aerial circuit, and the detected current is led from the terminals CC to the low frequency amplifier. The grid circuits of valves V_1, V_2, and V_3, contain condensers which have a capacity of about 0·001 or 0·002 microfarads to prevent oscillations. The amplitude of the atmospherics is reduced by decreasing the heating of the valves V_1, V_2 and V_3. The amplified currents are connected to a system of resonant amplifiers, V_4, V_5 and V_6, which are tuned to the note of the signals to be received. The circuits of these amplifiers contain transformers, which are constructed so that they are highly selective only for those currents having a frequency for which the transformers are tuned by their inductance and capacity, and the added capacity.

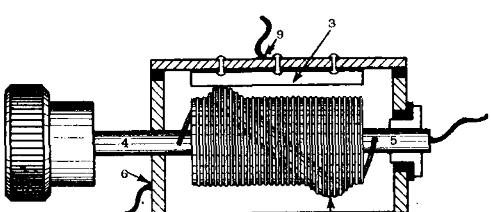


Fig. 2.

Variable Resistances.

A variable resistance may be constructed as shown in Fig. 2.* A resistance wire is wound upon an insulated former which may be cylindrical in shape, but has a projection 2 formed upon it. The contact consists of a spring blade 3 arranged parallel to the axis of the former. The former is mounted upon two spindles, 4, 5, which are supported in the framework.

When the arrangement is to be used as a variable resistance, one terminal of the circuit is connected to the spindle, 5, or to the point, 6, of the frame, while the other terminal is connected to the side, 9, of the frame.

The arrangement can be used as a potentiometer, as may be seen from the figure.

* British Patent No. 208,535, by Société Belge Radio-Electrique Société Anonyme.

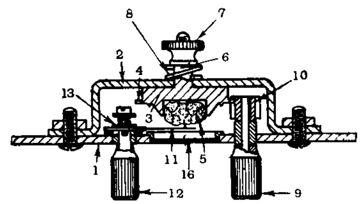


Fig. 3.

Improvements in Crystal Detectors.

This invention refers to crystal detectors comprising a crystal arranged in a rotatively mounted carrier, and a wire contact spring movable over the crystal.

One example of the construction is given in Fig. 3.* 1 is a cover plate of insulating material, to which is attached a metal frame, 2, in which the crystal carrier is mounted. The crystal carrier has a circular body, 3, and a toothed edge, 4, and the crystal is mounted in the recess 5.

In the construction shown, the body of the crystal carrier is formed with a stem, 6, which passes through the frame, 2, and is threaded at its end to receive a nut, 7; 8 is a short spring.

The crystal carrier is rotated by turning the knob 9, fastened on the spindle of a toothed pinion, 10, which engages the toothed edge, 4, of the carrier. A wire contact, 11, which rests on the face of the crystal, is secured to a pin, 13, which in turn is fastened to the spindle of the knob 12. The crystal may be adjusted by turning the knob 9, which moves the crystal, or the knob 12, which moves the wire contact.

W.J.

* British Patent No. 212,415, by the Sterling Telephone & Electric Company, Ltd., and T. D. Ward-Miller.

SOME SUGGESTED LINES FOR EXPERIMENTAL RESEARCH.*

By G. G. BLAKE, M.I.E.E., A.Inst.P.

ONE of our greatest difficulties as amateurs is to find sufficient time in which to carry out our experiments. Many of us get ideas which we individually have no chance of pursuing to a conclusion. If we cannot carry out our schemes ourselves it seems to me that the next best thing we can do is to bring them forward at our informal meetings, so that others with more time at their disposal may take them up where we lay them down.

The Tuned Microphone.

On January 5th, 1923, Major W. S. Tucker delivered an exceedingly interesting experimental lecture at the Royal Society of Arts, on his Gun Microphone.† During the lecture a possible application of this instrument to wireless interference prevention occurred to me, but perhaps I had better first describe the instrument which is shown in Fig. 1.

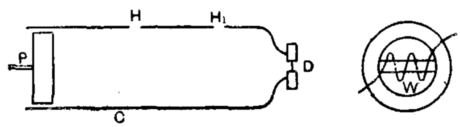


Fig. 1. The tuned Gun Microphone designed by Major W. S. Tucker.

C is a cylinder of metal closed at one end by means of a plunger P, a number of holes H, H^1, are drilled in the side of the cylinder, and there is a small hole about ½ in. in diameter at the other end D. Across this opening is fitted a filament of fine platinum wire W, which is kept at a dull red state of incandescence, and forms one arm of a Wheatstone bridge. (Fig. 2.)

The cylinder C can be tuned to any audible or even inaudible sound wave by means of plunger P. When properly tuned the received sounds cause pulses of air into and out of the cylinder, passing the heated filament, and these in turn cause alterations in its temperature, thereby giving rise to variations of resistance. Records are made by a sensitive galvanometer, a siphon recorder, or a telephone receiver, across the bridge.

This instrument is so sensitive that a year or so ago the explosion in Holland was faithfully recorded by its aid. It can be tuned to respond to the deep note of a distant gun many miles away and it is so selective that it will record the report from the gun, and yet reject the sounds of rifle fire in its vicinity. I remember that Major Tucker demonstrated this in his lecture in the following manner. He tuned his cylinder to the noise made by shutting a distant door, and showed that his microphone readily responded, and he showed that the blasts of a loud motor horn in close proximity to the cylinder failed to produce any effect.

In this microphone it seems to me we have a most valuable selector for wireless reception.

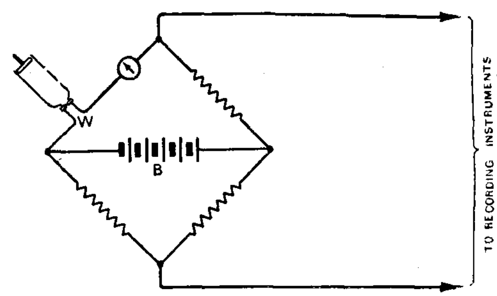


Fig. 2. Bridge connections of the Tucker Microphone.

Two or more spark or C.W. signals may be heard in the 'phones simultaneously on the same wavelength, producing complete jamming, yet with this instrument I believe, provided that each station transmits a distinct musical note, it should be possible to select any station at will. If this proves to be the case it would open up the ether to a greater number of transmitters, and tend towards greater secrecy.

Somewhat similar attempts have been made, I know, by Johnson, Guyott and others with tuned reeds and tuning forks, without very practical results, but the sensitivity of reeds and tuning forks is not to be compared with Major Tucker's microphone.

Experiments with the Speaking Arc as a Loud Speaker.

About a year ago I carried out a few experiments in rather a haphazard way, to see if a speaking arc might be employed as a loud speaker. The results were quite encouraging. Fig. 3 shows the connections employed.

Fig. 3. The Speaking Arc.

*Opening remarks at Discussion at informal meeting of R.S.G.B. May 14th, 1924, at I.E.E.

† Full description of the lecture will be found in *Journal of Soc. Arts*, Vol. 71, pp. 121–134.

The hum of the electric supply mains was weakly audible, but I believe it could have been smoothed out by a suitable system of condensers and chokes in the leads to the arc.

The quality of the speech was rather woolly, but this I believe was due to the employment of an excessively large condenser across the arc, and the improper design of the transformer. I used for my experiment an old transformer which I made for a speaking arc that I showed to this Society in my 1913 lecture, and at that date there was little published information on the subject. It had an equal number of turns on both primary and secondary and no iron core.

I feel sure that the scheme is capable of great improvement. As the sounds are produced by temperature variations in the arc causing sudden expansions and contractions in the surrounding air, there being no diaphragm employed, I believe we should avoid resonance phenomena and predominant troubles.

Suggested Method of Measuring Small Voltages.

At the discussion after Dr. Whiddington's paper to our Society in 1920 on "Wireless Valve Circuits as applied to the Measurement of Physical Quantities," I drew attention to an interesting experiment, which Dr. Eccles had then recently shown at the Royal Institution, in which he had placed a gold leaf electroscope between the plates of a condenser. When he held the charged rod near the electroscope he showed that a very slight divergence of the leaves produced large capacity changes, and altered the note emitted from suitably tuned circuits.

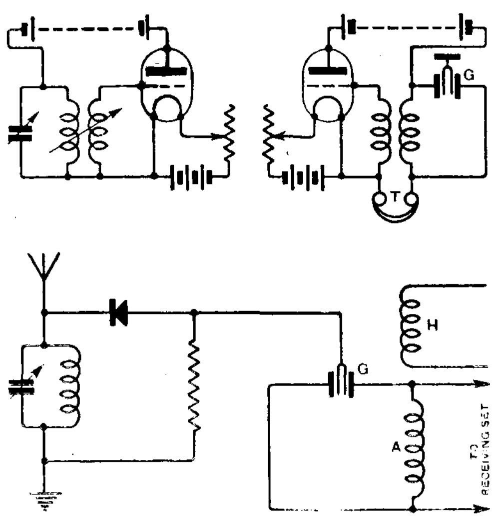


Fig. 4. A suggested arrangement of voltage measurement by the beat note method.

I suggested that an electroscope might be employed in connection with Professor Whiddington's apparatus for the measurement of voltages.

I think it would be well worth while to conduct some experiments on the following lines.

Two tuned circuits as employed by Professor Whiddington could be heterodyned to produce a beat note, the slightest voltage applied to the gold leaf G (Fig. 4) should then produce a change of frequency in the circuit, and could be detected by ear.

This idea could be carried a good deal further, I think, and curves might be plotted with a wavemeter to read off extremely small voltages, as represented by the various frequencies, thus providing an exceedingly delicate microvoltmeter. The detection could be done best probably on the wavemeter, employing the electroscope circuits simply to act as oscillator.

A Suggested Electroscope Amplifier.

Some such arrangement as that shown at the bottom of Fig. 4 might be employed, the leaves of the electroscope G being connected through a crystal rectifier to the top of the aerial inductance as shown. A high resistance leak R would probably have to be connected between the top of the electroscope and earth.

A separate heterodyne H could be employed to heterodyne circuit A (both of these circuits being tuned to very different frequencies to those being received in the A.T.I.). The voltage changes produced in the electroscope by the incoming signals could then be employed to alter the beat note, possibly completely silencing it at every signal, or by suitable adjustment it might be made to have the reverse action.

A separate heterodyne need not necessarily be employed. A similar result could probably be obtained by the employment of coupling from the set when in a state of oscillation, provided that A be tuned to the same frequency as the A.T.I.

The electroscope might provide sufficient electrostatic coupling to the A.T.I., if not the A.T.I. and A could be coupled magnetically.

This idea is analogous to one I heard of some time ago from Mr. Coursey, in which the diaphragm of a telephone formed one plate of a condenser, the capacity of which was varied by the diaphragm movements.

The Three-Electrode Valve employed as a Supersensitive Electroscope.

On March 22nd, 1922, in a paper before this Society on "Modern Views of Electricity and the Three-Electrode Valve," I demonstrated a new experiment which had been shown during the previous year before the Physical Society by Mr. Harrison Glew.

Two small spirals of wire coated with a radioactive material were employed. One was placed on the top of an electroscope, and connected to its gold leaf, and the other to the negative pole of a Wimshurst machine, or the negative terminal of a small coil, the positive terminal being earthed. The radium rapidly ionizes the air mainly by alpha particle bombardment, so that the atmosphere quickly becomes filled with negatively and positively charged ions. When the machine is worked at a distance from the electroscope, it then attracts the positive ions, and repels those negatively charged, so that a cloud of negative ions rapidly collects in the neighbourhood of the electroscope, and causes its leaves to diverge.

After the lecture Mr. Child suggested to me that it would be interesting to connect a spiral to the grid of a valve. I have since tried the following experiment, using a Marconi "Q.X." valve, chosen because its grid is so well insulated, and because of its high amplificating characteristics, its amplification factor being about 25. Fig. 5 is self explanatory. Using a plate voltage of 120, a steady reading of 1 *m*A was obtained in the plate circuit. This could be rapidly reduced to zero by means of a small Wimshurst machine operated at a distance of 7 or 8 feet, and the plate current could be brought back to 1 or even to 1·5 *m*A when the polarity of the machine was reversed. By referring to the Q.X. valve curves, it will be seen that the cloud of ions in the vicinity of the grid must have reached a voltage of between 1·8 and 1·9 volts to raise the plate current to 1·5 *m*A.

Employing a sensitive moving coil galvanometer in place of the milliampere meter, and only 60 volts in the plate circuit the valve, with a radium spiral attached to its grid, became so sensitive that a small piece of brown paper 1½ ins. square, heated and then excited by friction, would bring the plate current to zero, from a distance of 6 ft.

I tried replacing the two radium spirals by flames from two small pieces of cotton wool dipped in methylated spirit, and obtained equally good results.

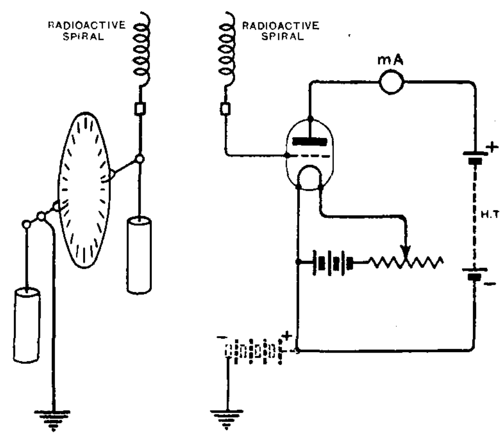


Fig. 5. The three-electrode valve employed as a supersensitive electroscope.

On the diagram, on the right-hand side of Fig. 5, I have shown in dotted lines a high tension battery the positive terminal of which was (for the experiment which I am about to describe), connected to one side of the valve filament. If the negative terminal of this high tension battery was connected to earth the plate current was at once reduced to zero.

I think the explanation of this is that the radium spiral, and the ionized air surrounding it, holds the grid at a fixed potential, and when the high tension battery is connected to earth, the whole circuit becomes relatively positive to the grid.

My next experiment was to connect the radium spiral to the grid of the valve of my receiving set, to see if, by means of a static machine, fitted with a radium spiral, I could from a distance impress a negative voltage on the grid, and so cut off the plate current. With a grid leak in position, I could only

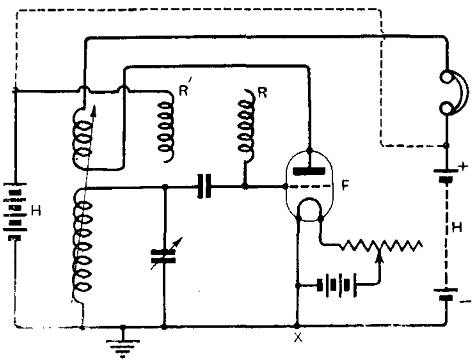


Fig. 6. Radium spirals employed to make the valve function near the top of its characteristic curve.

produce effects when the machine was very near. I tried the experiment, working with the A.T.I. directly coupled to the aerial, and also inductively coupled ; but on removing the grid leak, the valve at once became supersensitive, and I could cut out **2 LO** from right across the room, by the electrification of a small scrap of brown paper.

The radium spiral, to some extent did duty for the grid leak, but of course the signal strength was considerably reduced by its absence.

By placing a second radium spiral in the vicinity of the one attached to the grid, and connecting it to the positive terminal of a high tension battery, the negative terminal of which was earthed, I was able to make the valve function near the top of its characteristic curve, and signal strength was then approximately as good as when an ordinary grid leak is employed.

As an alternative, the second radium spiral could be connected to the positive high tension battery supplying the plate current. The arrangement is shown in Fig. 6.

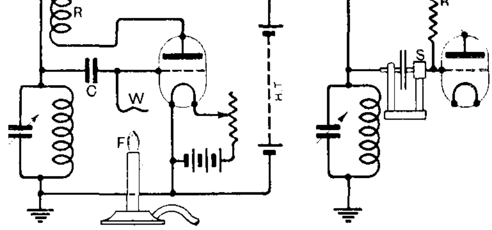


Fig. 7. Grid control by means of a flame.

Yet another idea might be to use a radioactive plate or plates in the construction of the condenser, and to add H.T. between the bottom of the aerial tuning inductance and the point X.

Flame Grid Leak.

Fig. 7 shows a sort of "Heath Robinson" arrangement which I have tried, in which I made use of the ionization of the air surrounding a flame to act as a grid leak. This works perfectly and gives excellent grid control. I found that the leak was too great when the wire W (leading from the grid) entered the flame; a critical position was very easily found at a very short distance from the side of the flame, or above it.

The foregoing experiments were repeated using for grid condenser two small metal plates 2 ins. square with air dielectric between them in place of the usual mica grid condenser, the grid plate being carefully insulated with sulphur.

With the valve circuits unearthed and connected inductively to the aerial, I found that the valve was still more sensitive to outside electrostatic fields.

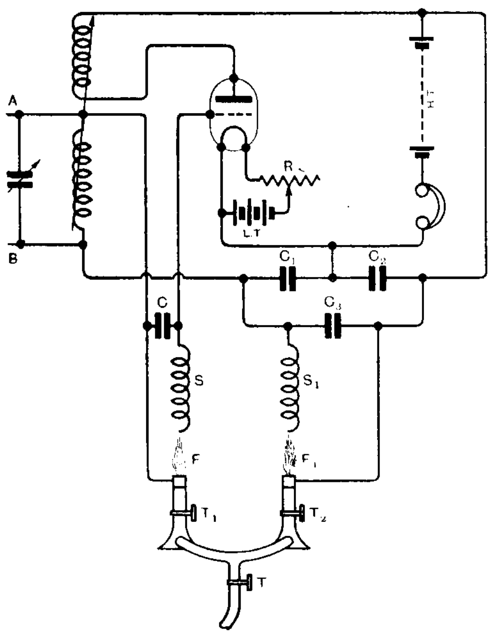


Fig. 8. Flewelling super circuit with simultaneous control of both grid resistances, using two flames.

From these results I conclude that a free, or shall we say semi-free, grid is much more readily effected by voltage changes than a grid anchored by means of a potentiometer or grid leak. We must, however, remember that the effects which I have so far observed were produced by stationary or comparatively slowly changing voltages. In the case of voltage variations taking place at a high frequency, we know that the grid responds quite readily in spite of potentiometer or leak. It is therefore questionable as to whether we can hope to achieve still further sensitivity by the employment of a less securely anchored grid voltage. It may be worth further experiment, I think.

In this connection it is interesting to note that between 1913 and 1914 Weagant employed a valve with an external grid both for reception and transmission, and he also showed an open detector in which only the A.T.I. was earthed. A tapping led from its upper turns to a variable grid condenser, and from thence to the grid. No grid leak was employed, and the filament and plate circuits were not earthed.

In another arrangement he tuned the plate circuit and coupled it magnetically with a coil of wire in the lead to the grid on the A.T.I. side of the grid condenser; in this case he also earthed the filament and plate circuits.

He also employed an air core transformer to step-up the voltage applied to the grid. I have tested out these circuits, and find that they give excellent signal strength, but were not very selective.

The Employment of Ionised Air Grid Leaks to Control a Flewelling "Super Circuit."

Fig. 8 shows an arrangement which I devised to control a Flewelling circuit which answered well. The main feature is the simultaneous control of both grid resistances. Two flames were employed as shown, both fed from one supply pipe. The gas pressure was regulated by tap T, so that only sufficient gas could pass to supply full pressure to one gas flame F (issuing from a pin hole). As soon as the second flame F^1 was turned on by tap T^2 the gas pressure was reduced and both flames burned at half length.

Both flames could now be controlled by either tap. As one flame was increased, so the other flame was reduced; by this means very simple control was achieved.

During my first experiments, I introduced strontium, potassium and other metals into the flames to increase their conductivity. For this purpose I impregnated carbon rods in solutions of strontium bromide, potassium hydrate, etc., in methylated spirits. The carbons when dry were introduced into the sides of the flames. I soon discarded the introduction of these salts into the flames, as I found that quite small normal flames gave sufficient conductivity.

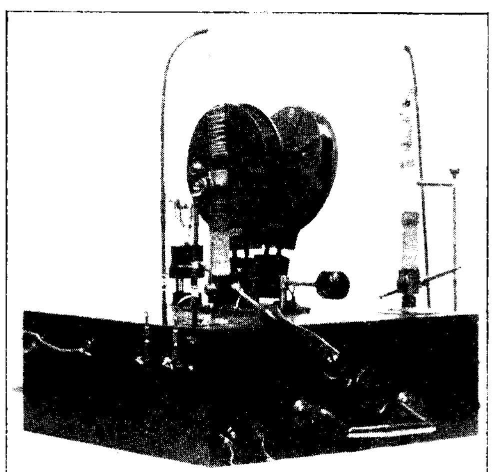


Fig. 8A. The Flewelling super circuit receiver embodying two flame grid leaks.

At first, also, I suspended small spirals of copper wire above the flames, connecting the condenser on one side to the spirals and on the other to the jet as shown in Fig. 8.

Later the jet connected was abandoned and replaced by three or four turns of stout copper wire arranged just above the jet and below the grid spiral. The flame was arranged to pass through the centre of the spirals without necessarily touching them.

I quite expected to find that the flames would be sensitive to the slightest draught of air, and would cause the grid leaks to be unreliable. In practice this did not prove to be the case; this is probably because the air for quite a long distance around the flames is ionised.

The Flame Grid Leak and Flewelling's Simplified Circuit.

Fig. 9 shows the connections employed. This circuit was tested (1) with aerial connected to A and earth to B; (2) Using no aerial and terminal A connected to earth; (3) Using no outside aerial or earth, and a small frame aerial in series with coil X.

The use of the outside aerial seemed to overpower the set, and very little difference in signal strength was observable in cases (2) and (3), though the latter of course had the advantage of being directional.

Using these connections I obtained two distinct types of results:—

(1) The true Flewelling effect, in which a steady whistling note is maintained to quench the oscillations of the valve, and over and above which the signals are heard. I had some difficulty at first in getting the set to function properly in this way. Eventually I found that I had not been using a sufficiently large reaction coil. Good control was obtained by adjusting the flame leak.

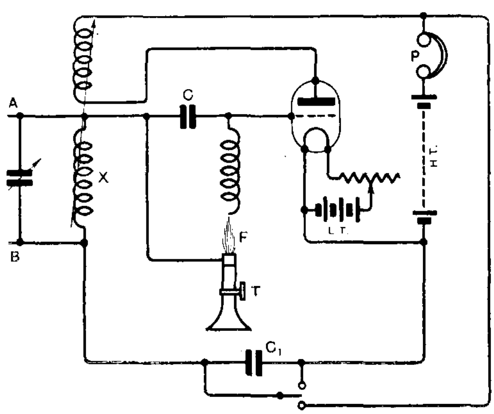


Fig. 9. Flame grid leak used in Flewelling's simplified circuit.

(2) The other type of result was obtained using the same connections under the following conditions: The grid was connected to earth at A, no aerial being employed. In this case, instead of using strong reaction, the reaction coil employed was smaller than the coil used for X. (I should perhaps have mentioned that Gambrell "plug-in" coils were used for all these tests.) It was approached towards the latter until the set just oscillated, without any sound being heard of the Flewelling whistle. When in this condition, although the signal strength was not so loud, I was able to pick up the following B.B.C. stations

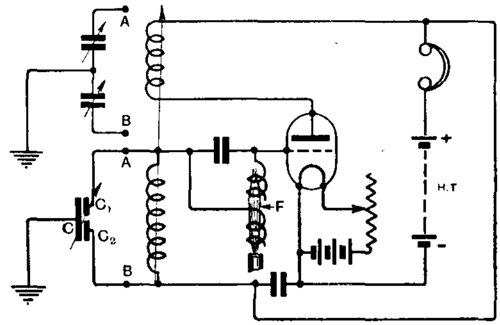


Fig. 10. The final arrangement, using a condenser with three sets of plates.

during a short test: London, Bournemouth, Birmingham, Manchester and Cardiff. (London was audible from a loud speaker right across the room at fair strength.)

The additional H.T. lead L was then disconnected, and condenser C^1 shorted, earth and all other connections remaining the same, except for fine adjustments such as closing the coupling between the reaction coil and X. Signals were still obtainable, greatly reduced in strength, from one or two powerful spark stations. **2 LO** also came in quite well, but there was no sign of any of the other B.B.C. stations.

There is a close similarity between the additional H.T. connections of Flewelling and my radium spiral experiment shown in Fig. 6.

The reason for the increased sensitivity of the circuit under conditions (2) is, I think, to be found in the fact that the additional positive grid bias causes the valve to function near the top of its characteristic curve. The potential of the grid being anchored to earth allows the set to act as a capacity aerial, and oscillate above and below the potential of the grid.

A variable condenser was then placed between the earth and the grid of the valve. Signal strength was slightly improved; it was also found that the self-oscillation of the set could be controlled thereby, and of course the tuning was affected.

There was one serious objection to this arrangement. The set became extraordinarily susceptible to capacity effects, and the listener had to sit bolt upright in one position, almost afraid to breathe, in case by some movement he should upset the tuning.

To get over this difficulty I anchored the grid to earth potential by placing a high resistance leak across the condenser to earth. This arrangement proved fairly satisfactory, though a slight loss of signal strength resulted.

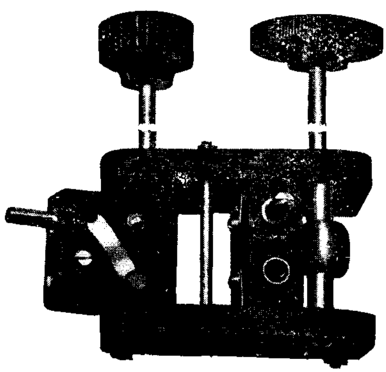
Fig. 10 shows the final arrangement adopted. A "3 EVC" condenser was employed, *i.e.*, a condenser fitted with three separately insulated sets of moving plates. The central plates were connected to earth. The plates V^1 were connected to the grid terminal A, while the third set of plates V^2 were connected to terminal B. It was found that the degree of oscillation could be nicely adjusted by altering the position of plates V^1, while fine tuning was possible by adjusting the position of plates V^2. In order to get the best results, the central plates were mainly engaged with those of V^1, while only engaging slightly with those of V^2.

This arrangement made the set quite workable, and did away with most of the objectionable capacity effects without appreciable loss of signal strength. The reception was not very far below that of an ordinary single valve set using a P.O. aerial and decidedly better than a crystal set on an aerial.

The great thing seems to be to keep all the variable capacities as near to each other as possible. Two condensers connected together, shown as an alternative arrangement in Fig. 10, acted equally well, but they are not so convenient, and take up more space.

SOME NEW COIL HOLDERS.

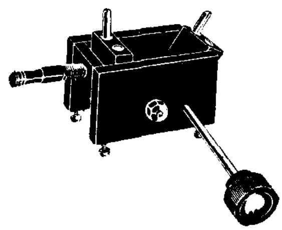
Many ingenious devices have made their appearance from time to time for the purpose of providing critical adjustment of the coupling between a pair of inductances. In any such arrangement a rapid or coarse adjustment must also be available, and in the case of a two-coil holder movement may be given to each coil holder, applying to one the coarse and the other the critical movement. Fig. 1 shows a system for providing fine adjustment by means of an eccentric cam, which, when rotated, drives the coil holder. Close contact between cam and coil holder is maintained by a spring. Provision has also been made in this holder for reversing the connections to one of the coils such as is required when one of the inductances is used to give reaction. This is accomplished by means of a pair of lever switches, one situated on each side of the holder.



[Courtesy : Goswell Engineering Co, Ltd.

Fig. 1. The "Quality" cam operated coil holder.

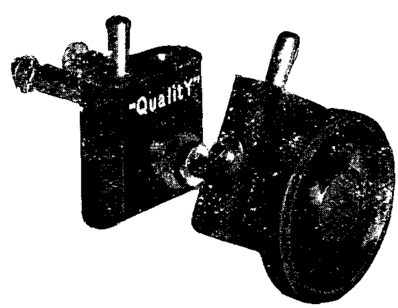
Another reliable method of giving fine adjustment is shown in Fig. 2, where a threaded stem engages against one of the coil holders and propels it through a small distance as the stem is rotated.



[Courtesy : G. Bristow.

Fig. 2. Coil holder with fine adjustment.

Fig. 3 shows a new design in coil holders for panel mounting. A pair of short rods support the holder and carry connection to the lower coil. The upper coil is arranged to swing across the lower one to provide reaction or loose coupling, or allow of the two inductances forming a variometer.



[Courtesy : Goswell Engineering Co., Ltd.

Fig. 3.

CORRESPONDENCE.

The Measurement of Low Frequency Amplification.

To the Editor of THE WIRELESS WORLD AND RADIO REVIEW.

SIR,—I thank Dr. R. L. Smith-Rose for his reply to my letter appearing in your issue of April 30th, and for his reason why measurements below 300 cycles were not given in his article referred to.

I believe it is the fact that none of the loud speakers yet produced give any appreciable response to lower frequencies than about 200 cycles, nor do the B.B.C. transmit them. The intervalve transformer is therefore not the only link in the chain which requires further development; but when one considers that this frequency is only a little below the middle of the musical scale, and that no frequencies below it are reproduced, it is surely a remarkable thing that the reproduction of music in this way sounds anything like the original.

I am sorry that Dr. Smith-Rose has jumped to the erroneous conclusion that my results obtained by the comparison of the three methods of intervalve coupling were either "subjective impressions" or "estimated values." They were actually obtained by instantaneous change-over switching, and in the case of the resistance-capacity coupling, extra H.T. was put into circuit by the switch to compensate for the drop in the anode resistance.

I can assure Dr. Smith-Rose that I fully realise the unreliability of the human ear as a means of sound intensity comparison unless such comparisons are made instantaneously. I would also point out that this method was employed by Mr. H. A. Thomas, with whom, as I mentioned in my previous letter, my results were in practical agreement, so that I do not think that Dr. Smith-Rose's references to "subjective impressions" and "estimated values" apply.

Of course I am well aware of the fact that any complicated wave-form can be resolved into a fundamental sine wave and its harmonics. The query in my mind at the time of writing the latter part of my first letter was, whether the behaviour of the transformer when dealing with a number of different frequencies simultaneously is the same as when it is dealing with a single frequency. It is a known fact that in other branches of A.C. engineering, this difference arises.

As regards my being unfortunate in my choice of a transformer, tests were made with a number of different specimens, including some of well-known make. I have, however, recently tested one which gives greater amplification than the other methods of coupling, though how much greater, I have not the necessary apparatus to enable me to measure.

I agree that the extra H.T. required is a serious drawback to the resistance coupling, and as at the present stage of development the lower frequencies are not there to amplify, and if they were amplified, would not be reproduced, there appears to be no advantage in using an intervalve coupling which will deal with them.

In conclusion, I am sorry if Dr. Smith-Rose formed the impression that I was criticising his article, or challenging the accuracy of his work. My object in writing was that I thought a little friendly discussion of this very interesting subject would have been of value.

A. C. HUSKINSON.

Sydenham, S.E.26.

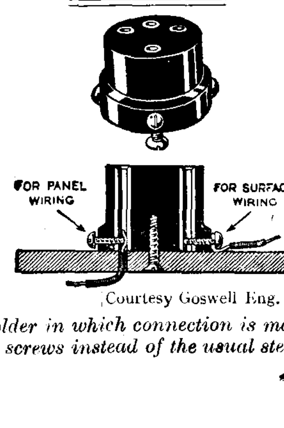
To the Editor of THE WIRELESS WORLD AND RADIO REVIEW.

SIR,—I thank Mr. Huskinson for his further letter, and as he remarks, the "accommodation" of the ear to reproduced music must be very considerable in view of the established facts. A study of the problem of distortion in radio-telephony is not complete without consideration being given to the physiological characteristics of the human ear. In this connection I would draw Mr. Huskinson's attention to a paper recently read by L. C. Pocock before the Institution of Electrical Engineers on this subject, the paper containing an excellent bibliography on the matter.

In spite of Mr. Huskinson's assurances of the care and precautions taken in the carrying out of his comparison tests, I must insist that theory and experiment agree on the point that a resistance-capacity coupling does not give nearly as much voltage amplification as a good transformer coupling. There is ample confirmatory experimental evidence to show that an intervalve transformer can give a definite step-up of voltage of from 3 to 5 times at all but the lowest audible frequencies, and that these figures therefore represent the superiority of the transformer over the resistance-capacity coupling. Mr. H. A. Thomas is a member of the scientific staff of this Laboratory's Wireless Division, of which I have the honour to be head, and I am able to state that he now completely agrees with my published results. The tests referred to by Mr. Huskinson were carried out by Mr. Thomas some 12 or 18 months ago, since when the construction and performance of transformers, the arrangement of amplifier circuits, methods of measurement and the general technique of low frequency amplification have considerably improved.

R. L. SMITH-ROSE.

The National Physical Laboratory,
Teddington.



[Courtesy Goswell Eng. Co., Ltd.

A valve holder in which connection is made by means of binding screws instead of the usual stem extensions.

NOTES & CLUB NEWS

Argentine **CB 8** has now been heard by Mr. B. L. Stephenson, of Withington, Manchester, and by Mr. H. J. Jarrold, of Norwich.

* * * *

The cost of erecting the new Rugby wireless station is estimated at about £400,000, the addition of four more masts, as recommended by the Donald Committee amounting to a further £62,000.

* * * *

The date of this issue witnesses the opening of **6 LV**, the Liverpool Relay Station of the B.C.C. It is understood that the wavelength to be used will be between 340 and 345 metres.

* * * *

Senatore Marconi, Professor G. W. O. Howe and Professor R. Whiddington are to attend the British Association meeting at Toronto during August.

* * * *

The "Radio Paris" broadcasting station has installed two microphones, one being for speech and the other for musical transmissions.

* * * *

Relay broadcasting stations are proposed for Nottingham, Stoke-on-Trent, Dundee and Swansea.

* * * *

Poldhu Telephony Transmissions Heard in Australia.

In an interview with a *Wireless World* representative, Senatore Marconi described the experiments which he has for some time been engaged upon at the Poldhu station. Whilst primarily undertaking the development of the beam directional transmitter he has devoted his attention to long distance telephony tests employing his short wave equipment.

Telephony transmission tests which were made on Sunday, June 1st, were attended by remarkable success. Listening in at Sydney, New South Wales, Mr. E. T. Fisk intercepted the transmission. The power employed was about 20 k.w. and the achievement marks a new record in long distance wireless telephony communication. The messages were also clearly read by Mr. J. H. Thompson, of the Canadian Marconi Company, in Montreal.

Radio Troubles in Belgium.

The Brussels Radio Club is waging a battle against legislation that would impose heavy taxation on wireless sets. Not only is the Club attempting to stop proposed taxes but efforts are being made to suppress those already in force.

Unidentified Transmission.

Mr. W. E. F. Corsham reports the reception of an unknown station on June 1st at 12.20 a.m., calling "**CQ CI 10 KZ.**"

We should be interested to know whether other readers have heard this station, and whether it has been identified.

Trans-European Amateur Transmission.

Mr. W. G. Dixon (**5 MO**), of Rowlands Gill, near Newcastle, states that he has received detailed reports of the reception of his signals in Eastern Czecho Slovakia, since January. The distance is 1,250 miles and the wavelength employed was 135 metres. The receiver consisted of a detector with one L.F. stage.

5 MO has also been heard on a similar receiver at Tarragona, in Spain, the strength of signals being R 4.

New French Station.

A new French station, "Poste des Etablissements Ancel," transmits frequently on 620 metres at 9.30 in the evening. Modulation is reported to be poor. The transmissions are chiefly composed of gramophone records.

Short Wave Meteorological Bulletins from FL.

The Eiffel Tower Station at present transmits a daily meteorological bulletin to America on 115 metres, at 4 a.m., 2.20 p.m. and 11 p.m. (G.M.T.).

Wireless with the Oxford Arctic Expedition.

Preparations are almost completed for the sailing from Newcastle of the Oxford University Expedition to Spit bergen, under the leadership of Mr. George Binney, who led the expedition last year. Wireless will again play an important part.

The chief object of the venture is the exploration of North Eastland, and for this purpose several sledging parties will be organised. A seaplane will also be taken for reconnaissance work.

Each sledging party will be equipped with a light hand-driven wireless transmitting set with which to keep in touch with headquarters. The Expedition hopes to maintain wireless communication with Norway, and possibly London, throughout.

"Pirates" in Edinburgh.

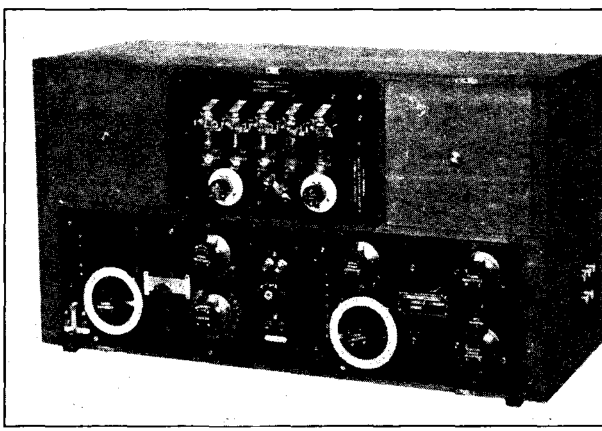
How many "pirates" are there in the Edinburgh area? This question is perturbing the Post Office authorities, who are confronted by a serious discrepancy between the number of wireless sets purchased in the district and the number of licences issued, which is approximately 5,000. One explanation advanced is that listeners have been tempted to await improved transmissions from the Edinburgh relay station before risking good money.

This policy is canny and consistent with Scottish traditions but, in view of the recent improvements at **2 EH**, the time seems to have arrived for "paying the piper."

Portability.

The merits of portable receivers have long been recognised, but a serious disadvantage was demonstrated at the Radio Section of the recent Paris Fair.

Dr. Titus Konteshweller, who had been advertising his portable set at the Fair, happened to leave his stand for a few moments, and on his return discovered that the extreme portability of the set had been taken advantage of. The thief has not been discovered.



Courtesy: Marconi's Wireless Telegraph Co., Ltd.

A new portable receiver, the Marconi type R.P. 1. The instrument is self-contained and embodies 2 H.F. and 2 L.F. amplifiers in addition to the detector valve. The careful layout provides for simple manipulation.

A New York Radio Fair.

The first Radio World's Fair is to be held in Madison Square Garden, New York City, from September 22nd to 28th, under the auspices of the Radio Manufacturers' Show Association. So great has been the demand for exhibiting space, nine-tenths of which is already allotted, that the exposition will probably have to spread to the other side of the street.

Among the features to be introduced will be a "Foreign Division," to which many European manufacturers and inventors are said to be contributing some "real surprises."

A special "Board of Radio Authorities" is being formed which will award suitable prizes to the most meritorious inventions perfected during 1924. The competition will be open to all and no entry fee will be charged. Special facilities are to be given to inexperienced successful competitors to market their inventions to the best possible advantage.

The Amateur Builder's Contest, which will be international in its scope, will form a large exhibition in itself. Entries are already being forwarded from Europe, South America and distant points in America.

Another Poacher.

Information regarding the reception of signals from any amateur station using the call sign **2 AIP** would be welcomed by Mr. Harrie King, of 2 Henslowe Road, East Dulwich, S.E.22. Mr. King, to whom the above sign has been allocated, suspects that it is being misused by a transmitter in the Midlands.

I.E.E. Visit to Northolt.

By the courtesy of the Post Office, the chairman of the Wireless Section, Institution of Electrical Engineers invites members to visit the Northolt Radio Station on Saturday, June 14th, at 3 p.m. Those desirous of joining the party should advise the Secretary of the Institution, when particulars regarding trains, etc., will be forwarded.

Street Aerial Dangers.

The Streets and Buildings Committee of Edinburgh, discussing the question of whether or not wireless aerials should be allowed to span the streets of the city, came to a sensible decision on May 30th. The Committee recommended that in view of the danger arising from insecurely or carelessly erected wires in public places, all aerials in such positions should be inspected and where found to be unsafe, should be removed at once.

This recommendation compares favourably with the tactics adopted by many smaller municipalities, who have placed wholesale bans on the erection of street aerials, regardless of care expended on their erection.

American Broadcasting Problems.

The problem confronting American broadcasters at the moment is that of paying for programmes. In this connection an appropriate competition has been organised by *Radio Broadcast*, of New York, in which competitors are asked to submit schemes to solve the difficulty.

Among the many questions awaiting solution are:—Should broadcasting be allowed to advertise? How are the restrictions now imposed by the music copyright law to be adjusted to the peculiar conditions of broadcasting?

Well-known men in radio and public affairs are to act as judges.

EIFFEL TOWER SHORT WAVE TRANSMISSIONS.

Further experiments in short wavelength transmissions are being conducted from the Eiffel Tower Station during the present month. The object of the transmissions is to ascertain the conditions covering the propagation of short waves by means of comparative reports from different locations.

Identification signals F or H are sent out with each transmission. F indicates that the aerial is functioning on approximately its fundamental wavelength, whilst H indicates that it is transmitting on a harmonic or by means of forced oscillation.

The following is the programme for June :

Monday	Tuesday	Friday	Saturday	Wavelength
9th	3rd	6th	7th	115 metres
16th	10th	13th	14th	75 ,,
23rd	17th	20th	21st	50 ,,
30th	24th	27th	28th	25 ,,

Time (G.M.T.)	Identification Signals
From—0500 to 0510	f f f f f
0515 to 0525	h h h h h
0530 to 0540	f f f f f
0545 to 0600	h h h h h
1500 to 1515	f f f f f
1520 to 1535	h h h h h
2100 to 2115	f f f f f
2120 to 2135	h h h h h

The following text will be transmitted in Morse very slowly, and finally dashes of a few seconds duration will be sent to enable measurements of signal strength to be taken :—

"v v v de FL— 115 m. — emission f f f or h h h"

The authorities at the Eiffel Tower would welcome reports of reception (which will be forwarded from this office) from any of our readers, as they are of the utmost scientific interest.

Reports should furnish the following information :

Date of observation, time (G.M.T.), signal strength under headings F or H according to the identification signal. Extent of disturbance (if any), from (1) fading, (2) interference, (3) atmospherics, (4) weather conditions, and finally, any detailed observations on the transmissions.

In reporting signal strength the following code should be used : R1 = signals unreadable ; R2 = readable with great difficulty ; R3 = weak but readable ; R4 = readable ; R5 = comfortably readable ; R6 = readable, quite strong ; R7 = signals strong ; R8 = signals too strong ; R9 = Loud speaker strength.

Forthcoming Events.

WEDNESDAY, JUNE 11th.

Radio Society of Great Britain. Informal Meeting. At 6.30 p.m. At the Institution of Electrical Engineers. Mr. A. H. Ninnis will give a talk entitled : "General Observations on the Radio Situation and the Development of Broadcasting in New Zealand."

North Middlesex Wireless Club. At 8.30 p.m. At Shaftesbury Hall, Bowes Park, N. Lecture: "The Carpet of Baghdad Circuit." By Mr. W. Gartland.

THURSDAY, JUNE 12th.

Hackney and District Radio Society. Vest Pocket Talks.

FRIDAY, JUNE 13th.

Radio Society of Highgate. At 8 p.m. At Edco Hall, 270 Archway Road. Lantern Lecture: "The Manufacture of Valves." By Mr. W. J. Jones, B.Sc., of the Cossor Valve Co.

MONDAY, JUNE 16th.

Hornsey and District Wireless Society. At Queen's Hotel, Broadway, Crouch End, N.8. Lecture and Demonstration : "Electromagnetic Waves." By Mr. G. J. Westgate.

Leicestershire Radio and Scientific Society.*

A Radio Problems Discussion was the feature of the Society's bi-monthly meeting on May 27th; many controversial points were raised and a very profitable discussion resulted.

It is hoped shortly to erect an aerial at the Society's new headquarters at the Y.M.C.A. Buildings, and much useful work should then be accomplished.

All communications regarding membership should be addressed to the Hon. Sec., Jos. W. Pallett, 111 Ruby Street, Leicester.

The Yeovil and District Radio Society.*

An experimental evening was held on Wednesday, May 14th.

During the summer, meetings will be held less frequently and the dates fixed are June 11th, July 2nd and September 3rd. It is hoped to arrange for outdoor experiments.

Hon. Secs., R. J. W. Marr, "Kismet," Sherborne Road, Yeovil; W. J. Hall, B.Sc.Tech., Greenhill, Sherborne.

Hackney and District Radio Society.*

At a well attended meeting held on May 22nd, Mr. Wall introduced the Society's new two-valve Experimental Panel. This has been so arranged that any circuit can be tested and tried out with a minimum of trouble and delay.

On May 29th, a "Surprise Night" was held. Each member drew from a hat a slip of paper, upon which was a question relating to Wireless. This question had to be answered to the best of the member's ability, such subjects as—"Why is Wireless so called?"—"What is in your opinion, the ideal aerial?"—"What is the difference between I.C.W. and T.T. transmission?" providing opportunities for constructive discussion.

Particulars of membership will be gladly sent on application to the Asst. Hon. Sec., Geo. E. Sandy, 70 Chisenhale Road, E.3.

Tottenham Wireless Society.*

On Wednesday, May 28th, Messrs. Willis and Ormandy, representatives of Messrs. Peto Scott, Ltd., gave a demonstration of their firm's apparatus, describing the advantages of the Unit System of wireless receivers.

The set on view was excellently finished, and consisted of Tuner Condenser panel, H.F. panel (with Transformer, Resistance Capacity, or Tuned Anode coupling) Detector panel and 2 L.F. panel with switch for the last valve.

A standard Amplion Concert model loud speaker was used, and excellent reception of Broadcasting was obtained.

Hon. Sec., A. G. Tucker, 42 Drayton Road, Tottenham, N.17.

Prestwich and District Radio Society.*

An interesting demonstration of a crystal detector and two-valve magnifier was given by the Western Electric Co. on May 22nd, and efficient working was obtained on an indoor aerial. The firm's standard valve amplifier and latest seven-valve receiver were also exhibited, the latter working on its own frame aerial. The selective properties of this set were extremely good. Members and friends later inspected the Society's new premises and the new receiving and transmitting gear in course of completion.

Hon. Sec., H. A. Wood, Spring Bank, Church Lane, Prestwich.

Wimbledon Radio Society.*

On Friday, May 23rd, the Transmitter Section of the Works Committee discussed further details in the design of the transmitting apparatus which the Society is assembling, whilst the Receiver Section completed the wiring of the four-valve amplifier panel of the receiving installation. Yet further improvements are being made to the aerial over the Red Cross Hall.

The Hon. Secretary of the Society, P. G. West, will be pleased to arrange to advise and assist any local residents who are in difficulty or doubt concerning their receiving apparatus, if they will communicate with him at 4 Ryfold Road, Wimbledon Park, S.W.19; whilst enquiries from prospective members of the Society are also welcomed.

The Southampton and District Radio Society.*

On Thursday evening, May 22nd, Mr. C. Fink, of the Igranic Electric Co., Ltd., gave an interesting lecture (illustrated by lantern slides), on honeycomb tuning coils, with special reference to short-wave work.

Hon. Sec., Lt.-Col. M. D. Methven, O.B.E., 22 Shirley Avenue, Southampton.

The Belvedere, Erith and District Radio and Scientific Society.*

On Friday May 23rd, Mr. A. H. Norman lectured on "The Armstrong Super-Regenerative Circuit."

Mr. Norman introduced his subject by reviewing the principles of what are generally known as reflex circuits. He then evolved, step by step, the Armstrong Super-Regenerative Circuit, explaining his points very clearly by means of blackboard sketches. The terms "positive and negative resistance" were gone into fully as it was essential, the lecturer said, to have a clear conception of these two properties in order to be able to understand the fundamental principles upon which Armstrong based his now famous circuit.

Hon. Sec., S. G. Meadows, 110 Bexley Road, Erith, Kent.

Lincoln Wireless Society.*

Great success marked the Society's first Field Day, which was held on Sunday, May 18th. The weather being entirely favourable, two parties set out from the City in different directions. Arrangements had been made with Mr. W. Herring (**5 ZV**), Mr. R. Bates (**5 OD**) and Mr. Cottam (**2 UL**) to send out test signals at different intervals during the day. Both parties succeeded in picking up signals remarkably clearly, considering difficulties encountered in obtaining reliable aerials and earths.

A well-attended discussion on "Loud Speakers *v.* Headphones" took place on Thursday, May 22nd, Mr. C. H. Fuskney (**5 NT**), speaking on behalf of Loud Speakers, explained the usefulness of these instruments. Mr. S. E. Layton defended Headphones, maintaining that they were preferable for accurate tuning. At the close of the meeting Headphones proved the favourites.

Hon. Sec., J. T. James, 126 West Parade, Lincoln.

North Middlesex Wireless Club.*

An attractive portable wireless receiving set, contained in a suit case, was exhibited by Mr. W. A. Saville on May 28th.

From the point of view of theory, very poor results should have been obtained from this set, as Shaftesbury Hall, the Club Headquarters, is a corrugated iron building, and the aerial employed was a few turns of wire in the lid of the suit case. Actually, however, very good signals were received and Mr. Saville was congratulated.

The lecture for the evening, "Looking Backwards in Wireless," was then given by the Hon. Secretary.

The lecturer gave a brief account of some of the early discoveries which made wireless possible, mentioning the work done by such men as Faraday, Wheatstone, Morse and Clerk-Maxwell. The various systems of line and earth current telegraphy were briefly touched upon and the epoch-making experiments of Hertz on electric waves and their propagation. Time would not permit of the story being brought up to date, so an account of the work of Lodge and Marconi and others was promised for another occasion.

Some preliminary arrangements for a "Field Day" were then undertaken, and it was decided to appoint a sub-committee to go into details.

On May 30th a small party of members spent an instructive and enjoyable evening at the up-to-date generating station of Messrs. Edmonds Bros., under the enthusiastic and capable guidance of the Engineer-in-Charge, Mr. Stephenson.

Hon. Sec., H. A. Green, 100 Pellatt Grove, Wood Green, N.22.

The St. Pancras and District Radio Society.*

A particularly interesting evening was spent on May 8th, when Mr. L. F. Fogarty gave a talk on "Distortion." The speaker first explained why certain harmonics were invariably introduced into speech or music owing to the upper and lower side bands heterodyning each other as well as the carrier wave. Next he explained some of the more avoidable causes of distortion in amplifiers, such as saturation, excessively sharp tuning, reaction, grid current, and badly designed L.F. transformers, concluding with a description of some remarkable experiments which he had performed with a number of well-known loud speakers. In reply to a question from a member, Mr. Fogarty explained that, since low impedance valves were a necessity in the last stage of a power amplifier, it was advisable to have the loud speaker wound to a suitably low impedance in order to obtain the maximum power output. He was also asked to give his opinion on resistance L.F. amplification, and he replied that he considered it far superior to transformer coupling.

As there is still room for more members, all those interested in joining the society should communicate with the Hon. Sec., R. M. Atkins, 7 Eton Villas, N.W.3.

Battersea and District Radio Society.

A demonstration with a five-valve set with loud speaker on Clapham Common was highly successful on May 3rd.

Arrangements have been made for a field day at Box Hill for experimental purposes in the near future.

Information regarding membership will be gladly forwarded on application to the Hon. Secretary, G. P. Phillips, 183 Lavender Hill, Battersea, S.W.11.

Wandsworth Wireless Society.

By the courtesy of the Management of the Pavilion, Lavender Hill, members and friends of the Society spent an enjoyable afternoon on Sunday, May 25th, when a concert was given in the theatre.

During the interval, the host, Captain Edward S. Davis, expressed his pleasure in seeing such an interested gathering and took the opportunity of thanking all those who had contributed to the afternoon's entertainment.

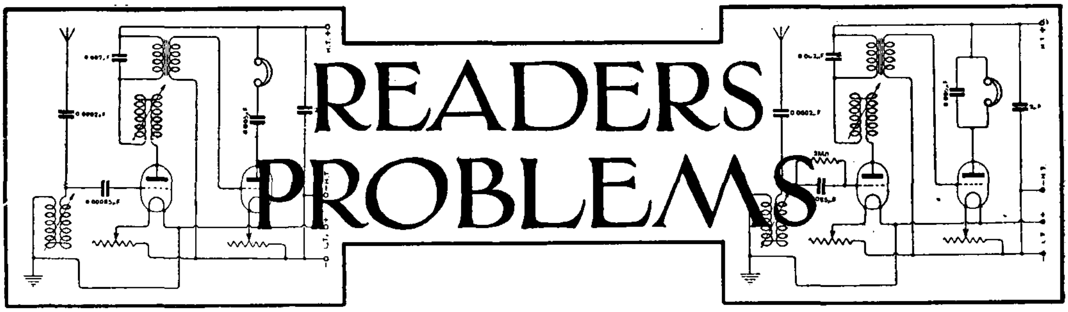
A film of radio interest was shown and proved at once instructive and amusing.

Particulars regarding the Society can be obtained on application to the Hon. Sec., F. V. Copperwheat, Technical Institute, High Street, Wandsworth.

The Birmingham Wireless Club.

On Friday, May 30th, a demonstration on the Club's set was given by Mr. H. G. Jennings, who provided an interesting explanation of various methods of rectification.

Hon. Sec., H. G. Jennings, 133 Ladywood Road, Birmingham.



READERS PROBLEMS

1. All questions are answered through the post. A selection of those of general interest is published. 2. Not more than four questions may be sent in at any one time. 3. Every question should be accompanied by a postal order for **1/-**, *or* **3/6** *for four questions, and by a coupon taken from the current issue. 4. A free coupon appears in the first issue of each month, and if this is sent in together with coupons from the three previous issues, the reader is entitled to have one question answered free of charge.*

"*J.A.C.*" (*Liverpool*) **asks for a diagram of a five-valve receiver with two stages of H.F. amplification, in which the number of H.F. valves in use may be controlled by means of a three-way distributing switch.**

The diagram is given in Fig. 1. The two H.F. valves are coupled by means of H.F. transformers, and a potentiometer is provided to control their grid potential. When the three-way switch is on stud 2, both H.F. valves will be in operation if the filament current is switched on by means of the filament resistances. On stud 1, one H.F. valve will be functioning, and on stud D the detector will be connected directly to the tuner. As requested, a switch is provided to cut out the last L.F. valve when not required.

"*H.W.*" (*Brede*) **has a receiver designed for broadcast reception, which picks up morse signals, but will not receive any telephony stations.**

The fact that you are able to receive morse signals clearly and yet are unable to pick up any of the B.B.C. stations seems to indicate that the tuning coils which you are using are too large, and that the wavelength range of your receiver is in the neighbourhood of 600 metres. We therefore recommend that you try the use of smaller tuning coils.

"*J.F.*" (*Manchester*) **asks if any methods are available for testing the efficiency of L.F. transformers.**

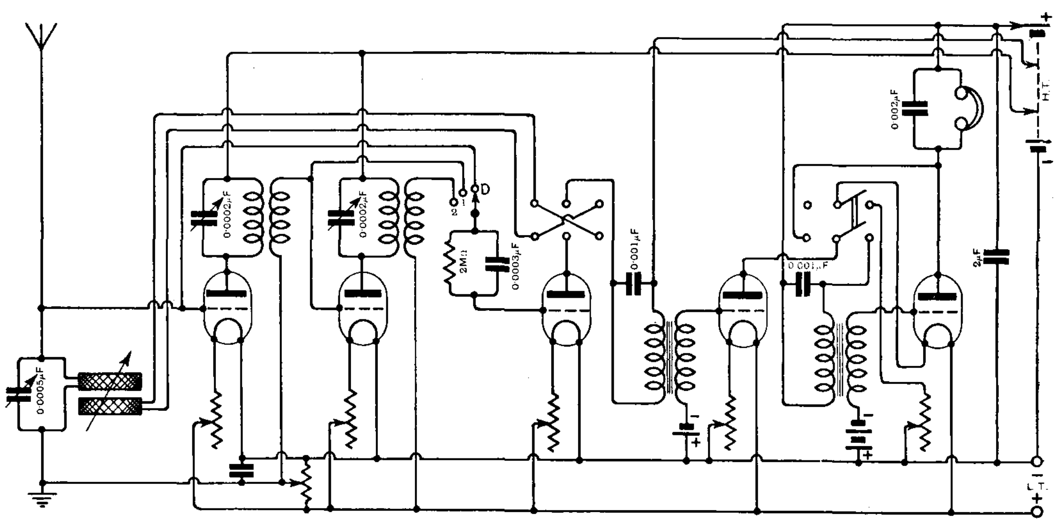


Fig. 1. "*J.A.C.*" (*Liverpool*). *A five-valve receiver with 2 H.F., transformer coupled, valve detector, and two transformer coupled note magnifiers.*

The method which is used at the National Physical Laboratory for testing L.F. transformers in conjunction with amplifying valves has been described in an article appearing in the issues of March 5th and 12th, 1924. This method is capable of giving very reliable results, and provides an effective method of matching valves and transformers. A method of testing the insulation between turns in intervalve transformers was given on page 728 of the issue of March 12th, 1924.

" *B.W.N.*" (*Bradford*) **asks for a diagram of a simple two-valve receiver for reception on wavelengths between 100 and 250 metres.**

We recommend that you use a detector valve followed by one stage of low frequency amplification, connected as in Fig. 3. The tuning coil L_1 may consist of 45 turns of No. 22 D.C.C. on a former 2½ ins. in diameter, the first tapping to − L.T. being taken at the 30th turn. The remainder of the coil will form the A.T.I., and should be tapped at every turn after the 35th, the aerial being connected to the arm of the 10 point switch. The aerial circuit may be tuned by means of a 0·0005 μF condenser in series if desired, but this is not always necessary.

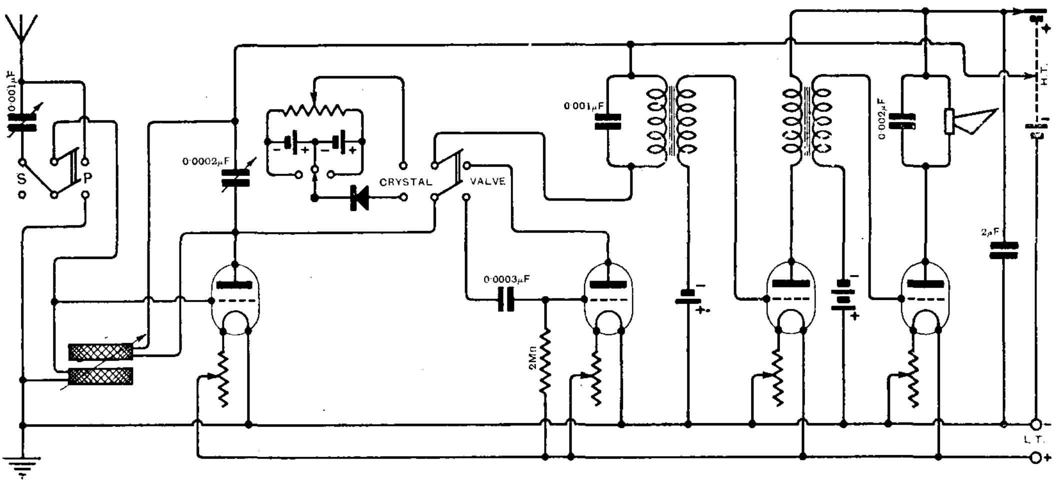


Fig. 2. " J.W.C." (Leicester). A receiver with 1 H.F., valve or crystal detector, and 2 L.F.

" *J.W.C.*" (*Leicester*) **asks for a diagram of a four-valve receiver in which the detector valve may be replaced by a crystal detector when required.**

The diagram is given in Fig. 2. The H.F. valve is tuned anode coupled, and by means of a change-over switch the crystal detector and first L.F. transformer may be connected across this circuit, or the plate of the H.F. valve may be connected to the grid condenser and leak in the usual way when the valve detector is required. If the anode coil is coupled to the A.T.I., it will be possible to obtain reaction effects when the crystal detector is used instead of the valve detector. This would not be possible if a reaction coil connected in the plate circuit of the detector valve were used. If you use a carborundum-steel crystal detector, a potentiometer and cells will be necessary.

" *W.J.P.*" (*Romsey*) **is using a "D.E.R." type valve which will not give satisfactory results until the voltage applied to the filament is in excess of 2 volts.**

The reason for the excessive filament voltage required to give satisfactory results may be that either the value of H.T. which you are using is excessive, or that the filament is nearing the end of its life and that the electron emission is falling off. You might try the effect of heating the filament at its normal temperature for about half an hour with the H.T. battery disconnected.

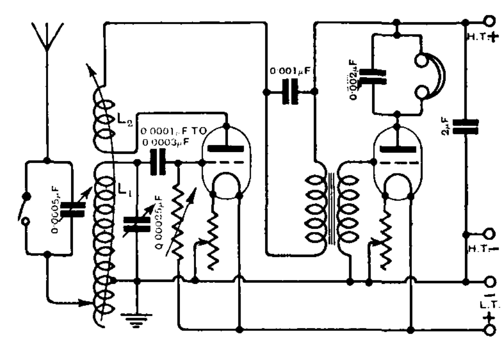


Fig. 3. " B.W.N." (Bradford). A short wavelength receiver.

The reaction coil L_2 may conveniently take the form of a basket coil of not more than 40 turns, mounted to rotate inside L_1. A basket coil has the advantage that the capacity coupling with the tuner coil is very small.

Calls Heard

Contributors to this section are requested to limit the number of calls sent in to those heard in the previous three weeks, these being of greater interest and value to transmitters than earlier records. The repetition of the same call sign in consecutive lists is not recommended. Contributors will also assist by kindly arranging reports in alphabetical order. Full address (not for publication) should be given to enable correspondence to be forwarded.

Osimo, Italy (up to April 28th).
2 AO, 2 AP, 2 CW, 2 DF, 2 FM, 2 FQ, 2 HF, 2 KF, 2 NM, 2 OD, 2 OM, 2 ON, 2 SH, 2 TA, 2 VF, 2 VS, 2 WJ, 5 BV, 5 KO, 5 QV, 5 SZ, 6 LF, 6 XX, ACD, 1 MT, 3 MB, 0 AA, 0 BQ, 0 FN, 0 KX, 0 MR, 0 YS, 0 ZK, 0 ZM, PCII, XY, 9 AA, 8 AB, 8 AG, 8 AP, 8 AQ, 8 AS, 8 AJ, 8 AZ, 8 BF, 8 BM, 8 BP, 8 BV, 8 CF, 8 CH, 8 CJ, 8 CM, 8 CT, 8 CZ, 8 DA, 8 DD, 8 ÉB, 8 ÉI, 8 ÉM, 8 ÉN 8 GK, 8 JL, 8 LY, 8 MH, 8 OH, 8 RO, 8 SSU, 8 ZM. American: **1 AF.** Canadian: **1 AR.** (Antonio Fiorenzi.)

Leytonstone, E.11.
2 AKS, 2 KW, 2 PC, 2 WJ, 2 ZT, 5 AW, 5 KO, 5 LF, 5 MO, 5 NH, 5 ST, 8 AAA, 8 AB, 8 AP, 8 BF, 8 BM (very Q.S.A.), **8 CC, 8 CF, 8 CK, 8 CM, 8 DN, 8 DP, 8 DV, 8 JD, 8 ML, 8 RO, 0 AA, 0 AAC, 0 AG, 0 CM, 0 DV, 0 FN, 0 KX, 0 MR, 0 NN, 0 NY, 0 US, 0XO, 0 ZN, XY, ACD, P 2, 1 JW.** American: **1 XW, 8 XS.** 1—v—1.) (Brian Wickham.)

Islington, London, N.1 (April 1st-30th).
2 ABZ, 2 DR*, 2 OS*, 2 SH*, 2 TA, 2 UV,* 2 VJ, 2 VW,* 2 XAX,* 5 BB, 5 BV,* 5 CV, 5 IL(?), **5 MA,* 5 OA,* 5 OT,* 5 PD, 5 SI,* 5 UN,* 5 XC,* 5 ZL, 6 BY, 6 FG,* 6 HV, 6 IV,* 6 OB,* 6 OB, 6 QM, 8 CK,* 8 CZ,* 8 DA,* 8 ÉB,* 0 NU.*** * Morse. (Clemence Bradley.)

Edgbaston, Birmingham (since December).
2 AGS, 2 DR, 2 FQ, 2 IN, 2 KF, 2 KW, 2 UR, 2 WJ, 2 ZT, 2 ZW, 5 BA, 5 CX, 5 KW, 5 MO, 5 NN, 5 ST, 6 DW, 6 LJ, 6 NI, 6 OM, 6 TD, 6 XJ, 6 XX, 8 AU, 8 AZ, 8 BÉ, 8 BM, 8 BP, 8 CS, 8ÉP, 8 ÉW, 8 JL, 7 ZM, 8 SSU, 0 AA, 0 BN, 0 MS, 0 NN, 0 XO, 0 XQ, 0 XW, PA 9. American: **1 ZO, 9 NBU.** (1—v—1 or 0—v—1.) A. C. Hulme, **5 NH.**)

Edinburgh (since April 1st).
2 AC, 2 AM, 2 QC, 2 QR, 2 UV, 4 IN, 4 PK, 5 BV, 5 DO, 5 KF, 5 KO, 5 LF, 5 NW, 5 OC, 5 OL, 5SW, 6 AW, 6 GRQ, 7 DU(?), **8 AQ, 8 BF, 8 CN, 8 DD, 8 DN, 8 EC, 8 GH, 8 RO, 8 OS, 1 AR, 0 KT.** (One valve Flewelling—frame aerial.) (Ian G. Munro.)

Shipley, Yorks (during April).
2 DW, 2 KW, 2 NM, 2 QK, 2 RB, 2 TO, 2 UF, 2 UV, 2 WJ, 2 XY, 5 BG, 5 BU, 5 BY, 5 FD, 5 KO, 5 MO, 5 OT, 5 OX, 5 QV, 5 SI, 5 SZ, 5 TK, 6 IG, 6 UW, 6 XJ, 6 XX, 8 AG, 8 AQ, 8 CN, 8 CM, 8 DP, 8 JC, 0 AA, 0 AG, 0 BA, 0 MR, 0 PC, 0 XO, W 2, 1 CF, 1 MT. American: **1 AR, 9 AK.** S. R. Wright, **2 DR.**)

Wembley (March 22nd-May 9th.)
2 AB, 2 AC, 2 AD, 2 AJ, 2 AR, 2 BC, 2 BZ, 2 DY, 2 HZ, 2 ID, 2 IL, 2 KV, 2 LI, 2 MK, 2 OM, 2 PY, 2 QC, 2 SF, 2 SH, 2 TI, 2 UC, 2 UV, 2 UZ, 2 VJ, 2 VR, 2 VS, 2 VW, 2 WA, 2 WD, 2 WI, 2 WJ, 2 WN, 2 WS, 2 XL, 2 XO, 2 XZ, 2 YR, 2 ZO, 2 ZX, 2 ABR, 2 AB 2, 2 ACU, 2 BBN, 5 AN, 5 AS, 5 AV, 5 CB, 5 CP, 5 CS, 5 DK, 5 DT, 5 EL, 5 FL, 5 FN, 5 IO, 5 PU, 5 UC, 5 UW, 5 VR, 5 VT, 5 YW, 6 BO, 6 BV, 6 CV, 6 EA, 6 GM, 6 GZ, 6 HD, 6 IM, 6 IS, 6 IV, 6 JS, 6 KI, 6 LJ, 6 PD, 6 PS, 6 VK. French: **8 AO, 8 AQ, 8 BG, 8 BL, 8 DO, 8 DX, 8 ZM.** Dutch: **0 BA, 0 MR, 0 SA, 0 XW.** Rhineland: **1 CF.** (0—v—0.) (A. L. Carrad.)

Newark, Notts.
American: **1 AFN, 1 ALJ, 1 AUK, 1 AUR, 1 ERI, 1 XAM, 1 XJ, 1 YW, 2 AGB, 2 CEI, 3 LG, 4 IO.** Canadian: **1 AL, 1 AR, 1 BQ, 1 DD, 3 BP.** (1—v—0.) (N. G. Baguley, **2 NB.**)

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PARIS (Radio "Paris"), SFR, 1,780 metres. 12.30 p.m., Cotton Prices, News; 12.45 p.m., Concert; 1.30 p.m., Exchange Prices; 4.30 p.m., Financial Report; 5.0 p.m., Concert; 8.30 p.m., News and Concert.

PARIS (Ecole Superieure des Postes et Telegraphes), 450 metres. 3.45 p.m. (Wednesday), Talk on History; 8.0 p.m. (Tuesday), English Lesson; 8.30 p.m., Concert; 9.0 p.m., Relayed Concert or Play.

PARIS (Station du Petit Parisien), 340 metres. 8.30 p.m., Tests

BELGIUM.

BRUSSELS, BAV, 1,100 metres. At 2 p.m. and 6.50 p.m., Meteorological Forecast.

BRUSSELS ("Radio Electrique"), 265 metres. Daily, 5 p.m. to 6 p.m., Concert. 8 p.m. to 8.15 p.m., General Talk. 8.15 p.m to 10 p.m., Concert.

HOLLAND.

THE HAGUE, PCGG, 1,070 metres. 4 to 6 p.m. (Sunday), 9.40 to 11.40 p.m. (Monday and Thursday), Concerts.

THE HAGUE (Heussen Laboratory), PCUU, 1,050 metres. 10.40 to 11.40 a.m. (Sunday), Concert; 9.40 to 10.40 p.m., Concert; 8.45 to 9 p.m. (Thursday), Concert.

THE HAGUE (Velthuisen), PCKK, 1,050 metres, 9.40 to 10.40 p.m. (Friday), Concert.

HILVERSUM, 1,050 metres. 9.10 to 11.10 (Sunday), Concert and News.

IJMUIDEN (Middelraad), PCMM, 1,050 metres. Saturday, 9.10 to 10.40 p.m., Concert.

AMSTERDAM, PA 5, 1,050 metres (Irregular), 8.40 to 10.10 p.m., Concert.

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SWEDEN.

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STOCKHOLM (Radiobolaget), 470 metres, Tuesday and Thursday, 7 to 9 p.m. Sunday, 6 to 8 p.m.

GOTHENBURG (Nya Varvet), 700 metres. Wednesday, 7 to 8 p.m.

BODEN, 2,500 metres. 6.0 to 7.0 p.m., Concert.

GERMANY.

BERLIN (Koenigswusterhausen), LP, 2,370 metres (Sunday), 10.40 a.m. to 11.45 a.m., Orchestral Concert. 4,000 metres, 7 to 8 a.m., Music and Speech; 12.30 to 1.30 p.m., Music and Speech; 5.0 to 5.30 p.m News.

EBERSWALDE, 2,930 metres. Daily 1 to 2 p.m., Address and Concert; 6 to 7.30 p.m., Address and Concert; Thursday and Saturday, 7.20 p.m., Concert.

BERLIN (Vox Haus), 400 metres. 11 a.m., Stock Exchange; 1.55 p.m., Time Signals; 5.40 to 7 p.m., Concert; 7 to 8 p.m. (Sunday), Concert.

BERLIN (Telefunken), 425 metres. 7.30 to 8 p.m. and 8.45 to 9.30 p.m., Tests and Concert.

BERLIN (Funkstunde A.G.), 726 metres.

FRANKFURT AM MAIN, 460 metres. 7.30 to 10 p.m. Tests. Gramophone records.

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MUNCHEN (Die Deutsche Stunde in Bayern), 486 metres.

AUSTRIA.

VIENNA (Radio-Hekaphon), 600 metres.

CZECHO-SLOVAKIA.

PRAGUE, PRG, 1,800 metres. 8 a.m., 12 a.m. and 4 p.m. Meteorological Bulletin and News: 4,500 metres, 10 a.m., 3 p.m., and 10 p.m., Concert.

KBELY (near Prague), 1,150 metres. 7.15 p.m. and 10 p.m., Concert and News.

SWITZERLAND.

GENEVA, 1,100 metres (Weekdays). At 3.15 and 8 p.m., Concert or Lecture.

LAUSANNE, HB 2, 780 metres. Daily, 9.15 p.m., Concert and Address.

SPAIN.

MADRID, PTT, 400 to 700 metres. 6 to 8 p.m., Tests.

MADRID (Radio Iberica), 392 metres. Daily (except Thursdays and Sundays), 7 to 9 p.m. Thursdays and Sundays, 10 to 12 p.m., Concerts.

MADRID, 1,800 metres. Irregular.

CARTAGENA, EBX, 1,200 metres, 12.0 to 12.30 p.m., 5.0 to 5.30 p.m., Lectures and Concerts.

ITALY.

ROME, ICD, 3,200 metres. Weekdays, 12 a.m. 1,800 metres, 4 p.m. and 8.30 p.m., Tests, Gramophone Records.

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THE OFFICIAL ORGAN OF THE RADIO SOCIETY OF GREAT BRITAIN.

No. 253. (No. 12. Vol. XIV.) JUNE 18th, 1924. WEEKLY

EDITOR:
HUGH S. POCOCK.

RESEARCH EDITOR:
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ASSISTANT EDITOR:
F. H. HAYNES.

QUESTIONS AND ANSWERS DEPARTMENT:
Under the Supervision of W. JAMES.

CONTENTS

THE EDITOR will be glad to consider articles and illustrations dealing with subjects within the scope of the Journal. Illustrations should preferably be confined to photographs and rough drawings. The greatest care will be taken to return all illustrations and manuscripts not required for publication if these are accompanied by stamps to pay return postage. All manuscripts and illustrations are sent at the Author's risk and the Editor cannot accept responsibility for their safe custody or return. Contributions should be addressed to the Editor, "The Wireless World and Radio Review," 12 and 13, Henrietta Street, Strand, London, W.C.2.

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The WIRELESS WORLD AND RADIO REVIEW

CONCERNING AMATEUR TRANSMISSIONS.

By the EDITOR.

WE are glad to note that the Postmaster-General is now issuing new licences to those authorised to use wireless transmitting apparatus for experimental purposes, and to each individual receiving the new form the instructions are given for old licences to be returned to the Post Office for cancellation.

The necessity for a clear understanding of the official regulations controlling the use of experimental apparatus for transmission purposes was pointed out in our editorial of May 14th, 1924, when it was explained that a great deal of uncertainty existed as to just what were the conditions under which such apparatus might be employed and how these conditions had been affected by various changes in regulations made by the Postmaster-General from time to time.

Some of the principal new points in these conditions as now set out, are :—

That spark transmission is specifically forbidden ;

The wavelengths for use for transmission are 150-200 metres, inclusive (tonic train c.w. and telephony), and 440 metres fixed wave (c.w. and telephony only).

The wavelength of 440 metres is not to be used between 5 p.m. and 11 p.m. on week-days or whilst the British Broadcasting Co.'s transmissions are being conducted on Sundays.

A record must be kept of all transmissions giving details.

But probably the most important restriction which has been imposed definitely, for the first time, we believe, is that which states :—

> "Messages shall be transmitted only to stations in Great Britain or Northern Ireland which are actually co-operating in the licensees experiments and shall relate solely to such experiments."

We opine that in inserting this condition the Post Office has been controlled to a certain extent by other Government Departments. It has evidently been considered inadvisable to give amateurs a free hand to conduct experiments and exchange of experimental messages with amateurs abroad. Of course, if such a regulation is enforced and no exceptions are made, then it is good-bye to Transatlantic and long distance tests of every kind, and the possibility of amateur links round the world and connections with all parts of the British Empire is an achievement which will have to be abandoned at the moment when amateur transmitters are realising what great possibilities lie in this direction.

We cannot believe that it is the intention of the Postmaster-General to put any such interpretation on the new regulations and we are confident that responsible bodies of amateurs or individual amateurs will still be authorised, as in the past, to conduct experimental tests with stations abroad. Apart from this reservation we welcome the new conditions and particularly the recognition by the Post Office of the necessity for putting the Regulations into a clear and concise statement.

The unrestricted use of the band of wavelengths from 150 to 200 metres in and out of broadcast times will certainly be a boon to the experimenter and provides the opportunity for experimental work to be conducted without the feeling that one is interfering with reception of the broadcast transmissions by other people.

The allotment of this wavelength for use during broadcast hours is an indication that in the opinion of the Post Office broadcast receivers should be sufficiently selective not to be interfered with by transmissions on 200 metres whilst the broadcast transmissions are being received.

TELEPHONE DIAPHRAGM RESONANCES.

In this article the author describes some experiments of extreme interest which show the nature of the vibrations of telephone diaphragms at different frequencies. The experiments can all be repeated easily by amateurs.

By Prof. E. MALLETT, M.Sc., M.I.E.E.

LET us strike a tuning fork on the table and in the usual way press the point on the table to obtain the very pure note which is characteristic of the fork. We know that this note is caused by the vibrations of the fork, that its pitch is the number of vibrations per second, 256 with a C fork, 427 with an A fork and so on, and that this number depends upon the length and thickness of the fork. If, however, we listen carefully when the fork is

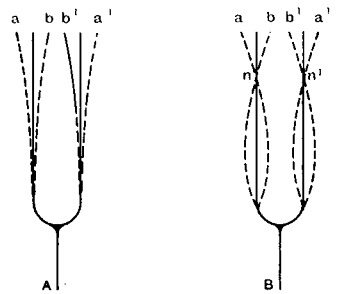


Fig. 1. Illustrating what happens when a tuning fork is vibrated.

struck we shall also hear a much higher note. This higher note is also due to vibrations of the fork, but of a different form from those of the low note.

The difference is indicated in Fig. 1, where A shows the manner in which the fork vibrates to produce the low note, or fundamental, and B that for a higher note, which is referred to as an overtone. In each case while the end a vibrates from a to b and back again, a' vibrates from a' to b' and back.

It is seen in B that the outlines of the fork in its extreme positions enclose a loop and that there are two points n and n' which do not move at all. These points are called nodes.

The possible vibrations of the fork are not however limited to these two methods but others may exist, and probably do exist, when the fork is first struck, in which the vibration outlines enclose two or more loops with two or more pairs of nodes, which cause higher and higher notes to be sounded. The higher notes die away much more quickly than the lower; they are more highly damped.

The tuning fork, therefore, is a mechanical device which is capable of a series of free vibrations. There are many other examples of similar devices, such as a stretched string, a bell, the air column in an organ pipe, and a telephone diaphragm.

In the case of a telephone diaphragm a much more convenient means of exciting vibrations than by striking it exists, that is by applying a periodic force by passing an alternating current through the receiver windings. Vibrations caused in this way are known as forced vibrations, to distinguish them from the free vibrations caused by a momentarily applied force. They will have the frequency, and emit the corresponding note of the alternating current, but will vary greatly in intensity as the frequency of the current is altered. Whenever the

Fig. 2. One diameter.

frequency of the alternating current is the same as that of one of the nodes of free vibration, the intensity of the note emitted reaches a maximum, and the diaphragm is found to be in most violent agitation. If the frequency is that of the fundamental node, the diaphragm is moving up and down as a whole in the same way as the prongs of the fork were moving backward and forward as a whole in A, Fig. 1. But with the overtones nodes develop. In the fork the vibration can be depicted by a line, and the nodes by points ; in the telephone diaphragm the vibration is over a surface, and the nodes become lines. Whenever therefore the frequency of the current through the receiver coils is that of one of the overtones of the diaphragm, lines will exist on the diaphragm where there is no movement of the diaphragm, but the vibration of the diaphragm in between the lines will be a maximum.

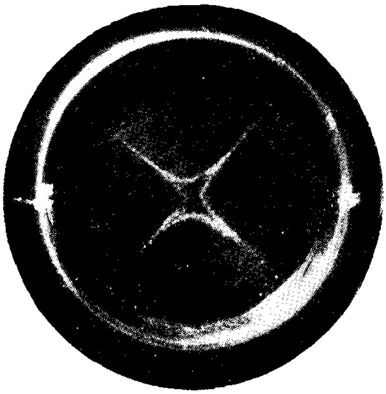


Fig. 3. Two diameters.

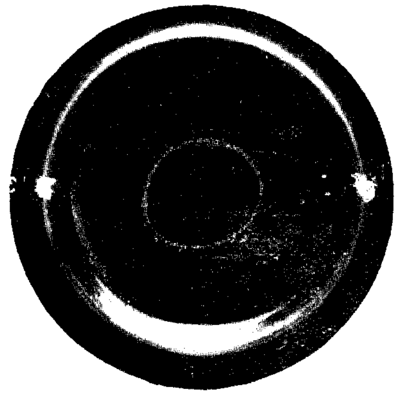


Fig. 5. One circle.

Fig. 4. Three diameters.

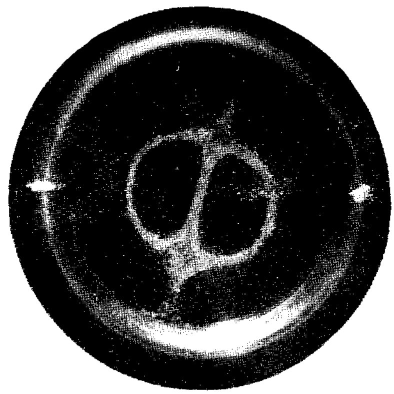


Fig. 6. One circle, one diameter.

In some experiments on the "howling" telephone which Prof. MacGregor-Morris and the writer made some time ago* the results indicated that the receiver was vibrating in one of its higher nodes, and in order to find out definitely whether this was the case the sand figure method used many years ago by Chladni in investigating the vibrations of plates was tried with success. If sand is sprinkled on a plate vibrating with nodal lines, the sand will very soon leave the parts of the plate which are vibrating and collect on the nodal lines, which are at rest. The sand will therefore draw out a picture of the nodal lines. In this way the photographs of Figs. 2 to 10 were obtained.

These experiments may very easily be repeated. The hole in the cap of an ordinary receiver is opened out so as to expose nearly the whole of the diaphragm, and the receiver is placed with its diaphragm horizontal and uppermost, and clean dry silver sand is

* See Proc. I.E.E., Vol. 61, No. 323, p. 1134.

sprinkled uniformly over the diaphragm. A valve oscillator capable of giving currents of a few milliamperes at frequencies from 1,000 upwards (see Fig. 11) is connected to the

Fig. 7. One circle, two diameters.

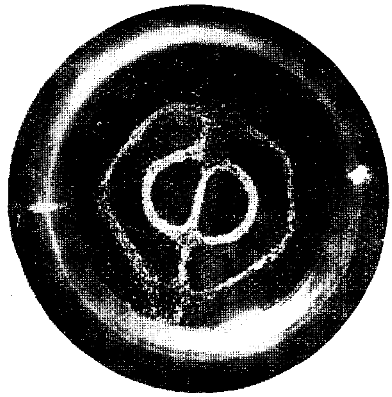


Fig. 9. Two circles, one diameter.

Fig. 8. Two circles.

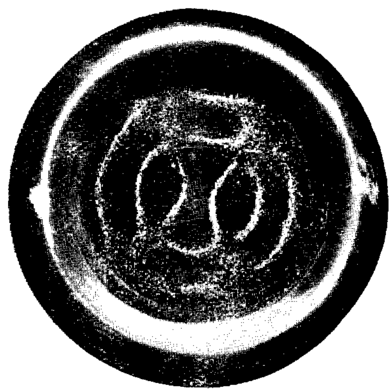


Fig. 10. Two circles, two diameters.

receiver, and the frequency is gradually raised by altering the variable condenser. As each of the frequencies of the resonant nodes is reached, the sand arranges itself in definite figures such as those depicted in the photographs. It is observed also that at the frequencies at which definite sand figures are observed, the intensity of the sound emitted is a maximum.

Sand figures may also be obtained in a very simple manner with no more apparatus than a toy tambourine with a parchment diaphragm and a little silver sand. The tambourine is placed on the table with its diaphragm uppermost, sand is sprinkled over the diaphragm, and sustained notes are sung with the mouth within an inch or two of the diaphragm. The sand arranges itself in various patterns with particular notes sung. In this way the writer has obtained some beautifully defined pictures, but not with his own voice! It appears that a trained singer obtains the figures far more readily than a

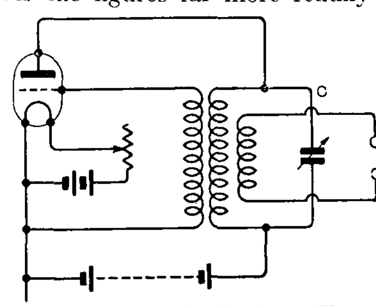
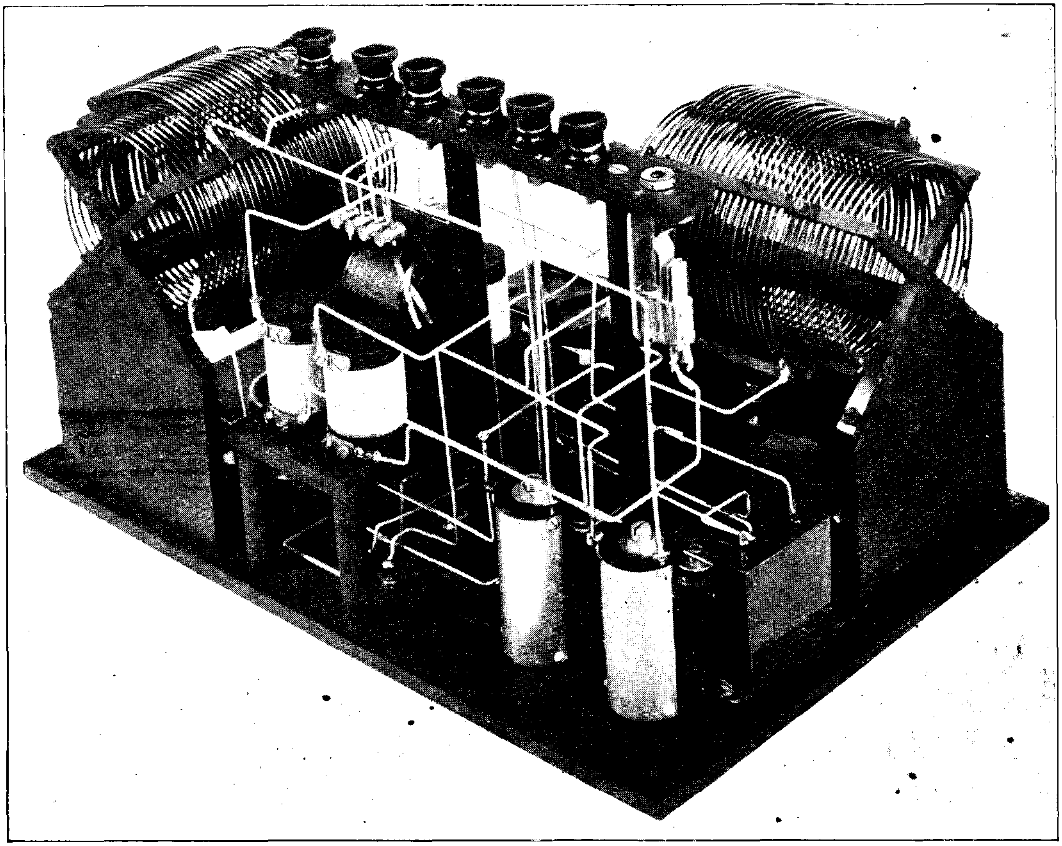


Fig. 11. Circuit of valve oscillator.

pure novice, and that vowel sound "ah" gives the best results.

(To be concluded.)



An underside view.

SHORT WAVE RECEIVER.

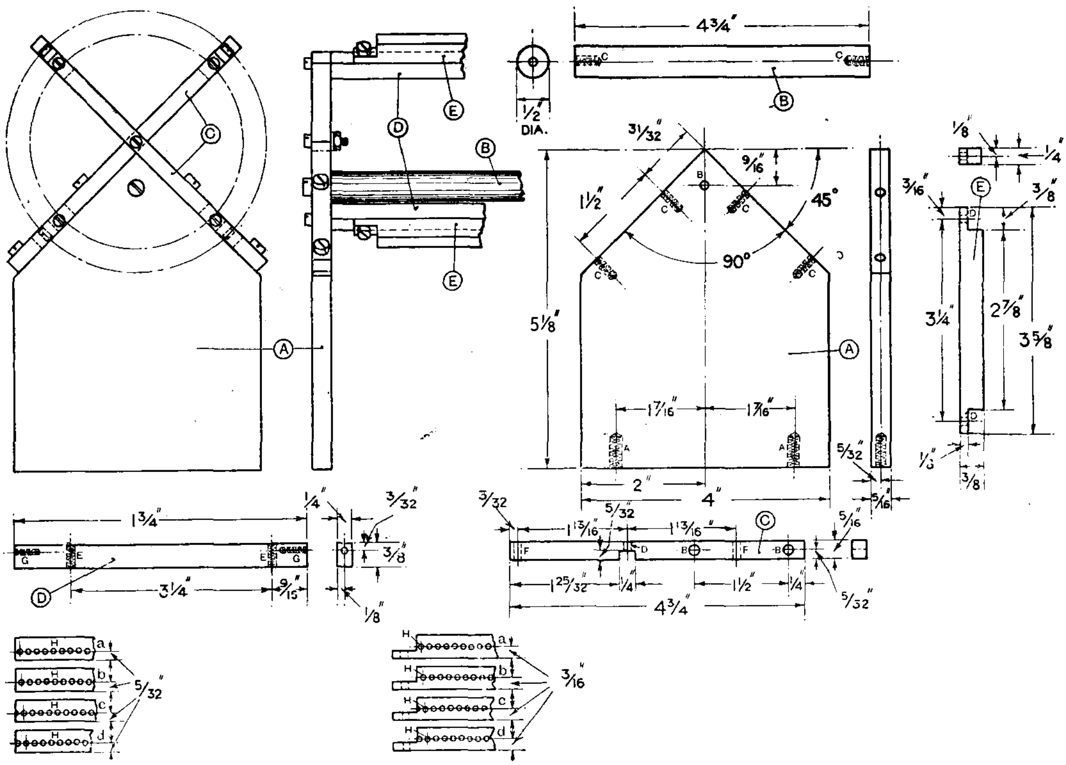
CONSTRUCTIONAL DETAILS OF THE COMPONENTS.

The problems which have to be contended with in setting up a short wave receiver were dealt with in the previous issue, and it only remains to describe details of construction.

By F. H. Haynes.

ALTHOUGH the working drawings given here contain all essential details and can, if necessary, be worked to exactly, it is thought that the skilled experimenter will, perhaps, introduce certain modifications to suit the particular components he may have to hand. Whatever modifications are made, certain general requirements must be observed. The variable condensers, for instance, should have a very low minimum, which is obtained in the Sterling condensers shown, by using insulating end plates instead of ebonite bushes and cutting away the fixed plates. " Square law " shaped plates are more of a necessity in this receiver than when they are required to tune circuits operating on longer wavelengths. The only other replaceable components are the filament resistances and potentiometer and intervalve transformer, which are Ashley and G.E.C. types. The intervalve transformer must be one possessing a liberal primary winding, as it is connected in the plate circuit of a " Q " valve which has a very high impedance. The feed-back condensers are Ashley type W 370, which have a maximum capacity of 0·00003 mfds.

In order that all components may be to hand, the building of the inductances might be proceeded with first. The construction of inductances of this type was first described in an earlier issue of this journal* and the above figure gives the necessary data for building the high frequency transformers used in this receiver. One of the longer strips D is made up first and used as a template for drilling out its three companions. The setting out of the holes of this first strip must be most carefully executed, for an individual hole out of line or too widely spaced will prevent the wire from sliding freely through the holes. The template strip should have two or three more holes than are required so that the necessary number of turns can be supported when the ends of the strips are trued up for mounting. It is held in position over other strips for drilling, end holes being made first, and both pieces secured firmly to the bench by inserting a spare drill of the size of the hole at each end. The drill should pass through quite vertically to avoid the cutting away of the strip that is used as a template and to ensure that the positions of the holes are identical. Centre punch marks should be made on the top face of each strip and at one end so that when they are threaded on the wire they can all be



Constructional details of H.F. transformers with low loss inductances. Sizes of holes :—A, Tapped 2 B.A. × ½" deep. B, Drilled 5/32" dia. C, Tapped 4 B.A. × ⅜" deep. D, Drilled ⅛" dia. E, Tapped 6 B.A. F, Drilled 7/64" dia. G, Tapped 7 B.A. × ⅜" deep. H, Drilled 5/64" dia. Strips to be drilled as shown above, commencing hole in first batten (a) *set back edge 1/16", first hole in batten* (b) *set back 3/32", first hole in batten* (c) *set back ⅛", and first hole in batten* (d) *set back 5/32", thus giving the required lead. Each piece* D *to have 34 holes 5/64" dia., and spaced equidistant ⅛" centres. Pieces E have 30 holes.*

* Page 613, Vol. XIII, Feb. 13th, 1924.

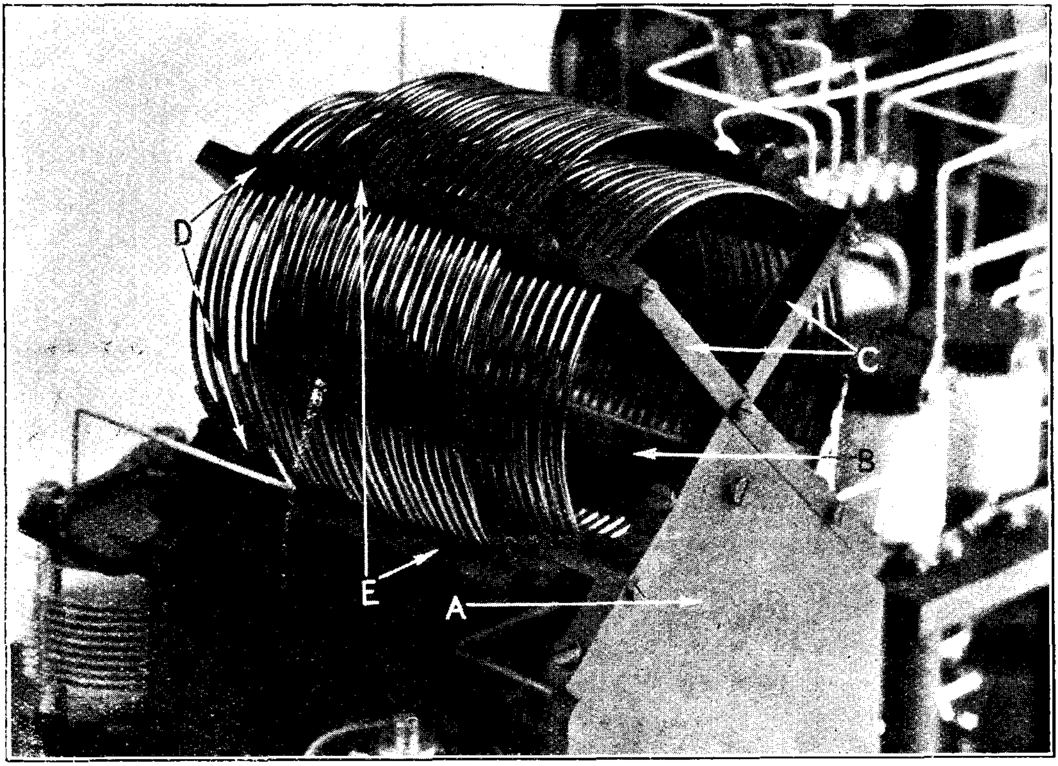
placed one behind another and with holes coinciding.

Before making up the remainder of the strips and the supports it is advisable to shape the wire for the inner coil and thread it on to the strips. This coil has a diameter of 3½ ins. and as the wire will spring open somewhat a former of 3 ins. in diameter should be used. The writer employed a 1 lb. paint tin, while for the larger coils a 2 lb. tin, 3½ ins. in diameter, served quite well. The wire is No. 16 enamelled and the requisite length was paid out and stretched to remove all kinks, and wound as tightly as possible on to the tin, with turns touching. Each turn may be made to bind back a little over the previous one, so that a good tight coil results. The wire must not be allowed to run slack for a moment and the tension is only released when the end of the wire is reached. The strips will be found to slide quite freely round the wire as No. 16 S.W.G. is about 1/16th in. in diameter and the holes are made 5/64th. in. The sides of the coil may need some adjustment to make them parallel and this is done by loosening or tightening the turns at one end.

The cross end pieces can next be made up and attached to the strips. Positions for holes should not be set out with dividers and rule, but carefully marked *with the pieces held in position.*

Having thus determined by the mounting the exact diameter of the inner coil, the outer one may be built to fit tightly over it, and all necessary details can be seen in the drawings. The outer inductance is, however, wound in the opposite direction to the inner coil and thus the former on which the turns are shaped must be rotated to produce a spiral of the reverse direction. The inner coil resembles a left-hand and the outer a right-hand thread.

The supporting brackets are next fitted up and these serve the purpose also of keeping the end pieces at exact right angles.



The reference letters relate to the dimensional drawing on the previous page.

Although these are shown made of 5/16th in. ebonite, hard wood may be substituted. Ebonite rod is placed inside the coils to hold the brackets firmly together and to relieve the drilled strips of strain.

There is no great difficulty in constructing inductances to this design and the reader is fully repaid for his trouble by the results he will obtain.

It has been suggested that pairs of strips might be employed clipped on to the turns, but having tried the method it was found to involve many more difficulties and there was the extra trouble of truing up twice the number of narrow strips, while screws had to be put through at intervals to prevent the strips from bowing out. It is essential to employ ebonite of a grade which is not brittle or the pieces will snap while being sawn from the ¼-in. sheet and it will be difficult to prevent the holes from breaking away at the back.

(*To be concluded.*)

THE TUNED CATHODE CIRCUIT.

The writer describes a new circuit principle which he has developed. He gives his views on its action and advantages over the more usual system of high frequency amplification.

By J. F. Johnston (**5 LG**).

THE tuned anode circuit and the merits of the tuned high frequency system of amplification are well-known and the circuit about to be described, although being a tuned system of high frequency amplification, possesses advantages over the more usual method.

Its advantages, I think, will be found to consist of—

(1) That several high frequency stages may be employed in cascade without the circuit having any tendency to self-oscillate.

(2) Good selectivity without critical adjustment, and

(3) Fewer components are required for each stage of high frequency amplification.

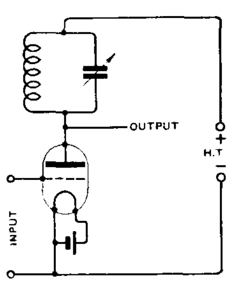


Fig. 1. The well-known tuned anode arrangement.

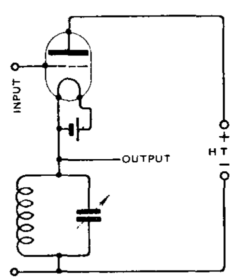


Fig. 2. The tuned cathode system.

It is probably the great stability produced by this method that has led the author to develop the circuit shown in the accompanying figures.

Fig. 1 shows a circuit employing the well-known tuned anode method of H.F. amplification. In this circuit the impedance of the rejector circuit remains constant, while the impedance of the valve varies according to the potential of the grid, thus causing fluctuations of voltage at the point from which the output is taken.

Now when the grid of the valve is made more negative (as by an incoming signal) the number of electrons emitted by the filament which succeed in passing through the grid to the anode is reduced, i.e., the current through the valve is reduced. In other words when the grid becomes negative the resistance of the valve is increased. When the grid becomes positive electrons are assisted by the grid to reach the anode or when the grid is positive the resistance of the valve decreases.

The main thing to notice is that when the input point becomes more negative the output point becomes more positive and *vice versa*.

Now the internal electrodes form plates of a condenser and the voltage changes of the output point are communicated back to the grid through this inter-electrode capacity, and as they are of the correct sign to reinforce the original oscillations, self-oscillation often results.

It will at once be seen that if we could arrange for the changes of potential at the input point to cause fluctuations of voltage of a *similar* sign at the output point, the impulses communicated back to the grid of the valve would be of the wrong sign to produce regeneration.

Fig. 2 shows how this desirable result is obtained. The plate of the valve is now connected direct to H.T. positive and the rejector circuit is connected in the cathode circuit, while the output is now taken from the cathode of the valve instead of from the anode.

It will be seen that with this arrangement when the resistance of the valve increases (by the grid becoming more negative), the output point also becomes more negative, and when the grid becomes more positive the output point follows suit.

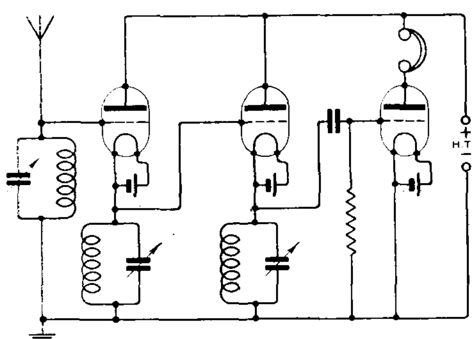


Fig. 3. A three-valve receiver having two tuned cathode H.F. stages followed by a detector, using dull emitter valves throughout.

In the practical construction of the circuits shown in Fig. 3 it will be seen that a separate L.T. battery is used for each H.F. valve. However, as the dull emitter type of valve is used for the H.F. stages, and as one dry cell per valve would be necessary in any case, this is no disadvantage.

It will be noticed that in each case the coupling between the H.F. stages consists merely of a wire connecting the cathode or filament of one valve to the grid of the next, thus omitting the usual coupling condenser and its attendant grid leak, and greatly simplifying the wiring. It will be noticed that the low tension dry cells are at a point of high frequency potential, so need of course be well insulated from earth. The leads to them should be as short as is consistent with the cells themselves being placed away from the rest of the apparatus.

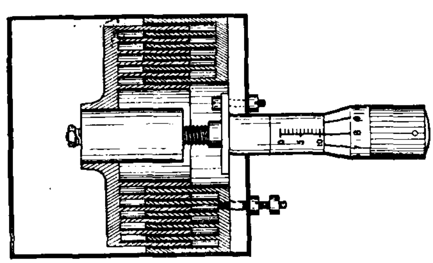
In the wiring up of these circuits the same care in keeping the various wires well spaced as in tuned anode sets is advisable, as the inter-lead capacity, while not so important in the tuned cathode system as in other systems of H.F. amplification, is best kept small as its presence produces a reverse reaction effect which tends to weaken signals. This principle is still in the experimental stage.

In the writer's set the tuned cathode coils are placed parallel to each other, and about 3 ins. apart, and the connections are the right way round to introduce a certain amount of magnetic reaction. This compensates for the reverse reaction effect of the inter-electrode capacity.

It is possible to design a tuned cathode set using one L.T. battery and one H.T. battery and bright emitter valves throughout, but in the above description the writer describes a set which has actually been constructed and which has given excellent results.

Micrometer Variable Condenser.

This condenser, manufactured by *René Sir* of Paris, is intended for providing precise capacity adjustment. The interleaving Portions are cylindrical, the view shown is a section.



THE CRYSTAL DETECTOR IN THEORY AND PRACTICE—IV.

THE SENSITIVITY AND PHYSICAL PROPERTIES OF CRYSTALS.

By JAMES STRACHAN, F.Inst.P.

THE sensitivity of a crystal rectifier depends upon:

Internal.—
1. Composition of the crystal.
2. Its physical properties.

External.—
3. Degree of contact.
4. Temperature.
5. The potential acting on the crystal.
6. Cleanliness of the loose contact.

1.—Composition.

We have seen already that the sensitivity of a crystal rectifier varies with its chemical composition. Apart from peculiarities of crystal form, one substance is essentially better than another as a rectifier. Individual substances, however, may vary in their composition and sensitivity. The sensitivity of zincite, for example, appears to vary with the percentage of manganese present, the deep red varieties containing about 10 per cent. of manganese oxide being much more sensitive than paler varieties containing less than one-half of that amount. Natural galena is much less sensitive than synthetic galena. While this is largely due to physical conditions, the composition of galena undoubtedly affects its sensitivity. Synthetic galena, prepared by fusion and crystallisation of pure lead sulphide or by sublimation of impure varieties, is much more sensitive than any specimen of natural galena containing impurities. On the other hand the sensitivity of galena may be increased by combination with silver sulphide or with antimony sulphide in certain proportions, while tin sulphide decreases the sensitivity when present in appreciable quantity. A finely crystallised specimen of lead and tin sulphides in molecular proportions had no rectifying properties. It should be noted that silver and antimony sulphides are themselves useless as rectifiers, although they affect the sensitivity of galena in combinations with it.

2.—Physical Properties.

The physical properties associated with the sensitivity of crystals are electrical resistance and hardness. Generally, the hardest crystals such as silicon and carborundum have the highest resistance, while softer crystals such as galena and graphite are lower in this property. While the softer galena and its associated compound sulphides are much more sensitive than the harder crystals, this does not imply that softer crystals are invariably more sensitive, because as we have already seen, increase of conductivity, which is associated with some soft crystals, such as graphite, reduces sensitivity. Sensitivity may thus increase with conductivity and then diminish. The following table gives some crystals, in order of sensitivity, their degree of hardness and rectified current measured under equal conditions.

Name of crystal	Hardness	Rectified Current mA.	Remarks.
Synthetic Galena.	2·5	2·	
Zincite ..	4·5	1·5	Deep red specimen
Iron Pyrites ..	6·5	1·25	Fractured crystal.
Natural Galena	2·5	1·	Selected cube.
Silicon ..	9·	1·	Fused.
Carborundum	9·5	1·	Anhedral.
Molybdenite ..	1·5	·75	Edge of perfect crystal.
Copper Pyrites	4·5	·5	Fractured crystal.
Graphite ..	1·	·25	Massive, very pure.
Magnetite ..	6·	·1	Crystal.
Ilmenite ..	6·	·05	Crystal.

3.—Degree of Contact.

The degree of contact, involving the best active area at the loose contact, is obviously largely a question of the hardness of the crystal and the hardness of the metal point.

The pressure required at the contact is theoretically and practically, most easily controlled when the points of contact are approximately equal in degree of hardness. Thus hard crystals such as carborundum, silicon and iron pyrites, are manipulated best with points of hard metal such as steel or phosphor-bronze, while soft crystals such as galena and molybdenite are better regulated with soft metal points such as lead, silver and platinum. In the case of a crystal-crystal contact the two crystals should be of approximately equal hardness and should not oppose each other in the direction of rectified current. In the case of zincite, bornite is undoubtedly the best contact crystal, because it is almost equal to zincite in hardness, it is a very good conductor and in itself has a very low rectification value.

4.—Temperature.

The fact that each crystal rectifier operates best at its own critical temperature is not of great practical import as any means of temperature regulation would involve arrangements tending to complicate the great simplicity of the crystal detector.

It is important to note, however, that when a crystal detector has been adjusted the application of heat for a few moments, from a small spirit lamp, will generally improve the degree of rectification. This effect is most marked in the case of zincite and persists after the removal of the heat so long as the contact remains unbroken.

5.—Applied Potential.

The operation of a crystal detector without the use of an applied D.C. potential appears to depend upon the nature of the crystal used and the potential difference between aerial and earth. From experiments with direct currents on crystals it has been proved that there is for a certain contact on any particular crystal, a critical potential for maximum sensitivity. It follows theoretically, from this fact, that any crystal detector will not operate without an applied D.C. potential unless the potential difference in the aerial-earth system of the circuit is of a magnitude sufficient to operate the crystal. In practice this is generally found to be the case and each particular crystal has its own range of action for rectification from a source of oscillations of constant strength. It is also found that some crystals do not rectify without an applied D.C. potential unless the receiving aerial is very near to the radiating station, and with other crystals of a more sensitive nature, in circuits remote from the radiating aerial, weak reception may be amplified by the use of an applied potential.

On the other hand we have found that many crystals* acquire greater sensitiveness by the application of a D.C. potential for a few minutes only on a given contact and that the more sensitive condition persists until the contact is broken. It is also found that this only holds good when the applied D.C. potential is passed through the crystal contact in the same direction as that of the rectified current in the simple crystal circuit.

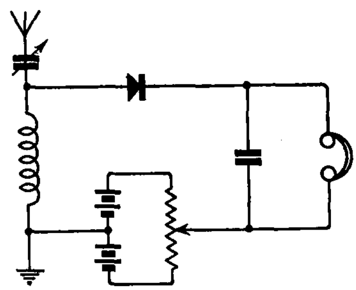


Fig. 1. Crystal circuit employing a potentiometer.

For these reasons a crystal circuit should always be fitted with a potentiometer (300-500Ω) as in Fig. 1, and terminals for the application of a direct current from a dry battery and when an applied potential is employed either constantly or intermittently, care should be taken that the current from the battery passes in the natural direction of the rectified current. Full particulars of the natural direction of the rectified current for various crystals will be given later.

Synthetic galena, either pure or in combination with other metallic sulphides, stands alone in its remarkable sensitivity without the use of an applied D.C. potential. The only other crystal which was found to rival synthetic galena in this respect was a compound telluride of lead and gold. Natural galena requires an applied D.C. potential to operate it at maximum efficiency. This extreme sensitivity of synthetic galena, which is associated with the very low critical voltage required to operate it as a rectifier, accounts for the popularity of this type of

* *e.g.*, Zincite and molybdenite.

crystal. At the present time there are over fifty proprietary synthetic crystals of the galena type on the market the majority of which bear pseudo-mineralogical names, *i.e.*, ending in "ite."

In the investigation and description of the sensitivity of a crystal, care should be taken to distinguish between the sensitivity of the average loose contact to reception and sensitivity of contact required to obtain rectification. A crystal which is a very good conductor, *e.g.*, graphite, may exhibit extreme sensitiveness in manipulation of the loose contact but as in the example mentioned may not prove a sensitive rectifier even at its optimum contact. Synthetic galena, on the other hand, although extremely sensitive to reception, is not super-sensitive in the manipulation of the loose contact. The addition of silver sulphide to synthetic galena, which will be dealt with more fully later, gives, in certain proportions, no greater sensitivity in actual reception, but increases tremendously the sensitivity of manipulation of the loose contact.

The composition of the metal used as a "catwhisker" at the loose contact is not important so long as the point is kept clean and attention is paid to the relative hardness of metal and crystal as indicated above. For crystals of the galena type, platinum or pure gold are ideal, but lead may be used with excellent results provided this metal is protected from oxidation as described below. For harder crystals gold wire may be obtained varying in hardness with its degree of purity. Hard nine-carat gold wire makes an excellent contact for such crystals as zincite, cassiterite, silicon and iron pyrites. For carborundum and silicon, rustless or stainless steel may be employed.

6.—Cleanliness of Loose Contact.

Assured cleanliness of the metal point or "catwhisker" may be obtained by use of metals which are not corroded by exposure to the atmosphere. On the other hand it should be noted that all crystals of the galena and pyrites types are themselves liable to oxidation. The depreciation of crystals by repeated handling is not due (as so often repeated and so widely advertised) to the formation of grease on their surface, but to the natural salts exuded in perspiration. These give rise to electrolytic effects at the loose contact, and also to oxidation of sulphides, which interfere with the rectification. Such salts absorb moisture from the atmosphere and give rise to the conditions producing lead sulphate from galena, according to the equation,

$$PbS + 2O_2 = Pb\,SO_4$$

This lead sulphate is the cause of the greyish appearance of a galena crystal which has lost its lustre. Such crystals may be cleaned by dipping them for a second or two into strong nitric acid followed by immediate washing with plenty of clean water and thorough drying. Another method of cleaning is to shake the crystal for a few minutes in a bottle containing some fine dry sand.

It should be noted that lead sulphate is a bad conductor and does not rectify, so that a film of this substance on the crystal immediately renders it insensitive. On the other hand a film of oxide on the "catwhisker" not only increases the resistance of the contact but forms a film coherer which may operate in a direction contrary to the crystal in respect of the direction of the rectified current.

For these and other reasons the writer has devised a crystal detector* in which the loose contact is perfectly protected from atmospheric influences by immersing or cementing the members in a suitable insulating medium.

Investigation of a number of well-authenticated cases of long-range crystal reception of B.B.C. telephony has not resulted in any very definite positive evidence. The negative evidence, however, was rather extensive and appeared to eliminate :

(1) Super-sensitivity of crystals used.
(2) Peculiarities of aerials and tuning methods.
(3) Personal equation.

We are thus forced to the conclusion that, in such cases where re-radiation may be ruled out, the phenomenon is in some way connected with the nature of the earth connection between the earthing system of the transmitting station and that of the receiving set, *i.e.*, the conductivity of the geological strata involved.

7.—Resistance of Crystal Detectors.

The resistance of a crystal detector depends not only on the nature of the crystal, but also on the degree of contact with the metal

* Prov. protected.

point. In most of the text-books dealing with wireless telegraphy the practical resistance of the crystal detector is estimated at 10,000 to 15,000 ohms. While this is undoubtedly the case in the delicate settings required for long distance reception of weak signals, it should be noted that the advent of modern broadcasting with the comparatively powerful and continuous oscillations has altered the conditions under which the average crystal detector is employed. With the modern synthetic crystal operating under average conditions in a B.B.C. area and with such comparatively strong potentials operating on the crystal, with the average degree of contact required for good reception, the resistance of the detector may fall as low as 1,000 ohms, and seldom exceeds 2,000 ohms. Under such conditions it is not surprising to find that headphones of very high resistance are not so efficient as those of more moderate resistance, while the best results are obtained in the case of high-resistance phones when the latter are connected in parallel.

Within one mile of a B.B.C. station this effect is so marked that ten galena detectors adjusted individually and then connected in symmetrical series did not diminish strength of reception appreciably, while a slight increase was observed with six detectors switched into series as compared with a single crystal. Under the same conditions two galena detectors placed symmetrically in parallel, after individual adjustment, reduced the resistance of the rectification circuit so much that reception was reduced by more than half.

With three detectors in parallel reception was very weak.

LOUD SPEAKER GRAMOPHONE ATTACHMENTS.

A NEW AMPLION PRODUCT.

For users of loud speakers possessing also gramophones, this device has been introduced. It is well known that the gramophone manufacturing companies have given considerable thought to true sound reproduction.

The matter of distortion as produced by a gramophone horn and its sound box is not quite the same of course as that set up by the wireless loud speaker, but this difference has been met by designing a special attachment which is fitted in place of the sound box and possessing sound characteristics which make it particularly suitable for giving good reproduction on a gramophone horn of standard design. A gramophone attachment is shown in the accompanying photograph, and in addition to being specially designed to operate in conjunction with the usual gramophone horn, is fitted with a new method of diaphragm suspension which on comparative test has been found to produce better quality than the earlier types.

In order that the wireless receiver and its amplifying apparatus may form part of a cabinet gramophone, it is a good plan to convert the compartment used for storing the records, so that it houses the tuning equipment, and by fitting a loud speaker attachment to the gramophone advantage is taken of the carefully designed horn.

VALVE TESTS.

THE MARCONI-OSRAM "R" AND MULLARD "ORA."

As our last subject we dealt with the Ediswan and B.T.H. "R" type valves, and we now continue our consideration of the remaining tubes of this type, the Marconi Osram "R," and the Mullard "Ora."

We have previously drawn attention to the similarity existing in regard to the filament characteristics of valves of the "R" class, which is further shown by reference to Figs. 1 and 4, which refer to the "R" and "Ora" respectively. Magnification and resistance curves of the former make are shown in Fig. 3, which give values of about 9 and 35,000 ohms respectively. Corresponding values for the "Ora" are shown in Fig. 6, and are both seen to be somewhat lower, about 8 and 20,000. These differences are reflected in the plate current grid volts characteristics of Figs. 2 and 5.

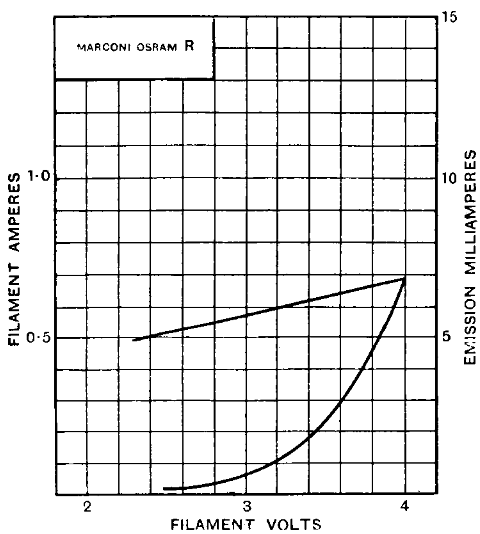


Fig. 1. Emission filament characteristic curves.

All valves of the "R" class are good general purpose valves; that is to say, they will give good performance when operating as high frequency amplifiers, low frequency amplifiers, and detectors. Of course, all general purpose valves must, to some extent be in the nature of a compromise, and consequently their curves will be a compromise between the various operating functions, but, suitably adjusted, these valves which we have considered will give excellent performance, at any rate, up to the first stage of a low frequency amplifier. Second and further stages of L.F. magnification call for valves with a more open grid.

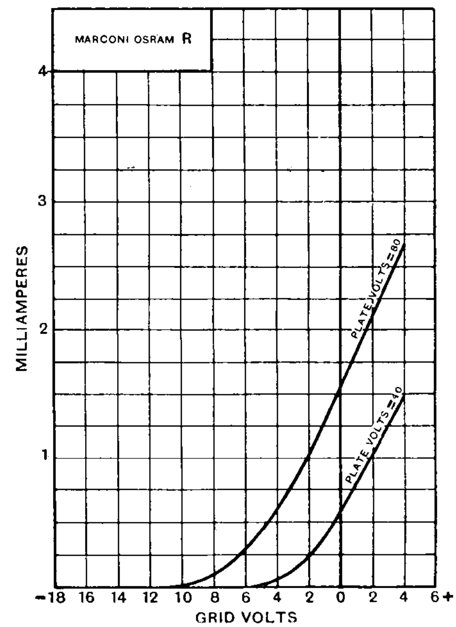


Fig. 2. Plate current grid volts characteristic.

All the foregoing valves are fitted with four pin caps, and, due to the extra capacity so introduced, are not so suitable for very

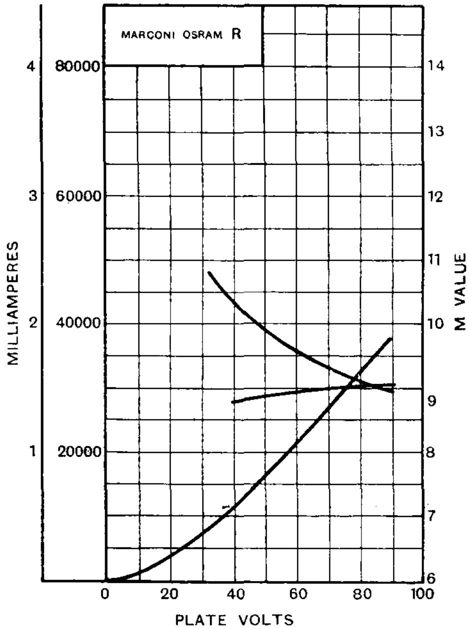


Fig. 3. Magnification and resistance curves.

short wave work as are others which have been specially designed to keep the internal capacity low.

Both makes under consideration operated very satisfactorily as H.F. amplifiers or

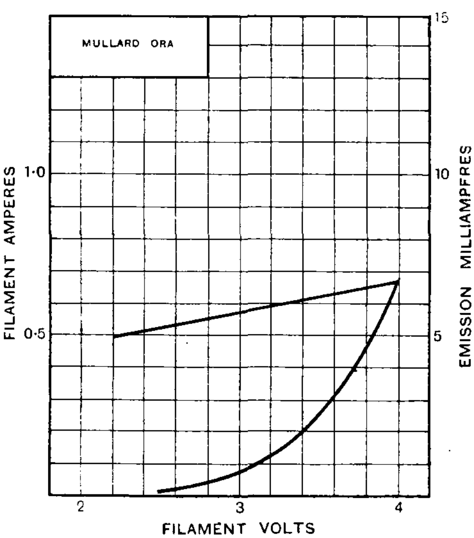


Fig. 4. Emission filament characteristic curves.

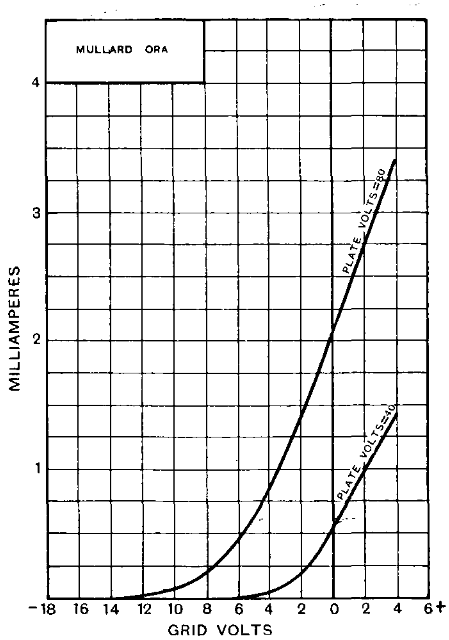


Fig. 5. Plate current grid volts characteristics.

detectors with 40 volts, or even slightly less plate potential, while for L.F. work we found 60 to 80 volts and a small negative grid bias very effective.

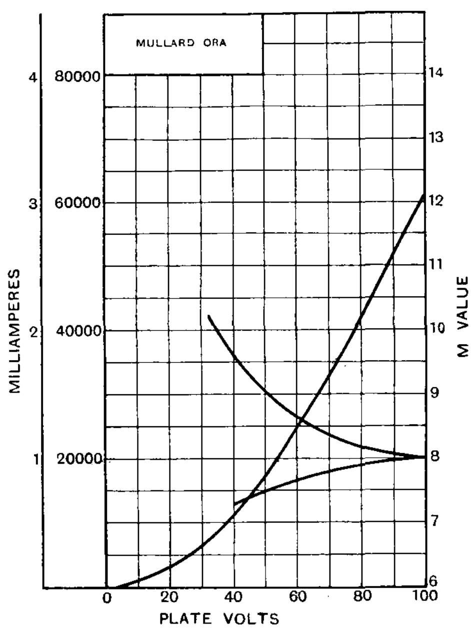


Fig. 6. Magnification and resistance curves.

DEAD END EFFECTS ON TUNERS*

It is generally known that dead ends on tuning coils lead to loss of efficiency. In this article data is given as to the magnitude of the loss due to this cause for various arrangements of the dead ends, and an improved arrangement is suggested.

W. B. MEDLAM, B.Sc., A.M.I.E.E. and U. A. OSCHWALD, B.A.

FOUR methods of arranging the dead end turns of an A.T.I. are shown in Figs. 1, 2, 3 and 4. In Figs. 1 and 2 the turns not in use are left open, while in Figs. 3 and 4 they are shorted. In Figs. 2 and 4 the unused part of the coil is electrically disconnected from the circuit. The results of measurements made on **2 LO**'s carrier with these four arrangements are given below.

Method 1. Open Dead Ends.

The manner of variation of the voltage across the receiver with the number of dead ends is shown in Fig. 5 for various numbers of turns in the active part of the coil. The coils (of the basket type) were all wound initially to 90 turns with 23 S.W.G. D.C.C. wire. A fixed number of these turns was connected across the receiver (in this case a thermionic voltmeter) and readings of the voltage across the active turns were taken as the dead ends were removed. The test was then repeated with the different numbers of active turns indicated by the figures against the graphs.

These graphs lead us to the following conclusions: (*a*) when the dead end turns are zero, *i.e.*, when using a plain untapped coil, there is an optimum value of inductance. In this case the optimum value is that of about 45 turns.

(*b*) When the number of active turns exceeds the optimum, each additional dead-end turn reduces the voltage a little, the reduction per turn increasing slightly with the number of active turns.

(*c*) When the active turns are below the optimum number a small number of dead ends may give a very slight increase in voltage, as shown by the rise of the curves for 20 and 30 active turns. The dead ends increase the apparent self-inductance of the coil, bringing it nearer its optimum value, and the increase in efficiency due to this effect may more than balance the loss of efficiency due to the dead ends.

The above results refer to the case in which the number of dead ends is comparatively small. The results for a large number of dead ends are shown in Fig. 6 for 40, 50 and 60 active turns. In order to accommodate the larger number of total turns on the same formers, finer wire (28 S.W.G.) was used in this case. The curves in Fig. 6 show that as the dead ends are increased up to a certain point the voltage falls gradually. Beyond this point the fall becomes extremely rapid. For example, with 40 active turns, the voltage falls gradually from 2·4 to 1·62 volts as the dead ends are increased up to 100 turns. The addition of another 11 turns causes the voltage to drop to zero. It then remains at zero or any further increase in the number of dead ends. It will be noted that the voltage drops to zero when the whole coil—in this case about 152 turns—is self-tuned, and before the dead ends themselves become tuned. It is this resonant effect which is the great danger with dead ends.

Comparing Figs. 5 and 6, it will be noted that by winding with 28 S.W.G. wire in place of 23 S.W.G. the voltages are reduced 5 per cent. with no dead ends, and about 12 per cent. with 50 dead ends.

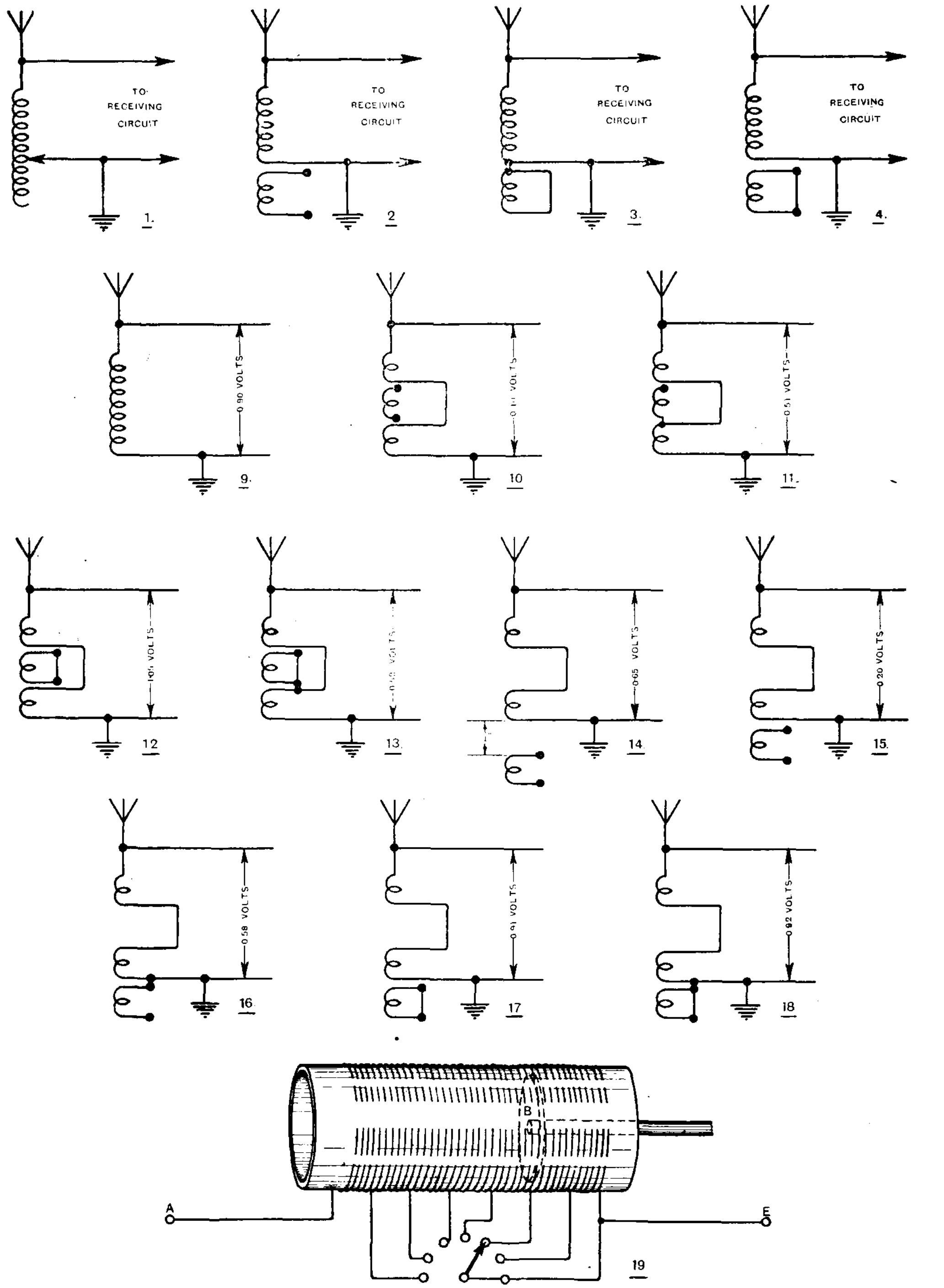
Method 2. Isolated Turns.

Complete curves for this case are not shown as they are very similar to those given above. The efficiency of this method is in most cases a little lower than that of method 1, and it is preferable to leave the ends connected rather than to isolate them.

Method 3. Shorted Ends.

The effect, on the voltage, of varying the number of shorted ends is shown in Fig. 7 for the numbers of active turns in-

* The experimental work described in this article was carried out at the Chelsea Polytechnic.



Figs. 1 *to* 4 *show four methods of arranging dead ends in coils ; figs.* 9 *to* 18 *illustrate the effect of the position of the ends with respect to the active turns ; fig.* 19 *shows one method of introducing copper disc shielding.*

dicated by the figures on the curves. The top two curves refer to coils of 23 S.W.G. wire, the lower three to coils with 28 S.W.G. For the particular tappings shown there is a sharp drop of volts when the number of shorted ends is very small, but this is not always the case. Sometimes the shorted ends show rising characteristics of the type shown in Fig. 8. The exact shape of the

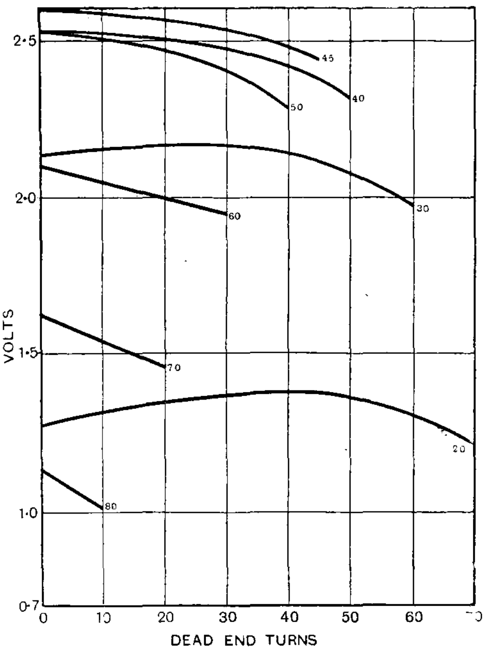


Fig. 5.

curve for a small number of shorted ends depends on whether the number of active turns is above or below its optimum number. In all cases, as the number of ends increase, the volts rise slowly to some asymptotic value.

The loss of voltage due to a large number of shorted ends may, with careful choice of the tapping point, be as low as 5 per cent. with wire of 23 S.W.G., or 15 per cent. to 20 per cent. with 28 S.W.G.

Method 4. Shorted and Isolated Ends.

The efficiency of this method is practically identical with that of method 3, and the data given above in connection with the latter method applies equally to this method.

Summarising the above results, we find that with open ends, either connected or isolated, the efficiency falls as the number of ends is increased, finally becoming zero when the turns exceed the number required to cause resonance. With shorted ends, either connected or isolated, the efficiency increases indefinitely as the number of ends is increased, except in some cases where there is an irregularity with a very small number of ends. Also the loss with ends of fine wire is, for any of the arrangements, greater than that with thicker wire. This extra loss with fine wire is *additional* to that due to winding the active turns with fine wire.

All the results given above apply to cases in which the ends and the active turns form a continuous winding, *i.e.*, there is close coupling between them. As the coupling is loosened, the efficiency of all four arrangements is increased until, with nearly zero coupling, there is no loss whatever. The effect of the position of the ends with respect to the active turns is shown in the series of diagrams, Figs. 9 to 18. In all cases the coils were of the solenoid type, the active part being divided into two equal portions separated by a distance just sufficient to allow the solenoid carrying the "ends" to be inserted coaxially, so as to give a

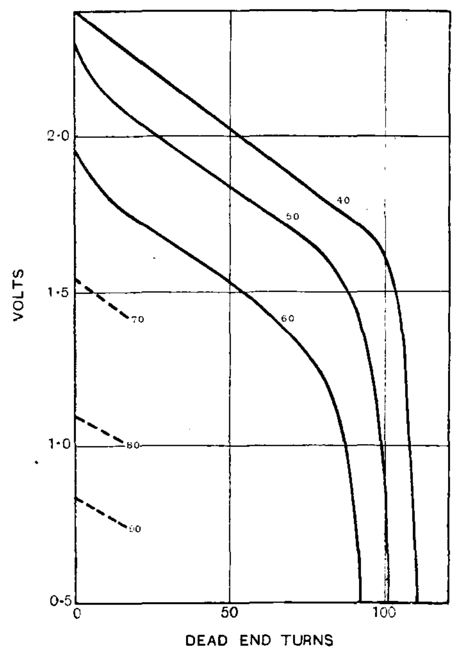


Fig. 6.

very close coupling. The ends when on the earth side were coupled as tightly as possible except in the case of Fig. 14, where the separation was 1 in., as shown in the diagram. The diagrams themselves are self-explanatory.

It will be noted that the arrangement shown in Fig. 12 gave a greater voltage than was obtained with the plain coils

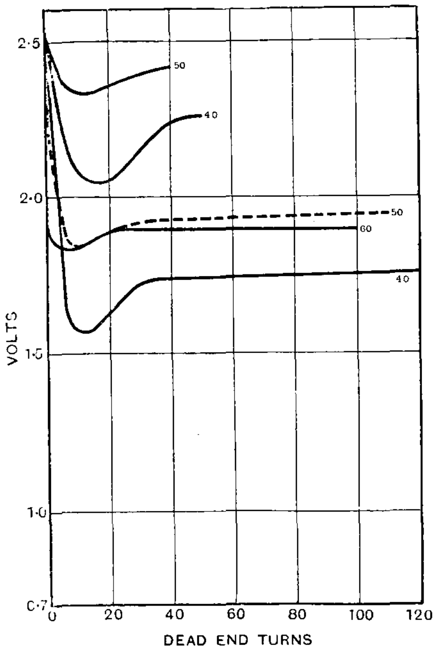


Fig. 7.

(Fig. 9). It must not be inferred from this that the arrangement in Fig. 12 is the better one. In this test the inductance of the active coils was considerably above the optimum value. The short-circuited winding placed in the field of these coils has the effect of reducing their self-inductance, bringing it nearer the optimum value. In this particular case the increase in efficiency due to this effect was greater than the loss of efficiency due to the presence of the short-circuited winding. Using the optimum number of active turns in all cases our measurements show the efficiency to be greatest when the dead ends are on the earth side of the active turns, and least when in the centre of them.

A Method of Eliminating Dead End Losses.

As the loss with dead ends is due to the magnetic coupling between them and the active turns, it may be practically eliminated by shielding the ends with a copper disc, or tube, placed in the path of the lines of force. One form of the arrangement is shown diagrammatically in Fig. 19, in which a copper disc B is arranged to slide along the inside of the solenoid until it is opposite the tapping to which the switch arm is connected. A better arrangement would be to replace the disc by a copper tube, sliding either inside or outside the former as close as possible to the turns. The tube should be put in such a position that it covers all the end turns. By sliding the tube over some of the active turns as well, a fine-tuning effect is obtained which would enable single turn tappings to be dispensed with.

Copper plate or tube tuning is highly efficient: in many cases it is more efficient than condenser tuning. The method is equally efficient as a dead end shield. In one severe test a basket coil wound with a large number of turns of fine wire was used as a dead end to another basket coil used as the A.T.I. The voltage across the A.T.I. was practically zero, whether the "ends" were connected as in Fig. 1, or isolated as in Fig. 2, unless the coils were several inches apart. With a copper disc, about 1/16 in. thick, between the two coils and the closest

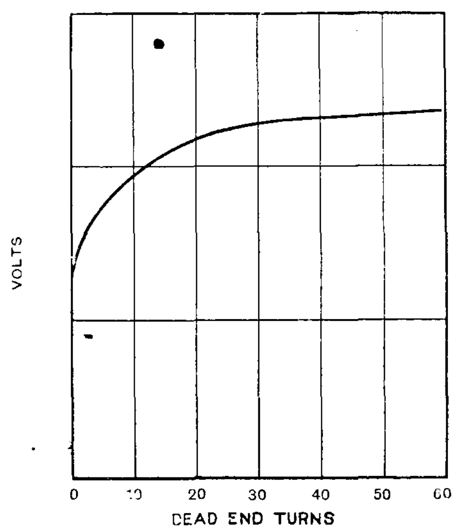


Fig. 8.

possible coupling between them (the coils were in contact with opposite faces of the copper) the voltage was practically unaffected by the presence of the dead end coil when shorted, and was not greatly reduced when the ends were open.

PATENTS AND ABSTRACTS

Improvements in H.F. Transformers.

It is well known that the inductance of the windings of a high frequency transformer may be varied by arranging a metal plate close to the transformer in such a manner that it may be moved. According to the present invention,* a high frequency transformer is constructed which comprises, for example, the transformer and a metal disc.

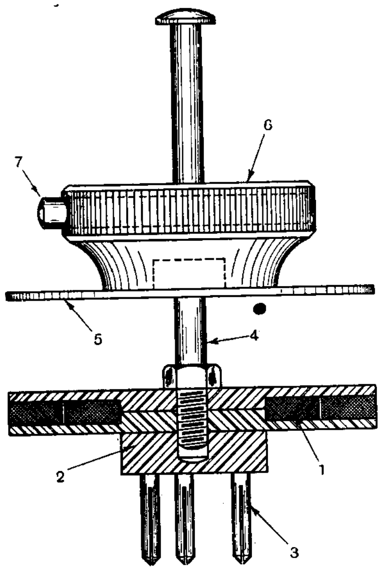


Fig. 1.

Referring to the sketch, Fig. 1, which shows one construction, the transformer is of the usual plug-in type, consisting of the former, 2, containing the windings 1, and carrying the contact pins, 3 A rod, 4, passes through the centre of 2, and is screwed into the plug. A metal disc, 5, is mounted on the carrier 6, while both the disc and the carrier are slidably mounted on rod 4.

By sliding the carrier, 6, along the rod, the transformer may be tuned.

* British Patent No. 214,338, by A. H. S. MacCullum.

Variable Condensers.

The plates of variable condensers are usually spaced apart by means of washers, or by pouring lead between the plates, or by milling the plates from pieces of metal stock.

In another construction† the plates (Fig. 2) are provided with projecting pieces 3, which may be punched or drawn from the metal sheets 1.

The portions 3 project from the same side of each plate, and may be made of equal length by any suitable means. The projections therefore take the place of spacing washers, and it is claimed that this construction has several advantages, which will be apparent.

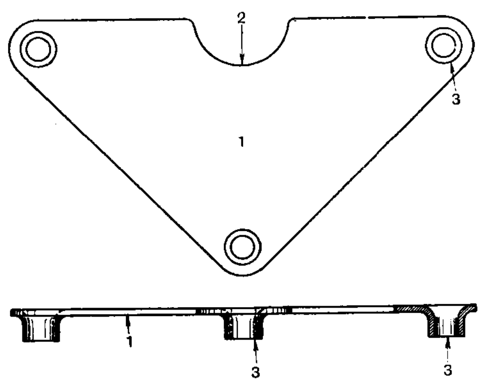


Fig. 2.

W.J.

† British Patent No. 201,890, by A. B. Cole.

PARALLEL DUAL AMPLIFICATION.

This brief article describes a method of dual amplification which has not received a great deal of attention by the amateur. The high frequency oscillating potentials from the aerial inductance are fed to the H.F. valve grid in parallel with the detected signals, while a small grid condenser avoids leakage of L.F. currents and an H.F. choke coil prevents oscillation leakage.

By W. H. PAULETT.

IN dual, reflex or double magnification circuits, there are two well-known methods of superimposing the rectified signal on the grid circuit of the high frequency valve. Only one method in which the high frequency and low frequency grid circuits are connected in series has received much attention. The other method is known as the parallel circuit because the two grid circuits are connected in parallel. In this method, which is probably more stable than the series method, the high frequency signals reach the grid through a small fixed condenser and the low frequency impulses through a high frequency choke coil.

The circuit shown in Fig. 1 and using the reaction coil L_4 (omitting L_5) is particularly suitable for British broadcast reception, as no direct reaction is applied to the aerial circuit and very excellent results indeed may be expected from this circuit. The circuit is capable of bringing in the distant stations and will work a loud speaker at comfortable strength up to about 20 miles from a broadcast station.

The circuits can be readily connected up and tried out by using two three-coil holders and two variable condensers. If good selectivity is required a loose coupled tuned aerial circuit should also be used.

If there is any tendency for the valves to oscillate on their own account, it is probably due to the use of too large an inductance coil in the plate circuit of the high frequency valve.

The method of coupling the two valves is the tuned transformer arrangement and while plug-in coils are suggested, other types, such as basket or cylindrical coils, may be used. High frequency transformers, particularly for dual circuits, should, in my opinion, be specially made; by that I mean they should be wound with thick wire, No. 20 or 22 D.C.C., and there should be an air gap of at least ⅛ in. between the primary and secondary coils. The basket type of transformer is perhaps the best.

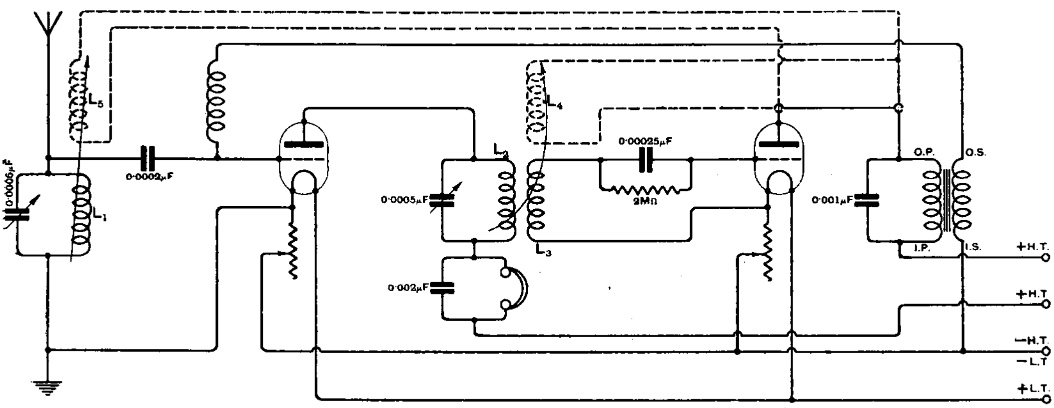


Fig. 1. The parallel method of dual amplification.

These circuits are suitable for all types of British general purpose valves and as a separate H.T. tap is provided for the detector valve, both valves will function best at the values specified by the makers for the purpose in which they are employed.

In this circuit the first valve functions in a dual capacity and the second as a detector.

The small affixed condenser, 0·0002 mfds., between the aerial and grid of the first valve prevents the low frequency signals passing to earth through the aerial inductance, while the high frequency choke, which may be a No. 200 plug-in coil or several basket coils in series, prevents the high frequency impulses escaping to earth through the secondary of the low frequency transformer. The high frequency transformer L_2, L_3, consists of two plug-in or basket coils in a two-coil holder. Although the coil in the plate circuit of the first valve is shown tuned, excellent results and stable working are obtained by tuning the coil in the grid circuit of the second valve and circuit is connected to the negative L.T. through the filament resistances. This tends to damp the circuits and prevent self-oscillation.

It is perhaps not necessary to mention that good results can only be obtained with good apparatus carefully connected up. "Remember that your set is no better than its poorest component."

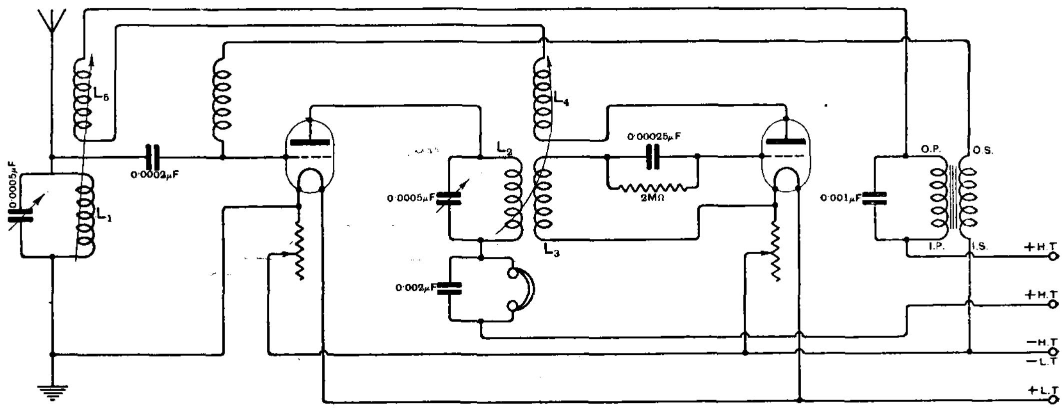


Fig. 2. Parallel dual circuit with double reaction.

leaving the other coil untuned. The fixed condenser 0·001 mfds. across the primary of the low frequency transformer is not critical and may be omitted with many types of transformers. For broadcast reception the coils L_1, L_2 and L_3 may be Nos. 35, 50 and 75 respectively. It is advisable to have a separate H.T. tap for each valve, as shown.

By means of the reaction coil L_5, which can be one of the usual No. 75 coils, reaction may be arranged on to the aerial inductance as alternative to the use of L_4. When three-coil holders are employed in both the aerial and H.F. valve anode circuits, the reaction coil may be transferred across from one holder to the other.

Fig. 2 is an interesting circuit employing dual amplification and double reaction. The reaction coils L_4, L_5, being connected in series with the plate circuit of the detector valve and coupled to the aerial and H.F. transformer respectively. Note that the grid

RADIO FIELD DAY.

The Western Metropolitan Area of Associated Societies of the Radio Society of Great Britain, acting on the initiative of the Golder's Green Radio Society, have organised a Field Day for Sunday, June 22nd, and experimenters are particularly requested to co-operate and make a point of listening in to the transmissions to be carried out on portable sets.

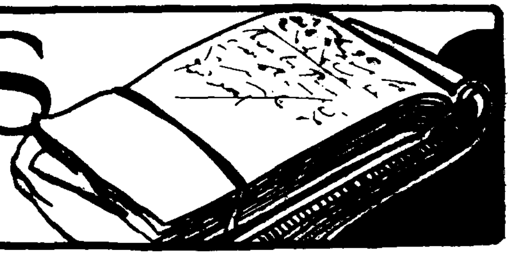
The stations will be operated at Stanmore (**5 GF**), Blatchworth Heath (**6 IV**) and Gerrards Cross (**2 GO**), using C.W. and telephony on a wavelength of 180 to 200 metres. Communication tests will be carried out between 1 p.m. and 3 p.m. and again at 5 p.m. and 6 p.m. Reports of reception which should be sent in as quickly as possible after the event, will be welcomed by Mr. W. J. T. Crewe, 111 Princes Park Avenue, Golder's Green, N.W.11. It is hoped that this Field Day will prove a great success.

The organisation of combined outings of this sort should make an appeal to other Clubs and facilities now exist for making such arrangements through the recently set up groups of Radio Societies.

The Hampstead, St. Pancras and Highgate Societies of the Northern Metropolitan group have also arranged a somewhat similar outing which is to take place on Saturday, 19th July next, when portable transmitting sets will be made use of.

If any reader is willing to loan a hand generator for the day to the Western Metropolitan group for their outing on Sunday, 22nd inst., will he please ring Mr. Crewe at Hampstead 3792 immediately.

NOTES & CLUB NEWS



G2 KF Heard in Los Angeles.

A report has been received which indicates that a Californian amateur (**U6 CEN**) of Los Angeles copied signals from **G2 KF** on several occasions during the Transatlantic tests of last Winter and on other occasions in addition.

It is understood that the receiver used employed three valves, two of which were low frequency amplifiers.

This report leaves only the fifth district of the United States of America which has not so far reported reception of this British station.

10 KZ.

Mr. S. K. Lewer (**6 LJ**), confirms Mr. Corsham's report recently published in "The Wireless World and Radio Review," o freception of an unknown station, **10 K Z** as he also logged this call sign on May 6th.

Another station received on April 27th was **1 NA**, which, it was suggested by our correspondent, might be Italian, but another communication received from Mr. E. P. Pockham, of South Croydon, reports reception of **1 NA** when his location was given as Finland.

2 OY.

We should be interested to receive any reports during recent months, of reception of this station, with details as to strength, etc.

Plea for Co-operation with Canadian Amateurs.

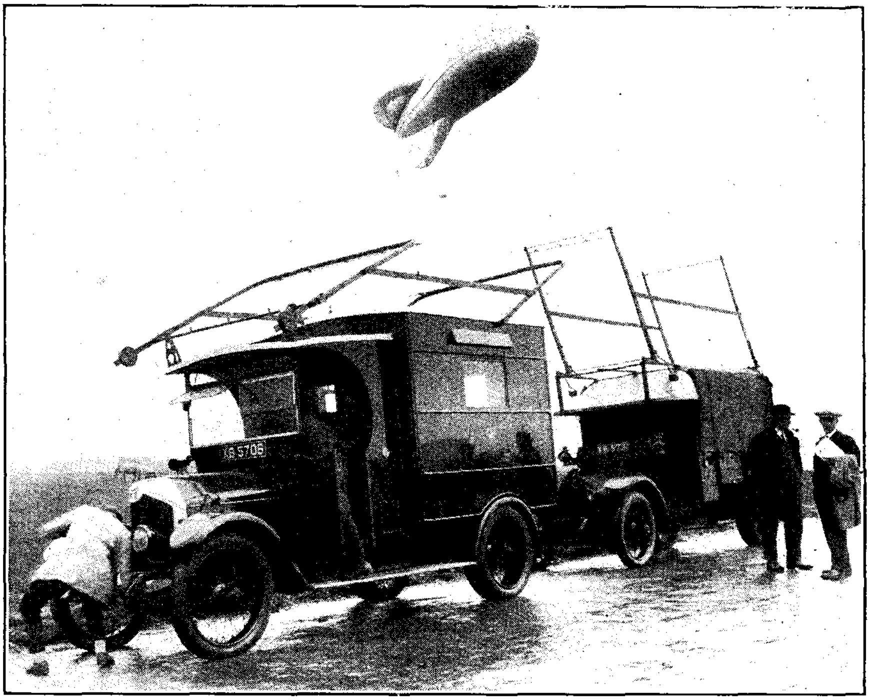
A well-known English amateur has recently had correspondence with Mr. Bernard G. Jones, of Winnipeg, Canada, who makes a strong plea for closer co-operation between Canadian and English amateurs.

It is pointed out that there seems to be a tendency on the part of English amateurs to group their Canadian friends with the amateurs of the United States of America as one body, whereas the Canadians would prefer to be recognised independently, especially in view of the fact that they form a part of the British Empire.

Naturally one hears more of the doings of United States amateurs on account of their numbers and influence, but we are assured that amongst the Canadians there are many who are every bit as keen and would welcome evidence of greater interest by English transmitters.

Working Wireless Model.

In the Radio Section of the recent Paris Fair was installed an interesting model of the large Bordeaux wireless station. Transmissions were carried out with a power of 50 watts from the miniature antenna, which was strung on 18-in. towers, a wavelength of 56 metres being used. The signals were received by many stations in the neighbourhood.



[Photopress.

Traffic Control at the Derby.—*The cars are equipped with telephony transmitting apparatus and communication can be established while travelling by means of the collapsible aerials. The observation balloon advised the mobile sets concerning the traffic distribution, and greatly assisted the police in avoiding congestion on the roads to Epsom.*

The "Radio Iberica" Transmissions.

The transmissions from this Spanish station are at the present time very strong and clear. We understand from Mr. J. W. Randall, of Willesden, N.W., that with a single valve dual receiver the signal strength is equal to that of **2 LO** when picked up on a crystal set at Willesden. Particulars of the wavelength and times of transmission of this station will be found in the list of broadcasting stations on another page.

Lifeboat Wireless.

The P. & O. steamer "Majola," which left Tilbury a few days ago for Sydney, is the first ship to carry the new type of Marconi installation for ships' lifeboats.

The apparatus includes a direction finder which has great possibilities in helping to ascertain the positions of other ships in the event of assistance being required.

Results of Eiffel Tower Short-wave Transmissions.

An interim report of results obtained with the Eiffel Tower tests conducted on wavelengths of 115, 50 and 25 metres is now available. It is stated that the 115 metre tests have been heard over a very ide area. Many reports have been received from Great Britain and from the United States of America, where strong reception was obtained with sets employing detector and one stage of low frequency amplification.

The 50 metre tests have been received only by eight French amateurs, the farthest distance being at Nice, where reception was made with a single valve receiver.

The 25 metre tests have not been reported at all, which is scarcely surprising considering the difficulty which would be experienced in getting down to such a wavelength with the apparatus ordinarily at the disposal of the amateur.

There are at least some amateurs in England, however, who mean to make a determined effort to receive the 25 metre transmissions and we would like to see their efforts meet with success.

Honour for Professor Pupin.

The Medal of Honour of the Institute of Radio Engineers for 1924 was presented to Professor M. I. Pupin at a meeting of the Society held in New York on June 4th. Professor Pupin delivered a short address dealing with wireless retrospectively and prospectively. Professor Pupin has contributed a great deal to the development of wireless telegraphy and particularly telephony. He is a Director of the Research Laboratory of Columbia University, New York, and is an ex-President of the Institute of Radio Engineers. He was born in Hungary in 1858, but went to the United States in 1874.

Disasters which Assist Development.

Even such a terrible disaster as the recent earthquake in Tokio has certain compensations. We learn recently that the whole of the telephone system in Tokio was utterly destroyed during the earthquake and a contract has now been placed with the Nippon Electric Co., Ltd., of Tokio, which is an Associate Company of the Western Electric Co., for the replacement of the entire system by automatic telephones. The initial order covers an equipment for 25,000 subscribers.

It is possible that had it not been for the earthquake the old system would have remained and perhaps automatic telephones would not have been introduced for very many years.

Does Light Travel Faster than Wireless?

An American Scientist, Captain T. J. See, who is Professor of Mathematics in the United States Navy, claims to have discovered that wireless waves travel at a speed of 165,000 miles a second, as compared with the rate of travel of light, which is 186,000 miles a second. This view is expressed as a result of experiments conducted in the early part of this year when a signal transmitted from New York was re-broadcast from Warsaw and received again in New York after an interval of 0·054 of a second had elapsed.

Australian Broadcasting Stations.

Those readers in this country who are optimistic as to the range of reception of their sets and who have heard all that is going in the way of transmissions in America, can now turn their attention to Australia, which has some six or seven broadcasting stations in operation. Reception of some of these stations is free whereas in the case of others the cost is defrayed by a system of subscription; we believe, however, that no charge would be made for reception in this country.

The two highest powered stations are stated to be 5 kilowatts, and of these one is located in Sydney with a call sign **2 FC**, and working on 1,100 metres; whilst the other is at Melbourne with a call sign **3 FC**, working on 1,720 metres.

Captain Eckersley on Holiday.

We understand that Captain Eckersley is on holiday until 25th June, and we hope that he will forget all about wireless for the period of his well-earned rest.

Internacia Radio-Asocio.

We understand that this Society, which has been formed to further the cause of Esperanto as an international wireless language, now has members in twenty-six different countries, and National Secretaries have already been appointed in eleven countries, whilst other appointments are pending.

Barnet and District Radio Society.*

On Friday, May 30th, a party of eleven members of the Society, including Mr. C. Randall, Postmaster of Barnet, who is Chairman of the Society, Mr. J. Nokes, the Hon. Secretary, Mr. H. B. Gardner (**2 AHM**), of Barnet, and others, paid a visit to the London station of the B.B.C. At Marconi House they inspected the transmitting apparatus. Mr. T. G. Petersen, engineer-in-charge, in the brief time at his disposal, managed to give the visitors a fair idea of the functioning of the transmitter as well as imparting to them a considerable amount of technical knowledge. The party afterwards walked across to Savoy Hill, and were shown over the building by Mr. H. Carter, of the B.B.C. staff. That the members enjoyed their visit goes without saying, and before leaving, Mr. Nokes, on behalf of the Society, thanked the B.B.C. and the Marconi Company for their hospitality.

At the bi-monthly meeting of the Society on the following Monday, June 2nd, Capt. M. A. Ainslie, R.N., in a talk on "Wireless Reception," related some of his experiences with receivers and transmitters both on land and sea.

Hon. Sec., J. Nokes, Sunnyside, Stapylton Road, Barnet.

The St. Pancras and District Radio Society.*

"Resistance and its Measurement" was the subject of a very interesting talk by Mr. J. S. Rowe on May 15th. He began with Ohms Law and showed a number of methods by which resistance might be roughly determined with the aid of apparatus which most experimenters would be likely to have. He then dealt with the various patterns of Wheatstones bridge and showed how these might be adapted to the measurement of capacity and inductance. Afterwards the resistance of the windings of several intervalve transformers was measured in order that members might form some idea of their relative number of turns.

On May 22nd Mr. R. T. Nunn gave a talk on wavemeters. He first explained how the calibration of a standard was arrived at by indirect comparison with the seconds pendulum of a clock, by means of the cathode ray oscillograph. He then described the types of wavemeters in common use, pointing out the particular advantages of the heterodyne. He finished by describing some special precautions advisable when building an accurate wavemeter.

Hon. Sec., R. M. Atkins, 7 Eton Villas, N.W.3.

The Belvedere, Erith and District Radio and Scientific Society.*

On Friday, June 6th, Mr. A. Cole gave a short lecture and demonstration on the use of a lathe in the making up of wireless components. He outlined briefly the mechanism of a lathe and the different uses to which it could be put. After the lecture he carried out several demonstrations in the turning and screw-cutting of brass for variable condenser spindles, and planed brackets for coil holders, etc.

A lathe is now permanently installed at the Radio Club House and Mr. Cole has put himself at the service of members for any class of lathe work necessary in the building of wireless sets.

A hearty vote of thanks was accorded Mr. Cole for giving the members a most interesting and instructive evening.

Hon. Sec., S. G. Meadows, 110 Bexley Road, Erith, Kent.

Ilford and District Radio Society.*

The third annual general meeting was held at Headquarters on Thursday, May 29th. The Secretary stated that the past year had been a successful one, the item of outstanding interest being the acquirement of more suitable headquarters.

The Treasurer reported a satisfactory financial position.

The officers elected for the forthcoming year were as follows:—President, Mr. J. E. Nickless, A.M.I.E.E.; Additional Vice-

Forthcoming Events.

WEDNESDAY, JUNE 18th.

Golder's Green Radio Society. 8.30 p.m. At the Club House. Informal Night.

THURSDAY, JUNE 19th.

Kensington Radio Society. Sale and Exchange.

FRIDAY, JUNE 20th.

Radio Society of Great Britain. Transmitter and Relay Section. Informal Meeting at 6.30 p.m., at the Institution of Electrical Engineers. Mr. Ashton J. Cooper will open a discussion on "Tuning Coils."

Radio Society of Highgate. 8 p.m. At 270 Archway Road. Lecture: "Harmonics." By Mr. J. D. Steell.

MONDAY, JUNE 23rd.

Hornsey and District Wireless Society. At Queen's Hotel, Broadway, Crouch End, N.8. General Discussion and Questions.

WEDNESDAY, JUNE 25th.

Radio Society of Great Britain. Ordinary General Meeting 6 p.m., at the Institution of Electrical Engineers. Lecture: "A résumé of Modern Methods for the Measurement of Radio Signal Strength." By Mr. J. Hollingsworth.

President, Mr. G. F. Gregory; Chairman, Mr. W. T. Weston; Deputy Chairman, Mr. Aston Cooper; Secretary, Mr. F. W. Gedge; Assistant Secretary, Mr. Aimes; Treasurer, Mr. D.S. Richards; Committee, Messrs. W. H. Dennis, J. W. Elliott, A. E. Gregory, L. C. Hobday and J. F. Payne.

It should be noted that headquarters are now situated on the premises of Mr. W. T. Weston, at 156 High Road, Ilford. Also please note the address of the new Secretary.

Hon. Sec., F. W. Gedge, 157 High Road, Ilford.

Smethwick Wireless Society.*

The third annual meeting of the above Society was held on Friday, May 30th.

Satisfactory reports were read by the Secretary, Treasur r and Auditors. Dr. Murray, F.I.C., F.C.S., was unanimously elected President for the coming session. The following officers were elected:—The whole of the Vice-Presidents *en bloc*, with the addition of our late Secretary, Mr. R. H. Parker (who, owing to pressure of business, has resigned); Hon. Secretary, L. H. Lee (**5 FH**); Hon. Assistant Secretary, A. Mackay; Technical Adviser, C. Grew (**2 AFS**); Hon. Librarian, A. Adams, F.I.C.; Hon. Treasurer, H. Allen.

A General Committee having been formed, Mr. Armstrong moved a vote of thanks to the retiring officers. He wished to place on record the yeoman service done to the Club by our Vice-President, Mr. A. J. Hulme, and also our last Secretary, Mr. R. H. Parker.

The new session will begin early in September, although a field day and possibly an ordinary meeting will be arranged in the interim. The Society is n a strong position financially, has a full equipment of receiving apparatus, and a fine meeting room at the Technical School, and the Committee anticipate many more new members next session. Will intending members please communicate to the Hon. Secretary, L. H. Lee, 155 Rosefield Road, Smethwick.

Lewisham and Catford Radio Society.*

The Society was given a very interesting lecture on May 29th by Mr. Conway Fink, A.M.Inst.R.E., of Messrs. Igranic Electric, Ltd., the subject being "Tuning Coils with a Special Reference to their Use in H.F. Amplification."

Many useful hints as to the sizes of coils to use for different wavelengths were given, together with a very interesting account of the construction of Igranic coils.

On Sunday, June 1st, the Society held a field day at Paul's Cray Common, Chislehurst, which, in spite of rather unsettled weather, was well supported by the members and their friends, both ladies and gentlemen. Many interesting experiments were carried out with portable apparatus and self-contained receivers.

It is hoped to hold more of these pleasant outings which, besides stimulating interest in radio, also makes for sociability amongst members and friends .

On June 5th a very interesting lecture and demonstration was given by Mr. R. G. Stanley, the Society's Director of Instruction, on "Accumulators and their Construction."

Owing to the kindness of the Assistant Hon. Sec., many interesting parts and chemicals used in the manufacture of accumulators were available for demonstration and exhibition.

Hon. Sec., Mr. Chas. E. Tynan, 62 Ringstead Road, S.E.6.

Lincoln Wireless Society.*

"Outdoor Aerials *v.* Indoor and Frame Aerials" was the subject of a debate before the Society at a meeting on June 5th.

Mr. R. Bates (**5 OD**) supported indoor and frame aerials, pointing out the usefulness of the latter in connection with direction-finding work, also the advantages of the frame for cutting out interference. He also described an excellent indoor aerial giving details of the results obtained with it.

Mr. T. Farren spoke for the outdoor aerial, pointing out that the ordinary well-known circuits worked much better on this kind of aerial. There was no risk of damage by lightning if precautions were taken and proper earthing system fixed.

The members of the Society, at the close of the debate, decided unanimously in favour of the outdoor aerial.

Hon. Sec., J. T. James, 126 West Parade, Lincoln.

Hackney and District Radio Society.

On Saturday, the 31st ult., a party of members visited the electrical works of the Hackney Borough Council.

At the meeting held at Headquarters on the 5th inst., a very interesting evening was spent in discussions on various technical matters appertaining to wireless.

All local enthusiasts should apply for particulars of membership.

Asst. Hon. Sec., Geo. E. Sandy, 70 Chisenhale Road, E.3.

Radio Association (South Norwood and District Branch.)

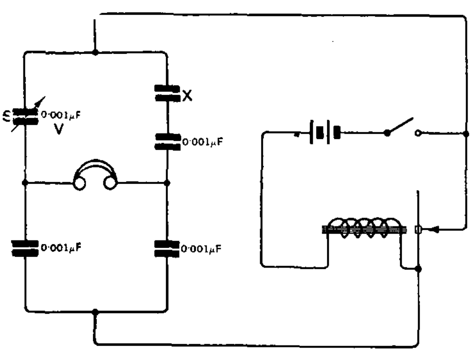
At a meeting on May 29th Mr. Sutton, A.M.I.E.E., read a paper on "The Amateur Wireless Society." The reading of the paper was followed by a talk on "The Aerial Tuning Circuit," by Mr. Purkiss.

Correspondence.

Direct-Reading Set for Measuring Capacity.

To the Editor of THE WIRELESS WORLD AND RADIO REVIEW.

SIR,—In the article in *The Wireless World and Radio Review* of May 7th describing a simple direct reading set for measuring capacity, it is suggested



Circuit for direct reading of capacity.

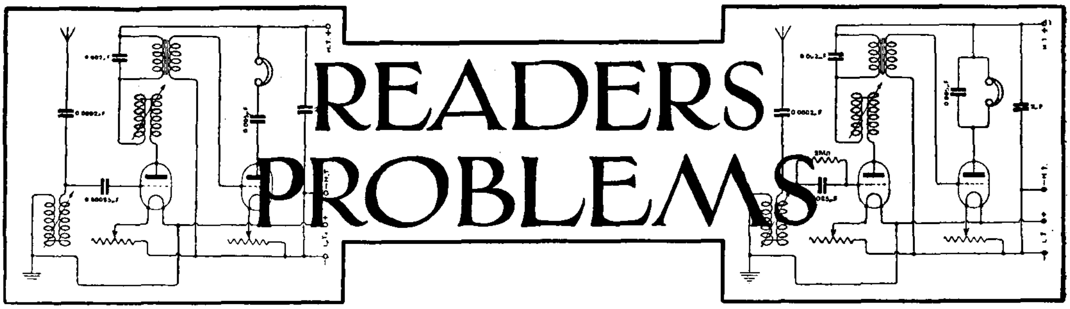
that for measuring condensers above the maximum of the variable condenser, extra ones of known value should be added in parallel, and due allowance made in computing the final result. There is a method which I have been using for a different purpose, but which is easily applicable in this case, whereby a much greater range may be obtained on one scale. In the diagram it will be noticed that a fixed condenser of 0·001 mfd. capacity has been added in series with the unknown condenser. A few simple calculations show that a 0·001 mfd. variable condenser can efficiently calibrate between 0·0001 or even less, up to 0·005 as a practical maximum, but even higher provided the scale be accurately marked, and the condenser allow of such delicate variations.

Value of X	Value of S
·0001 mfd.	·00009 mfd.
·0002	·0001
·0003	·00023
·0005	·00033
·001	·0005
·0015	·0006
·002	·00066
·003	·00075
·004	·0008
·005	·00083

With the instrument set out as above, the value of the variable condenser required to balance various unknown condensers is shown in the table. It will be seen that towards 0·004 the scale closes up rapidly and this fact limits the practical scale which in theory should extend into microfarads.

WALTER J. JOUGHIN, F.R.S.A.

Peckham, S.E.15.



1. All questions are answered through the post. A selection of those of general interest is published. 2. Not more than four questions may be sent in at any one time. 3. Every question should be accompanied by a postal order for **1/-** *or* **3/6** *for four questions, and by a coupon taken from the current issue. 4. A free coupon appears in the first issue of each month, and if this is sent in together with coupons from the three previous issues, the reader is entitled to have one question answered free of charge.*

" *S.M.*" (*London, N.W.*6) **asks for a diagram of a crystal receiver to include certain specified components.**

The diagram is given in Fig. 1. The aerial tuning condenser may be connected in series or in parallel by means of the six-stud double-arm switch. A potentiometer is included in the circuit in order that the normal potential difference between the two elements of the crystal detector may be adjusted to a suitable value. If a three-way switch is used in connection with the potentiometer, as shown in the diagram, a voltage range of 8 volts will be available, using only two 2-volt cells. In

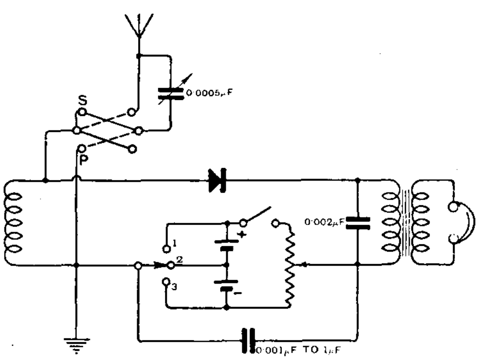


Fig. 1. " *S.M.*" (*London, N.W.*6.) *Crystal receiver with switch to extend range of potentiometer.*

position 1, the range will be from 0 to -4 volts; in position 3, from 0 to $+4$ volts; and in position 2, from -2 to $+2$ volts. When a new crystal is connected in circuit, the switch should be put in position 2 in order that the polarity of the potential required may be determined. The switch can then be put on stud 1 or 3 to extend the range in either direction if necessary.

" *W.J.M.*" (*Windsor*) **asks what modifications will be necessary in order to supply a three-valve set using "A.R.D.E." type valves from a 6-volt 30 ampere hour accumulator.**

If you connect the three cells of your 6-volt accumulator in parallel, thus providing a 2-volt battery of 90 ampere hour capacity, the ordinary filament resistances having a resistance of approximately 5 ohms will be satisfactory. If, on the other hand, you connect the 6-volt accumulator as it stands to the L.T. terminals of the set, the existing filament resistances should be replaced by resistances of approximately 15 ohms.

"*P.B.T.*" (*Enfield*) **asks by what method it would be possible to calibrate a receiver in which the A.T.I. consists of an aperiodic coil wound in a slotted ebonite former.**

To speak of the calibration of an aperiodic circuit is, strictly speaking, a contradiction in terms. An aperiodic circuit does not possess any resonant properties, and cannot therefore be calibrated. If any other sharply-tuned circuits, such as tuned anode circuits, are included in the receiver, one of these circuits should be calibrated. Alternatively a tuned circuit might be substituted for the aperiodic coil at present used to tune the aerial circuit.

"*H.J.*" (*Chester*) **asks questions concerning various types of H.F. coupling for use in multi-valve H.F. amplifiers.**

With the methods of H.F. coupling suggested, we are afraid that you will not be able to combine successfully the properties of sharp tuning and freedom from self-oscillation. It is only with the type of coupling used in the neutrodyne receiver that this ideal is approached. The use of variable resistances in parallel with the anode coils will certainly reduce the tendency to self-oscillation, but unfortunately they will also reduce the selectivity and signal strength obtainable with the receiver. Where a high degree of selectivity is required over a comparatively narrow band of wavelengths, the anode circuits may be tuned either by means of a plug-in coil and variable condenser, or by a variometer. The wavelength range of the variometer may be extended by providing a switch, so that the two windings may be connected in series or in parallel. Semi-aperiodic anode coils wound in slotted ebonite formers are very suitable where it is required to cover a wide range of wavelengths without the inconvenience of a series of anode coils or H.F. transformers. The selectivity obtained with this method of coupling is, however, not so high as in the case of tuned anode coupling.

is, of course, common to the plate-circuits of both valves. The latter coupling is the most frequent cause of L.F. oscillation, and can generally be remedied by connecting a large condenser of, say, 2μF across the H.T. terminals. If this measure does not completely stop the oscillations, you might try the effect of reversing the primary windings of the transformers, or of connecting resistances of the order of one megohm across the secondary windings. It is not good practice to try to stop the oscillations by reducing the value of the H.T. voltage, as this invariably results in distortion.

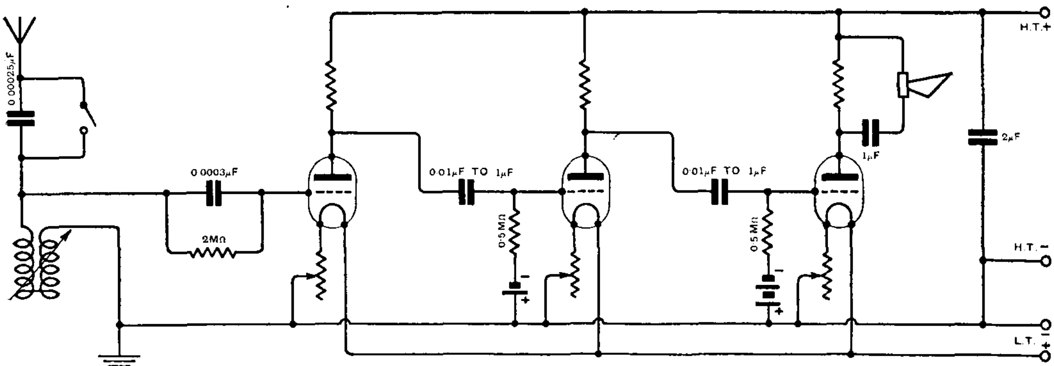


Fig. 2. "P.R.B." (London, W.3.) ***A three-valve receiver suitable for the reception of the local broadcasting station at loud speaker strength.***

"*P.R.B.*" (*London, W.3*) **asks for a diagram of a three-valve receiver to operate a loud speaker when used within 4 or 5 miles of a broadcasting station. Freedom from distortion is of first importance.**

We recommend that you use a detector valve followed by two stages of resistance-capacity coupled low frequency amplification. Referring to Fig. 2, it will be seen that the aerial circuit is tuned by means of a variometer. A fixed condenser may be connected in series with the variometer if the aerial has a high self-capacity. The value of this condenser is not critical, but best results are generally obtained with a capacity of approximately 0·00025 μF. In order to minimise the distortion produced by grid currents and rectification in the L.F. valves, grid cells should be connected in series with the grid leaks. The coupling condensers may have capacities between 0·01 μF and 0·1 μF, while the anode resistances should be given values between 50,000 and 100,000 ohms, depending on the type of valves to be used.

"*G.H.D.*" (*Carnarvon*) **is troubled with a persistent whistling noise in his receiver, which includes two stages of transformer coupled L.F. amplification.**

The fact that the pitch of the whistle is not in any way affected by the tuning of the receiver indicates that it is due to oscillation of the low frequency amplifying valves. The oscillation is caused by coupling between the valves, either through stray capacities in the wiring or through the internal resistance of the H.T. battery, which

"*H.B.*" (*Horsforth*) **asks why he is unable to obtain a satisfactory degree of amplification from the tuned anode coupled H.F. valve in his receiver.**

The failure of the H.F. valve to amplify properly would be accounted for if you have to use a large value of tuning capacity in order to reach the wavelength of a station which you require to receive. In order to keep the impedance of the tuned anode circuit to H.F. oscillations as high as possible, it is necessary that the anode coil should be chosen so that an absolute minimum of tuning capacity is necessary, in order to tune to the wavelengths required. For the B.B.C. band of wavelengths you will find it an advantage to use two coils, such as Igranic plug-in coils Nos. 75 and 100.

"*J.R.*" (*Burton-on-Trent*) **asks what steps may be taken to prevent interference from a small house lighting plant situated near his receiver.**

You will have considerable difficulty in eliminating the disturbances set up by the lighting installation, if the receiver is situated near the engine. Interference due to sparking at the commutator of the dynamo can often be eliminated by the use of a counterpoise earth instead of the usual earth connection. You may also find it an advantage to connect a large condenser across the brushes of the machine. Radiation from the ignition system of the engine can often be suppressed by encasing the H.T. wiring in metal braiding, which should be connected to the bedplate of the engine and to earth.

Calls Heard

Contributors to this section are requested to limit the number of calls sent in to those heard in the previous three weeks, these being of greater interest and value to transmitters than earlier records. The repetition of the same call sign in consecutive lists is not recommended. Contributors will also assist by kindly arranging reports in alphabetical order. Full address (not for publication) should be given to enable correspondence to be forwarded.

Stockton-on-Tees (April 16th-May 6th) (100 to 160 metres.)
2 CA, 2 NA, 5 DN, 5 HN, 5 IK, 5 MO, 5 RQ, 5 SI, 5 TU, 6 CV, 6 RY, 6 TD, 6 TM, 6 XG, 6 XX, 8 AA, 8 AU, 8 BA, 8 BP, 8 CF, 8 DI, 8 DP, 8 ÉM, 8 ÉO, 8 IPK, 8 JC, 8 PX, 8 RO, 8 SY, FL, 0 PC, 0 XQ, L 0 AA, 9 AA, 9 AB, 1 ER, 1 CF. (J. W. Pallister.)

Cambridge (April 23rd-May 12th).
2 AGT, 2 AKS, 2 ARX, 2 BP, 2 BQ, 2 CC, 2 DZ, 2 JV, 2 KW, 2 NB, 2 RQ, 2 VP, 2 WL, 5 CK, 5 IK, 5 OY, 5 RG, 5 UI, 5 UQ, 6 CV, 6 DY, 6 NK, 6 OB, 6 QO, 6 QR, 6 TD, 8 AE 3, 8 BL, 8 BP, 8 CN, 8 DD, 8 DI, 8 DP, 8 ÉI, 8 ÉM, 8 ÉU, 8 JBV, 8 JC, 8 IP, 8 LM, 8 P 3, 8 RO, 8 SSU, 8 SY, 8 TV, 8 ZM,, 8 ML, 0 BA, 0 GX, 0 HD, 0 MS, 0 NN, 0 PC, 0 XR, 0 ZN, PCRR, 4 C 2, 9 AB, 1 AJA, 1 AR, 1 AFN, 1 BAW, 1 ER, 1 SN, 1 XAH, 1 XAR, 1 XAS, 1 XAW, 1 XW, 2 BG, 2 CG, 3 HK, 3 KQ, 3 OT, 9 AK, 1 BQ, 1 EB, 9 BL, 1 CF, 4 QS, 7 DF, SALD. (G. W. Thomas, **2 AQK.**)

Herne Hill, London, S.E.24. (March 16th-May 14th).
2 AIU, 2 AQ, 2 AU, 2 BZ, 2 CA, 2 DM, 2 DY, 2 FM, 2 HS, 2 KF, 2 KT, 2 KV, 2 LP, 2 LZ, 2 MJ, 2 MO, 2 NM, 2 OM, 2 PX, 2 PY, 2 QC, 2 QI, 2 TI, 2 TQ, 2 VS, 2 VY, 2 WY, 2 XO, 2 XR, 2 XZ, 2 YR, 2 ZO, 5 AC, 5 BP, 5 BT, 5 BV, 5 CB, 5 CD, 5 DT, 5 FL, 5 IO, 5 MA, 5 NN, 5 OY, 5 PU, 5 UO, 5 WN, 5 XN, 6 AH, 6 IM, 6 IT, 6 KI, 6 MZ, 6 NH, 6 PD, 6 SY, 6 TQ, 6 TS, 6 VO, 6 VR, 6 WV, 6 WX. (o—v—1 and o—v—o.) (K. C. Wilkinson.)

Glasgow (March 8th-May 11th).
British: **2 DR, 2 GO, 2 JP, 2 KF, 2 KW, 2 LH, 2 MC, 2 MG, 2 MM, 2 NA, 2 NB, 2 NM, 2 OD, 2 PC, 2 QC, 2 RB, 2 RH, 2 SH, 2 SZ, 2 TO, 2 UF, 2 UV, 2 VJ, 2 VS, 2 WJ, 2 XG, 2 XY, 2 YQ, 5 AW, 5 BV, 5 OC, 5 CX, 5 FG, 5 FS, 5 IK, 5 JJ, 5 KO, 5 MO, 5 OT, 5 OX, 5 QM, 5 QV, 5 SI, 5 ST, 5 SZ, 5 UQ, 5 US, 5 WM, 5 WV, 5 YI, 6 AA, 6 AL, 6 BT, 6 BY, 4 CV, 6 DF, 6 EA, 6 IV, 6 NF, 6 NY, 6 RY, 6 XX, 2 ACU, 2 XAX.** Danish: **7 BJ, 7 EC.** French: **8 AB, 8 AQ, 8 AU, 8 BF, 8 BM, 8 BV, 8 CM, 8 CS, 8 CT, 8 CZ, 8 DP, 8 DU, 8 ÉB, 8 ÉD, 8 ÉN, 8 R 3, 8 WJ, 8 XV.** Dutch: **0 BA, 0 BQ, 0 KA, 0 KX, 0 MR, 0 NY, 0 PG, 0 ZN, PCII, PCTT, PA 9.** Belgian: **P 2, W 2.** Luxemburg: **4 ZZ, LO AA.** Italian: **1 ER, 1 MT, ACD.** Swedish: **SALD.** American: **1 XAR, 1 XM, 1 NA, 6 NKA**(?). Canadian: **1 AR, 9 BL.** (o—v—o and 1—v—o).
(J. G. Ritchie.)

Upper Tooting, London, S.W.17 (April 27th-May 11th). (Telephony).
2 AIU, 2 AQ, 2 BZ, 2 CA, 2 KG, 2 KF, 2 HS, 2 PY, 2 SF, 2 SX, 2 QZ, 2 TI, 2 TQ, 2 UJ, 2 VS, 2 VY, 2 WY, 2 XO, 2 XR, 2 XZ, 2 YR, 2 ZA, 2 ZZ, 5 AC, 5 BT, 5 CD, 5 CV, 5 DT, 5 FL, 5 MA, 5 PU, 5 UO, 6 IM, 6 KI, 6 NB, 6 NF, 6 NH, 6 MZ, 6 QM, 6 VR, 6 WV, 6 QZ. (o—v—o.) (F. and J. Rose.)

Manchester (April 7th-May 14th, 1924).
British: **2 DF, 2 DR, 2 FN, 2 FU, 2 MD, 2 NA, 2 SH, 2 TO, 2 VO, 2 VW, 2 WJ, 2 WY, 2 XD, 2 XQ, 2 YQ, 5 AY, 5 CS, 5 CX, 5 FC, 5 FS, 5 JJ, 5 JX, 5 KL, 5 MO, 5 NU, 5 OG, 5 QM, 5 QV, 6 AL, 6 BY, 6 CV, 6 FG, 6 NG, 6 NK, 6 UD, 6 WH.** French: **8 AAA, 8 AA, 8 AV, 8 AZ, 8 BA, 8 BF, 8 BM, 8 BN, 8 BP, 8 BV, 8 CH, 8 CN, 8 DE, 8 DY, 8 ÉM, 8 ÉN, 8 ÉU, 8 JC, 8 MF, 8 ML, 8 RO, 8 ZM, 8 P 3, 8 R 3.** Dutch: **PCRR, PCTT, PWW, 0 HD, 0 PC, 0 US, 0 XF, 0 XP, 0 ZN.** Italian: **1 ER, 3 MB.** Belgian: **P 2, 4 C 2.** Canadian: **1 AR, 1 DD, 9 AK.** Unknown: **1 NA, 4 I, NBS.** (o—v—1). (B. L. Stephenson, **5 IK.**)

Broadcasting.

REGULAR PROGRAMMES ARE BROADCAST FROM THE FOLLOWING EUROPEAN STATIONS:—

GREAT BRITAIN.

ABERDEEN, 2 BD, 495 metres; **BIRMINGHAM 5 IT,** 475 metres; **GLASGOW 5 SC,** 420 metres; **NEWCASTLE 5 NO,** 400 metres; **BOURNEMOUTH 6 BM,** 385 metres; **MANCHESTER 2 ZY,** 375 metres; **LONDON 2 LO,** 365 metres; **CARDIFF 5 WA,** 351 metres; **LIVERPOOL 6 LV** (Relay); **PLYMOUTH 5 PY** (Relay), 335 metres; **EDINBURGH 2 EH** (Relay), 325 metres; **SHEFFIELD** (Relay), 303 metres. Tuesdays, Thursdays and Fridays, 1 p.m. to 2 p.m. (**2 LO** only). Regular daily programmes, 3 to 7.30 p.m., 8 to 11.30 p.m. Sundays, 3 to 5.30 p.m., 8.30 to 10.30 p.m.

FRANCE.

PARIS (Eiffel Tower), FL, 2,600 metres. 7.40 a.m. Weather Forecasts, 11.0 a.m. (Sunday); 12.0 noon, Market Report; 12.15 to 12.30 (Weekdays), Time Signal and Weather Forecast; 3.40 p.m., Financial Reports; 5.30 p.m., Bourse Closing Prices; 6.15 p.m., Concert; 8.0 p.m., Weather Report; 9.0 p.m. (Wednesday and Sunday), Concert; 10.10 p.m., Weather Forecast.

PARIS (Radio "Paris"), SFR, 1,780 metres. 12.30 p.m., Cotton Prices, News; 12.45 p.m., Concert; 1.30 p.m., Exchange Prices; 4.30 p.m., Financial Report; 5.0 p.m., Concert; 8.30 p.m., News and Concert.

PARIS (Ecole Superieure des Postes et Telegraphes), 450 metres. 3.45 p.m. (Wednesday), Talk on History; 8.0 p.m. (Tuesday), English Lesson; 8.30 p.m., Concert; 9.0 p.m., Relayed Concert or Play.

PARIS (Station du Petit Parisien), 340 metres. 8.30 p.m., Tests.

BELGIUM.

BRUSSELS, BAV, 1,100 metres. At 2 p.m. and 6.50 p.m., Meteorological Forecast.

BRUSSELS (**"Radio Electrique"**), 265 metres. Daily, 5 p.m. to 6 p.m., Concert. 8 p.m. to 8.15 p.m., General Talk. 8.15 p.m. to 10 p.m., Concert.

HOLLAND.

THE HAGUE, PCGG, 1,070 metres. 4 to 6 p.m. (Sunday), 9.40 to 11.40 p.m. (Monday and Thursday), Concerts.

THE HAGUE (Heussen Laboratory), PCUU, 1,050 metres. 10.40 to 11.40 a.m. (Sunday), Concert; 9.40 to 10.40 p.m., Concert; 8.45 to 9 p.m. (Thursday), Concert.

THE HAGUE (Velthuisen), PCKK, 1,050 metres, 9.40 to 10.40 p.m. (Friday), Concert.

HILVERSUM, 1,050 metres. 9.10 to 11.10 (Sunday), Concert and News.

IJMUIDEN (Middelraad), PCMM, 1,050 metres. Saturday, 9.10 to 10.40 p.m., Concert.

AMSTERDAM, PA 5, 1,050 metres (Irregular), 8.40 to 10.10 p.m., Concert.

AMSTERDAM (Vas Diaz), PCFF, 2,000 metres, 9 a.m. and 5 p.m., Share Market Report, Exchange Rates and News.

DENMARK.

LYNGBY, OXE, 2,400 metres. 8.30 to 9.45 p.m. (weekdays), 8 to 9 (Sunday), Concert.

SWEDEN.

STOCKHOLM (Telegrafverket), 440 metres. Monday, Wednesday and Saturday, 7 to 9 p.m. Sunday, 11 to 12 a.m.

STOCKHOLM (Radiobolaget), 470 metres, Tuesday and Thursday, 7 to 9 p.m. Sunday, 6 to 8 p.m.

GOTHENBURG (Nya Varvet), 700 metres. Wednesday, 7 to 8 p.m.

BODEN, 2,500 metres. 6.0 to 7.0 p.m., Concert.

GERMANY.

BERLIN (Koenigswusterhausen), LP, 2,370 metres (Sunday), 10.40 a.m. to 11.45 a.m., Orchestral Concert. 4,000 metres, 7 to 8 a.m., Music and Speech; 12.30 to 1.30 p.m., Music and Speech; 5.0 to 5.30 p.m., News.

EBERSWALDE, 2,930 metres. Daily, 1 to 2 p.m., Address and Concert; 6 to 7.30 p.m., Address and Concert; Thursday and Saturday, 7.20 p.m., Concert.

BERLIN (Vox Haus), 400 metres. 11 a.m., Stock Exchange; 1.55 p.m., Time Signals; 5.40 to 7 p.m., Concert; 7 to 8 p.m. (Sunday), Concert.

BERLIN (Telefunken), 425 metres. 7.30 to 8 p.m. and 8.45 to 9.30 p.m., Tests and Concert.

BERLIN (Funkstunde A.G.), 726 metres.

FRANKFURT AM MAIN, 460 metres. 7.30 to 10 p.m. Tests Gramophone records.

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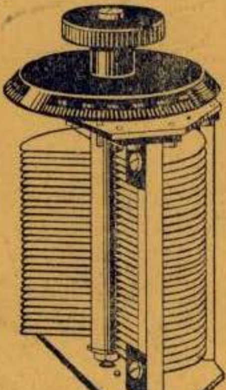

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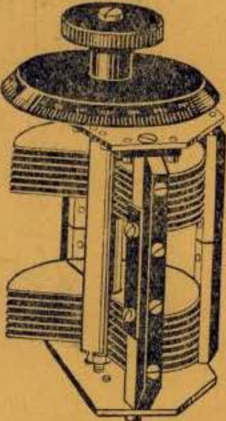

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Under the Supervision of W. JAMES.

CONTENTS

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OUTDOOR WIRELESS.

By The Editor.

A VERY great deal of interesting wireless work can be done both of an experimental nature and otherwise, which necessitates outdoor conditions and fine weather.

There is a limit to the duration of fine weather in this country even under the best conditions, and consequently it is as well to take full advantage of whatever opportunities present themselves for conducting outdoor wireless work. Those who live in towns especially, have the opportunity during the summer of comparing the performance of their sets when used under ideal conditions in open spaces with the results obtained in cramped surroundings in the town and astonishing differences in efficiency will often be observed.

Individuals can, also, whilst on holiday, derive a great deal of instruction and interest from operating a direction finding station properly laid out in the approved fashion with an absence of local obstructions.

We believe that it would be possible to collect information which might be of very considerable scientific value, if during the summer holidays, amateurs devoted special attention to the carrying out of experimental work which calls for outdoor facilities, but whilst individuals can do a great deal, much more can be done by collective effort by a Society or by several Societies working together.

As we go to press we understand arrangements are complete for a Wireless Field Day on quite a big scale, which has been organised by the Western Group of Affiliated Societies in the Metropolitan area, whilst other Societies and Groups of Societies in other London districts are also arranging for outdoor events to take place in the very near future.

We learn also that the Radio Society of Great Britain is arranging for some experimental work to be carried on between fixed stations and a station installed on a North bound passenger train and it is anticipated that these tests will arouse considerable interest extending far beyond amateur circles alone.

THE NEW LICENCES.

In a recent editorial we referred to the fact that new licences controlling the use of amateur transmitting apparatus were being issued by the Post Office and that these superseded all licences previously issued. In that editorial we drew attention to the condition which stipulated that communication was not authorised between British amateur stations and amateur stations abroad. We were correct in assuming then that the Post Office would make exceptions to this rule, for we already understand that this has been done in certain instances.

We still think, however, the position is not satisfactory because we doubt whether the Post Office officials who scrutinise applications are in a position to differentiate between the qualifications of one amateur and another which would justify an exception being made in some cases and not in others.

Frankly, we are disappointed with the methods adopted by the Post Office in dealing with the whole question of the issue of transmitting licences. We believe that there are genuine experimenters with satisfactory qualifications whose applications for transmitting licences have been turned down, whilst others with far inferior qualifications have obtained permits without difficulty. Something is seriously wrong with a system which allows such situations to arise.

ADDING A STAGE OF BALANCED HIGH FREQUENCY AMPLIFICATION TO A RECEIVER.

A simple method of adding a stage of **high-frequency amplification to a receiver in such a manner that good amplification is obtained, the selectivity** is considerably improved, and **interference due to the setting up of local** oscillations is prevented.

By W. JAMES.

A RECEIVER consisting of a valve detector and note magnifier connected, for example, as in Fig. 1, is a favourite with many amateurs because—

(1) There are only two tuning adjustments;
(2) The selectivity is fairly good; and
(3) The volume and quality are satisfactory.

(1) A signal is usually tuned in as follows: Connect the batteries and heat the filaments to their normal temperature. Alter the coupling between the reaction coil (L_5) and the aerial coil (L_4) until a slight hissing sound is heard in the head telephones. Then take the tuning condenser knob in one hand and the reaction knob in the other and turn them, keeping the receiver in that sensitive state indicated by the sound in the telephones. When the desired signal is heard, very carefully adjust the tuning condenser, reaction coupling, and the filament temperature of the detector valve.

(2) The selectivity will be fairly good because of the small capacity condenser (C) connected in series with the aerial, and the relatively large capacity tuning condenser connected across the aerial coil. In addition, the reduction in the effective resistance of the circuit through the employment of a reaction coupling increases the selectivity.

(3) The volume may be brought up by an increase in the reaction coupling, but one result of the use of reaction is that the quality is affected. As the reaction coupling is increased, there is usually a marked reduction in the quality of the telephony.

Receivers of this sort as ordinarily constructed are not always easy to adjust for good results. It is a common experience to find considerable overlap in the reaction coil adjustment. For instance, while searching for a signal the reaction coil may be turned a little too far, causing oscillations to be generated and radiated from the aerial. If these oscillations are of suitable frequency and combine with an incoming signal, beat notes are set up and heard as a whistle. When there is overlap, it is found necessary to turn the reaction coil back a considerable way before the set stops oscillating. A good receiver should oscillate quietly, or stop oscillating, as the reaction coil is turned forwards and backwards a few degrees.

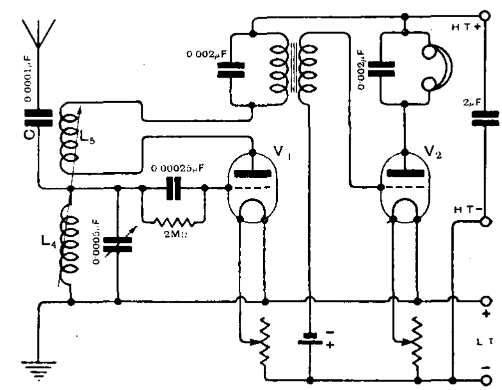


Fig. 1. Connections of a receiver having a valve detector V_1 and note magnifier V_2. $C = 0{\cdot}0001\ \mu F$; $L_4 = 60$ turns of No. 20 D.C.C. 3″ diameter; L_5 = basket coil, outside diameter 2½″, having 80 turns of No. 30 D.S.C., and should be coupled to the bottom (i.e. filament) end of L_4.

A good deal of interference is caused through the misuse of a receiver of this type, and considerable skill is required to obtain satisfactory results. The operation of the receiver is made easier, and full benefit of the reaction effects obtained by carefully choosing the size and position of the reaction coil, using the correct anode voltage and grid condenser and leak.

For the broadcast band of wavelengths the aerial coil (L_4) may consist of a winding of 60 turns of No. 20 D.C.C. on a thin paper former 3 in. in diameter. The reaction coil should be mounted at the fixed potential end of the aerial coil.

Probably the best type of reaction coil is a basket winding. The winding may be put on a thin slotted cardboard former. If the outside diameter of the former is $2\frac{1}{2}$ in., a winding of about 80 turns of No. 30 D.S.C. is usually satisfactory. The distance between the spindles carrying the reaction coil and the end of the aerial coil should be varied for best results ; the most suitable number of turns for the reaction coil should also be experimentally determined.

If the reaction coil is mounted at the grid end of the aerial coil, the capacity between the coils may prevent good operation. This capacity is quite high when a cylindrical or spherical reaction coil is employed, and is much lower when a basket coil is used.

The big disadvantage of a receiver of this sort is the ease with which oscillations may be generated and set up in the aerial circuit. The use of a coupled circuit tuner does not improve matters. In fact, it is probable that more interference is caused when adjusting a three-circuit tuner. There are, of course, four adjustments to be made—aerial tuning, secondary tuning, tuner coupling and reaction coupling.

Let us suppose a signal is to be tuned in. First, the aerial and secondary circuits are fairly tightly coupled, and the reaction is increased a little. Then the aerial and secondary tuning condensers are taken one in each hand and moved together until a signal is heard. The signal strength is then increased by using more reaction, until probably the receiver is just off the point of oscillation. If now the coupling between the aerial and secondary circuits is changed a little, or one of the tuning condensers slightly turned, the circuits probably start oscillating because of the reduction in the load due to the aerial. It is a very difficult matter to operate properly a three-circuit tuner, and the gain in selectivity brought about by the use of a tuned secondary circuit is not always worth while.

When a stage of ordinary high frequency amplification is connected, say as in Fig. 2, which shows the aerial circuit connected directly to the H.F. valve V_1, tuning takes an appreciable time, and there is probably more chance of causing interference by radiating energy than with the receiver of Fig. 1.

The trouble is not removed by coupling the reaction coil L_5 to the anode coil, unless the aerial and anode circuits are so designed that the anode circuit oscillates first. It should be noticed that oscillations in the anode circuit may set up oscillations in the grid circuit as the result of capacity coupling between the anode and grid. This capacity coupling may be reduced by carefully arranging the wiring and the position of the components, but cannot be eliminated owing to the capacity between the electrodes of the valve and the valve holder.

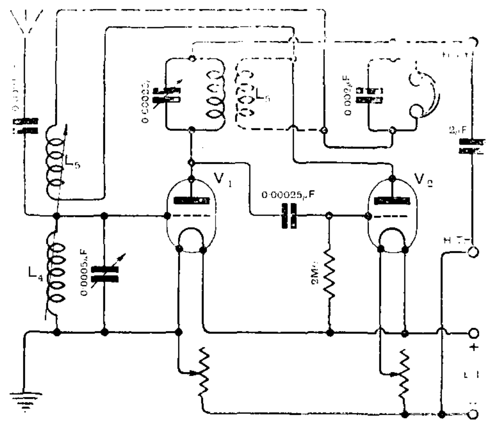


Fig. 2.

There are several ways of arranging the receiver so that the aerial circuit will not oscillate with any tuning adjustment, or will oscillate only after oscillations have been set up in the anode circuit. For example, a resistance of, say, 100,000 ohms may be connected between the grid and filament of the first valve, or the earth wire may be connected to the positive terminal of the filament battery. A signal then produces a current in the grid circuit which lowers the effective grid potential. Therefore the amplification obtained is considerably less than it would be if the resistance were not used, or if the grid return wire were connected to a point in the circuit which gives the grid a small negative voltage. Both these methods of damping the grid circuit reduce the selectivity.

Another method consists in connecting a non-inductive resistance either in the earth wire or in the wire joining the inductance

(L_4) and the tuning condenser. Either of these methods result in a reduction in signal strength and poor selectivity, and provided oscillations of sufficient strength are produced in the anode circuit, oscillations can be set up in the aerial.

Arranging the Balanced H.F. Stage.

It is, however, an easy matter to arrange a circuit so that no tuning adjustment will produce oscillations in the aerial. Several methods were described by the writer in Vol. XII, September 19th issue, in an article called " Short Wavelength High Frequency Amplification." One arrangement which has the advantage of simplicity and may be applied to any receiver is sketched in Fig. 3. The aerial is coupled to the valve through coils L_1 and L_2, or, alternatively, the aerial may be connected directly to L_2, and the coil L_1 dispensed with. A coil L_3 is joined in the anode circuit.

It will be seen that the anode battery is connected to a tapping made at the centre of the anode coil, and a condenser (C) is joined between the end of this coil and the grid.

This unit is connected to a receiver such as that of Fig. 1, as indicated in Fig. 4, where L_5 is the reaction coil and L_4 the grid coil, which is shown in Fig. 1 connected to the aerial and earth.

The special connections of the stage of high frequency amplification of Figs. 3 and 4 are made for the purpose of neutralising the capacity coupling which exists between the anode and grid. If the reaction coupling is

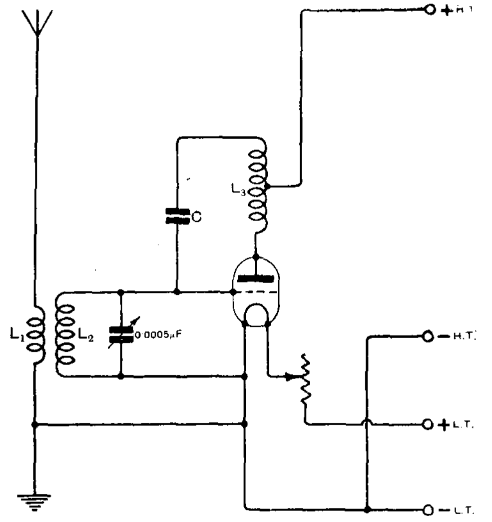


Fig. 3. L_1 = 15 turns of No. 18 D.C.C. wound over coil L_2; L_2 = 60 turns of No. 20 D.C.C. 3" diameter. When a short aerial is used, dispense with coil L_1, and connect the aerial to the top of L_2. The special anode coil L_3 and neutralizing condenser C are described in the text.

increased so that oscillations are set up in the grid circuit of the detector valve, oscillations are induced in the anode coil L_3.

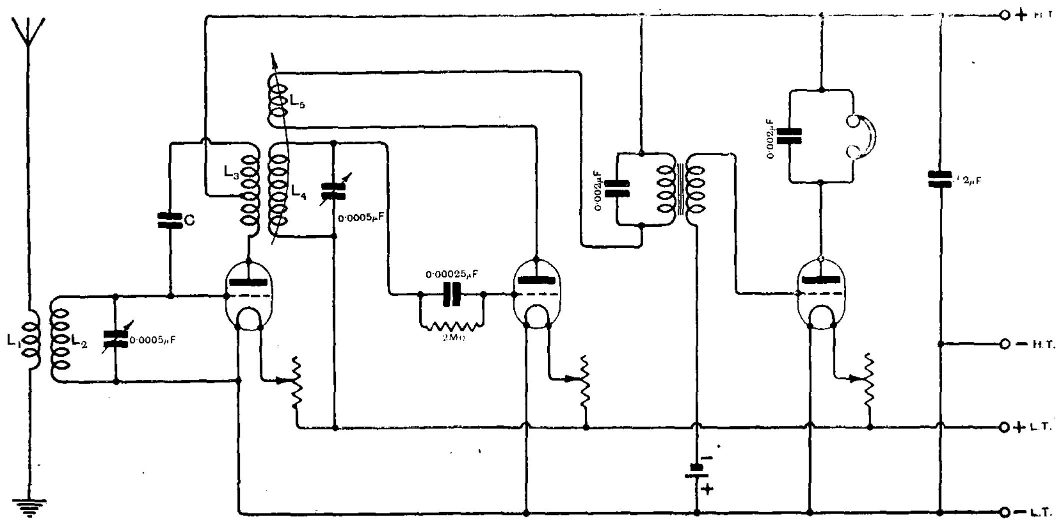


Fig. 4. Complete connections of a receiver having one stage of balanced high-frequency amplification, valve detector and one note magnifier. Coil L_3 should be coupled to the grid end of coil L_4, and the reaction coil L_5 coupled to the filament end of the grid coil L_4. Connect the moving plates of both tuning condensers to the filament battery. Results are better sometimes when the earth is connected to $-$L.T. as in Fig. 3.

When the condenser C is adjusted so that its capacity is the same as the capacity between the anode and grid, the voltage induced in each half of the coil is the same, and the current fed back through condenser C is equal to that passing through the stray capacity. The two currents, however, are in opposite directions; therefore the voltage of the grid does not vary. The two portions of the coil L_3, condenser C, and the stray grid-anode capacity when perfectly adjusted form a balanced bridge arrangement. Then the voltages across the two capacities are exactly equal and in opposite phase.

The coil L_3 may be a basket coil consisting of 90 turns of No. 30 D.S.C. wound on a former 1½ in. in diameter, with a tapping made at the centre turn, and fixed at one end of the grid coil. Alternatively, two wires may be wound on together, giving a basket coil with a double winding having 45 turns in each winding. The beginning of one winding is connected to the anode, and the end of the other winding is connected to the neutralising condenser C. The remaining two ends are connected together and to positive H.T. If preferred the anode coil may be a cylindrical winding placed inside one end of the grid coil L_4. A winding of 100 turns of No. 30 D.S.C. on a former 2 ins. in diameter, with a tapping at the centre turn is suitable. The coupling of L_3 and L_4 is not critical, but L_3 should be fixed near one end of L_4.

Adjusting the Receiver.

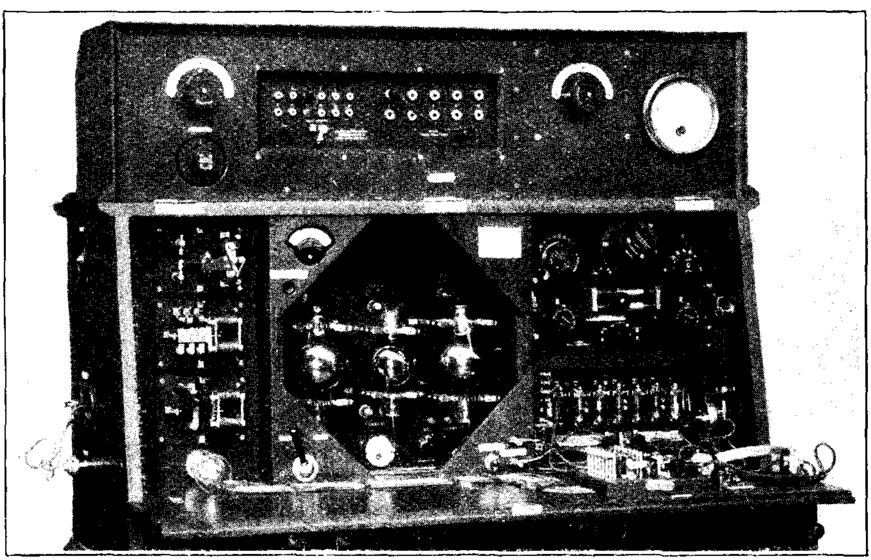
To adjust the receiver, the aerial and detector valve circuits are tuned together, and the reaction coupling increased to the desired extent. The neutralising condenser C is then carefully adjusted until turning the aerial condenser does not produce a beat note in the receiver.

It will be found that the tuning of the detector valve circuit is particularly sharp, and with this receiver it is an easy matter to eliminate unwanted signals.

It is almost essential that the circuits be calibrated, otherwise tuning may take some time, because of the sharpness of the tuning of the circuits. When the receiver is properly adjusted, although the detector circuit may be set oscillating by an adjustment of the reaction coil, no oscillations reach the aerial circuit.

The neutralising condenser may consist of two metal plates about 1 in. in diameter, arranged about ⅛ in. apart, and so that the distance between them may be adjusted, and then fixed.

[The dimensions of the reaction coil and the anode coil given above are suitable when valves of the R or 60-mA type are used. If special low impedance valves are employed, these coils can have fewer turns.]



[Courtesy Marconi's Wireless Telegraph Co., Ltd.

Cabinet ½ kW. transmitter and receiver for telegraphy and telephony. The transmitting inductances are in the upper compartment, and the lower section carries tuner and receiving amplifier, also power rectifier and oscillator valves. High periodicity alternating current is stepping up and rectified for plate current supply.

COLLOIDS

THEIR USE IN DETECTORS AND AMPLIFIERS.

In an article on "Electrolytic Detectors and Liquid Valves," by James Strachan (*The Wireless World and Radio Review*, Vol. XIII, pp. 533-4, January 23rd, 1924), we drew attention to the experiments being conducted abroad in the direction of replacing the thermionic valve by a liquid cell containing a colloid suspension. Reference was then made to the work of Suprin in France and Nienhold in Germany.

The present communication from a correspondent in France gives some particulars of the work done by another French worker, Roussel, and that of Nienhold. While we are of the opinion that this problem has not yet been solved practically, we believe that the following may be of interest to experimenters in this country as indicating the lines upon which such experiments are being conducted.

EVEN before the present extensive popularity of wireless telephony, when the thermionic valve was found to be of such great use in transmission and reception, frequent efforts were being made to do away with the perishable filament and the uncertain vacuum. More particularly in continental Europe, where both amateur and government stations have been operated on the lowest possible costs during and after the war, various workers have been devoting much time and thought to the idea of rendering radio work of all sorts less expensive. The demountable Holweck valve, many variations of the detector and amplifying valves, and other interesting discoveries have been the result of this research; and, among other things, perhaps one of the most interesting experiments has been that of applying colloidal liquids to replace the vacuum in a valve and thus dispense with the filament.

The average radio amateur doubtless is well enough acquainted with the elements of chemistry to know the character and properties of what is called a "colloidal solution," or, more properly speaking, a colloid suspension. Perhaps a short résumé of these peculiar substances will, however, be helpful in following the trend of this article.

The term "colloidal liquid," which is the most commonly applied one, is somewhat false, as is that of a "solution." In a true solution the particles of the solids which are in the liquid are completely dissolved, becoming a part of the liquid in which they are held. Such types of solids which will dissolve thus in a liquid are termed "crystalloids," and when the liquid is driven off by evaporation, they are always recovered in their crystalline state.

Colloids, on the other hand, do not actually dissolve in the liquids in which they may be put, but rather *absorb* that liquid (somewhat like a sponge), and their particles are held in suspension in the liquid. These solids which react to liquids thus may be described as being dispersed, rather than dissolved. When the liquid is driven off from a colloid by evaporation, one of two conditions may be found to prevail—either the colloid will not be able to re-absorb a liquid again, becoming a hard solid mass, generally somewhat translucent. The colloid in this condition is described as in the pectous or coagulated state. Such colloids are called irreversible.

The other condition is opposite, in that certain colloids will lose the water or other liquid, becoming solids capable of again absorbing the liquid. These are known as reversible colloids.

The colloids generally form some sort of "solution" called a "sol"—hydrosol, alcosol, glycerosol, acetonosol. An example of the crystalloid is common table salt, while a good colloid example is common gelatine. This latter in water is a hydrosol; a glycerine solution would be a glycerosol, and so on. When a quantity of liquid contains a colloid, it takes the general appearance to the naked eye of a salt solution, being perfectly fluid, but is generally not perfectly transparent, being more or less cloudy in appearance.

When these colloid solutions are examined under the ultra-microscope, the particles are found to have a constant zig-zag motion. These particles do not collide, but are always moving to and fro in the solution. This movement, first studied by Brown in 1828, is called the Brownian motion. There are several causes, but the most important one is apparently of electric origin, all these particles carrying a charge of the same polarity—sometimes negative, sometimes positive. They naturally repel each other and create the constant motion noted.[1]

It would seem possible, therefore, to transport charges in a determined direction between two electrodes raised to different potentials immersed in a colloidal solution; these electrified particles taking the part of electrons emitted by an incandescent filament or free ions resulting from the dislocation of molecules of gaseous materials. Here, then, would be the method of replacing the bothersome filament and doing away with the vacuum in a valve at the same time.[2]

Colloids are generally divided into two main classes, viz., emulsoids and suspensoids. In emulsoids such as starch paste solutions the water combines with or penetrates the particles. In suspensoids, on the other hand, the particles are not penetrated by the liquid but consist of solid particles surrounded by the liquid medium. Suspensoids are generally such substances as are insoluble in water, *e.g.*, metals, sulphur, etc., while emulsoids are chiefly organic substances.

The suspensoids have proved to be the most useful class of colloids for the experiments in radio work.

An interesting test of the properties of these suspensoids is to partially fill a U-tube with the colloid to be studied. The instruments used must be perfectly clean, the water recently sterilised and boiled to drive off absorbed gases, and in aqueous solutions, the receptacles should be coated inside with paraffin (vaseline). Now, filling each branch of the U-tube with water, on top of the colloid, two electrodes of platinum (M and N Fig. 1) are inserted. Establishing a sufficient difference of potential, displacement of the particles near one electrode toward those of the other side can be observed; manifested

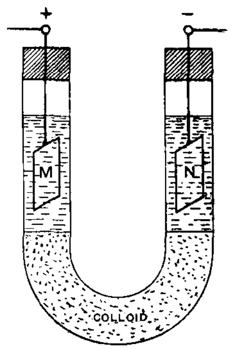


Fig. 1. Cell for examining the conductivity of a colloid.

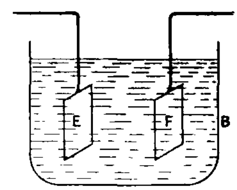


Fig. 2. Simple detector employing a colloidal solution.

to the naked eye by the concentration of colour at one electrode.

According to the French experimenter, Joseph Roussel, the conductivity of colloids is, in spite of their electric characteristics, extremely feeble; the intensity of the current in a column 36 centimetres long and 2 centimetres diameter, is about 2/10ths of a milliampere for a difference of potential of 160 volts at the terminals. The average filament-plate current in the usual radio amplifiers is about 2·5 milliamperes.[3]

The colloids which gave the best results in France for these tests were those of sulphur, selenium, gold and silver. Colloidal

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[1] The generally accepted theory of the Brownian motion is that of Ramsay, viz., that it is caused by impacts of the liquid molecules on the suspended particles.—ED.

[2] The analogy presented here should be qualified by the fact that the colloid particles are of immense dimensions compared with electrons or ions and have a relatively slower motion. Colloid particles may be regarded as being about a thousand times larger than a single molecule. For this reason it is obviously impossible to conceive that such comparatively large masses of matter could possibly respond to H.F. oscillations. The experiments described must therefore refer to rectified or L.F. currents.—ED.

[3] The low conductivity of colloid suspensions is a well-known fact. Pure colloid gold has approximately the same conductivity as the pure water in which it is suspended. The higher electrical conductivity of many colloidal preparations has been proved to be due to the presence of impurities, *viz.*, small quantities of electrolytes. In our opinion the use of aqueous suspensions introduces electrolytic phenomena.—ED.

preparations of many metals etc., are now standard pharmaceutical products. Silver colloid is called "collaragol," and is perhaps one of the purest. A colloidal preparation containing lead may be made by leaving pure metallic lead in a gelatine solution for several weeks. Sulphur colloid, however, is the one which has furnished in France the best results of detection, according to Roussel.

A glass beaker B, Fig. 2, carefully cleaned and paraffined, is used as a colloid container; E and F are the two platinum electrodes (it has been found possible to use aluminium electrodes instead). F has a surface nearly four times that of E. This arrangement was inserted in a circuit in place of the regular crystal detector, E replacing the cat-whisker and F replacing the crystal.

With an aerial of one wire, 50 feet long, the Eiffel Tower damped wave signals were received at a distance of some 12 miles from Paris, it is stated, nearly twice as strong as

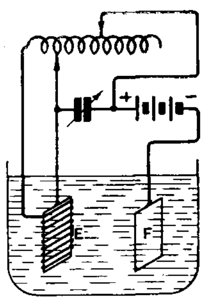


Fig. 3. An attempted method of introducing a control electrode for setting up an oscillator.

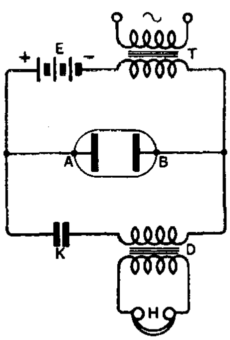


Fig. 4. The colloidal amplifier system suggested by Nienhold.

with a good crystal. The "note" of the C.W. transmissions were received without ticker or heterodyne, with great clarity. Also Havre, Boulogne, Bouseat and other stations were picked up. It was found necessary to modify somewhat the depth of E for best results.

However, this detector effect became rapidly weaker, and by the end of three or four hours the arrangement was useless. In spite of this, a heterodyne was mounted with the colloid detector, as shown in Fig. 3, the grid used being simply the spiral grid of a triode valve (French type.) After trying for some time to get the arc transmission of the Tower, some success was obtained using 25 volts on the plate, with the positive on F. Reversing the polarity the same effect, lasting an equally short time, was also obtained. The principal phenomenon remarked by Monsieur Roussel in his tests as described above was the coagulation of his colloids[4] marked by the fact that the particles, invisible before use, became visible in the same solution shortly after beginning to work with it.

Another worker who has recorded some practical study of colloids in this connection is a German from Berlin, named Nienhold. He is more optimistic than M. Roussel, having even gone so far as to register two patents on the subject. He makes use of the same electrical phenomena spoken of by Roussel in the colloidal liquids.

He claims that "the variations undergone by an electric current under the influence of a high frequency current closely follow the vibrations of the human voice, when these vibrations were transmitted to the "colloidal system" by means of electric or electro-magnetic energy." He claims also in his work that with appropriate mounting and connection for the colloidal "valve" in the primary and secondary circuits of the regular receiving circuit, "very slight increase in tension was sufficient to give a satisfactory sound intensity in the telephones."

In Fig. 4 the "valve" is furnished with two electrodes A and B, connected to which is, in the first part the primary receiving circuit, with the transformer T and the batteries E; and also the secondary receiving circuit, with the telephone H, transformer D, and condenser K. The oscillations at high frequency are applied by the intermediary of the transformer T to the "valve," causing a variation of resistance proportionate to the potential variations. According to the negative characteristics of the valve, a reinforcement of the potential oscillations in the transformer D is brought about, which variations are heard in the telephones.

In the circuit in Fig. 5, the valve also has the two electrodes A and B, as in the first case, but there is, however, a third electrode in this valve marked C, connected to electrode A across the primary circuit, the transformer T, and a battery E. The battery E_1 serves the secondary circuit. The currents

[4] Evidence of electrolytic conduction.—ED.

to be amplified provoke, by the intermediary of the transformer T, potential differences in the electrode C. These react electrostatically on the colloid particles between the electrodes A and B (movements which are maintained by the battery E_1.) There result corresponding variations in the current intensity in D, and the telephone circuit. It is claimed that the valve mounted in this fashion (Fig. 4 and Fig. 5) can work almost continuously, on condition that the direction of the passage of the current be reversed after it has been used in one direction, by changing over connections of the electrodes A and B, *i.e.*, the valve deteriorates in operation, and when it is "run down" by the passage of the current in one direction, it is ready to function in the other direction.

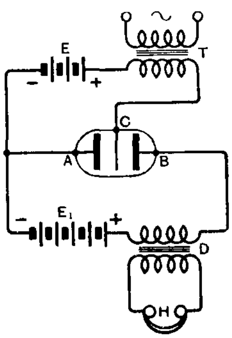


Fig. 5. Colloidal amplifier valve system with control electrode.

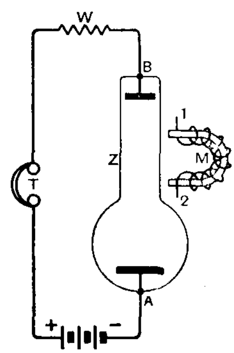


Fig. 6: The colloidal liquid in here influenced by the transverse field of the electro-magnet carrying the signals to be amplified.

In practice it is found preferable to reverse this current direction frequently so that one never reaches the point of exhaustion.

By mounting in cascade a certain number of these amplifiers, a greater magnification may be obtained than with one valve.

It is also claimed that the effect of reinforcement or amplification of weak alternating currents is produced equally well when the colloidal valve is only influenced inductively by the field of an electromagnet excited by the current to be amplified. The electromagnet is placed so as to deflect laterally the particles of the colloid, which provokes a variation in the intensity of the current which traverses the valve. The diagram in **Fig.** 6 shows one of the methods of realising an amplifying circuit in which the primary and secondary circuits are entirely separated, and consequently independent of electrical connections.

The valve is placed in the field of an electromagnet included in the circuit traversed by the weak alternating current to be reinforced, and thus is excited by this current.

In the figure the valve Z, filled with a colloid, is connected in series with a battery E. This circuit contains, also in series, the telephones and a regulating resistance W. When the circuit is closed the battery produces between the electrodes A and B an electric current, the intensity of which is controlled by the magnetic field of an electromagnet by the conductors 1 and 2. The current thus amplified to an audible intensity produces perceptible sounds in the telephone. The electromagnetic action on the valve is such that it adapts itself to telephone frequencies and allows for the use of the system as a telephone relay.

The same method of reversing the direction of the current flow is applicable in this circuit as in the first two. It is advisable to arrange the circuit so that the electromagnet receives a constant slight excitation, furnished by an auxiliary battery. A permanent electromagnetic field is thus produced, on which the oscillatory variations of the field of the current to be amplified are superposed. This may be obtained either by a single winding or by means of two distinct windings on the same core (one for the permanent excitation and one for the oscillating current).

The colloidal valve differs in this property, of being influenced by a magnetic field, from existing electrolytic apparatus. There is also a decided difference between these valves and the thermionic valve in that the dimensions and the speed of the particles dispersed are of an entirely different order.

In conclusion the whole field of this subject offers an opportunity to the wireless experimenter for research work and one that does not present serious difficulties in the way of expensive or complicated apparatus.

[While the results so far published by the authors of such work lack many details essential to substantiation of their claims by other experimenters, the above gives a good indication of the lines on which they have been working. We hope at a later date to give full particulars of some experiments at present being conducted in this country on similar lines.—ED.]

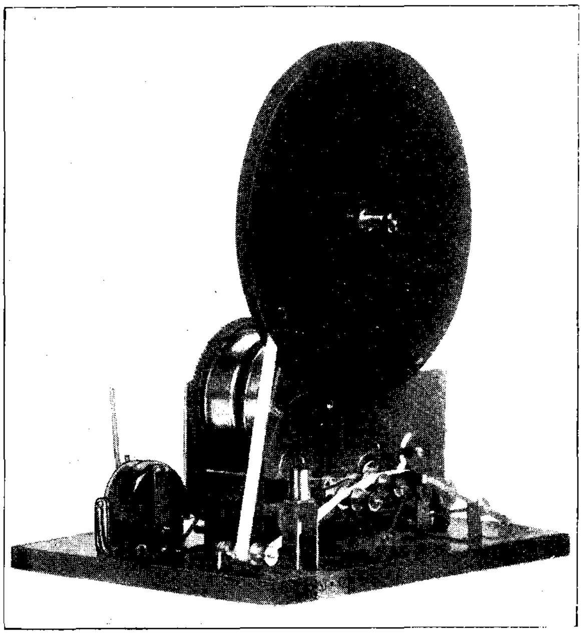
CONSTRUCTING A SYPHON RECORDER.

Recording equipment is usually expensive and somewhat difficult to set up. The design given in this article is particularly ingenious and embodies reliable working with simple construction.

By W. WINKLER.

SINCE the publication of my previous article,* I have made certain constructional modifications to the design, the principal alteration being the mechanical operation of the pen. As it is thought that many readers may be interested in the construction of recorders of this type, I give below details of its component parts.

A single bobbin is used for the electromagnet, having a core 1½ ins. in length by ⅜ in. in diameter, wound to 1 in. in diameter with No. 28 D.S.C. wire. This bobbin is mounted on one leg on an "L" shaped yoke which is 1½ ins. in height and ¾ in. in width and is made simply by bending a piece of soft iron. The bobbin is secured to the yoke by means of a centrally placed screw (Fig. 1), tapped into the soft iron core with its centre ¾ in. away from the rim of the yoke. The armature is of very simple and light construction and is built from tin plate. It is attached to the yoke by means of an 8 BA screw, whilst a tension adjustment is provided by a screw passing through from the outside, so that the gap between the end of the magnet core and the armature may be varied, thus controlling the excursion of the pen point on the paper.



Recording set with relay and syphon recorder.

The electromagnet is operated from the relay, which is constructed and completely contained within a Brown "A" type earpiece. The ebonite cover is removed and a hole about 1½ ins. in diameter is made on the perforated face, which leaves an ebonite band about ¼ in. wide. This is used to support a brass strip ½ in. in width by 3/32 in. in thickness, to which it is secured by screws. The brass piece is so mounted on the cap that when screwed up tightly the strip is exactly parallel and directly over the receiver.

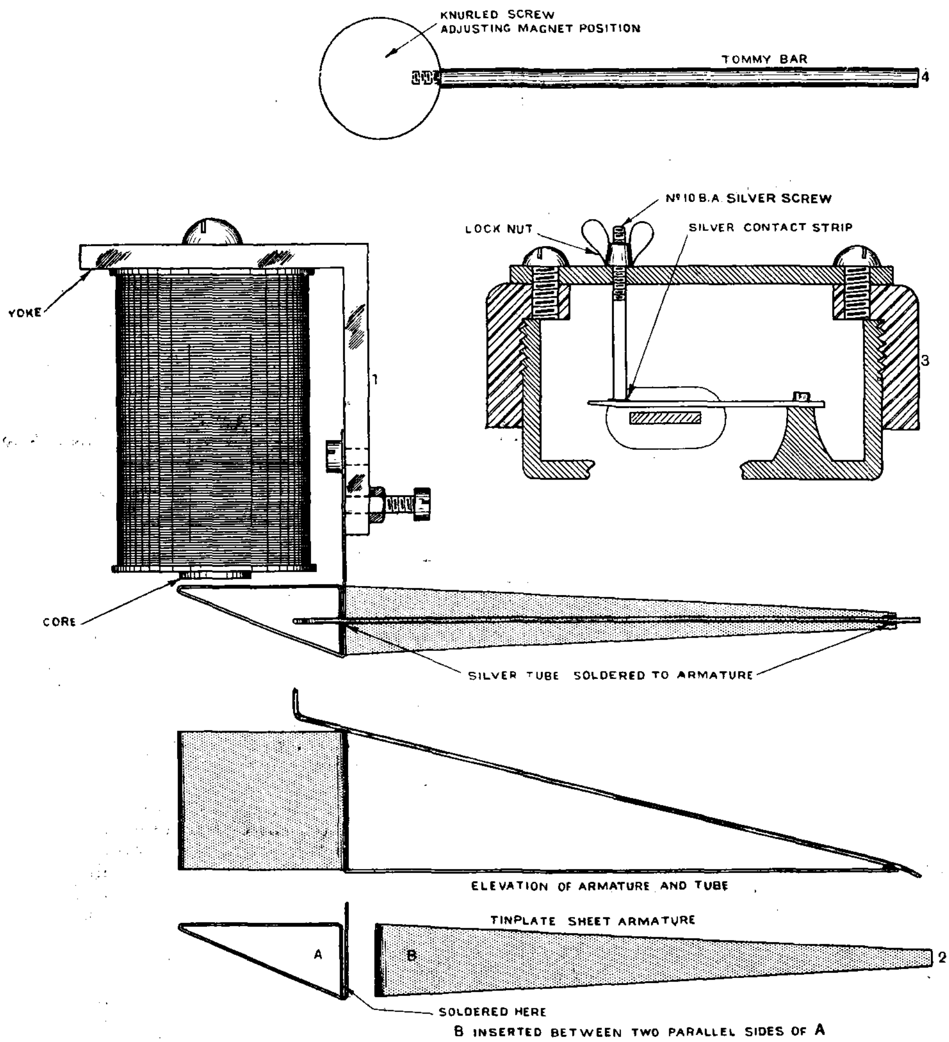
A small piece of silver to form a contact is soldered to the top of the reed on the side away from the magnet poles, and may be made from No. 30 gauge silver sheet, and measures about ⅛ in. by 3/16 in. Non-corrosive soldering flux such as resin must be used for the purpose. A 10 BA hole is next made in the brass strip over the reed contact, into which is fitted a piece of silver wire threaded to be a good fit. The wire is fitted with a lock-nut which can, if necessary, be made from a small scrap of sheet brass. On the side of the milled adjusting screw

* "A Syphon Recorder of Simple Design," Vol. XI., page 301, December 2nd, 1922.

of the receiver will be found a 10 BA screw which acts as a stop. This should be removed and into the hole a brass stem inserted to provide fine adjustment.

The procedure for setting the relay consists of adjusting the magnets clear of the reed and the closing of the silver contacts.

Across the silver contacts is connected a 200 ohm non-inductive shunt and this may be made up by winding six yards of No. 40 D.S.C. " Eureka " wire on a piece of ebonite rod or a small bobbin. The wire should be wound double from its mid-point. When the syphon magnet is operated from a single 1·5



Constructional details of simple syphon feed recorder and the relay built from a Brown telephone earpiece.

The adjustment should be such that a slight turn of the lever on the milled screw in an anti-clockwise direction is sufficient to break the contact before the reed is pulled off against the magnet poles.

volt cell there should be complete absence of arcing at the contacts of the relay. In this as in the machine previously described, the motion of the pen is controlled by the breaking of the local circuit, which occurs at each buzz of the reed of the relay, allowing the pen to travel across the paper for short or long intervals of time, returning to normal when the buzz stops and contact is again made.

It will be seen that since the movement of the reed is vibratory, it will be impossible to get a satisfactory contact while the reed is in motion. It is necessary, therefore, to make contact when the reed is at rest and to utilise the vibrations to break the circuit. This means that current is running in the local circuit when no signals are being received and it is advisable therefore to fit a small tumbler switch to break the battery circuit when not in use. The current consumed is about 0·15 amps., and even less when the apparatus is working. A little trouble taken in the accurate construction of the component parts and in particular in the initial adjustment of the contact screw, will enable the operator to achieve some surprising results. Should it be found that the ebonite cover of the relay is not quite a good fit, or has got too easy on its thread, it may be securely attached with an application of thick shellac before screwing on. This must be allowed to dry thoroughly before the cover is replaced.

Instructions for building the other components will be found in the previous article, though sufficient details are probably given here for the amateur of average skill to construct a reliable recorder.

Book Review.

Wireless Telephony and Broadcasting, by H. M. Dowsett, M.I.E.E. (London: The Gresham Publishing Co., Ltd.), in 2 vols.

Mr. Dowsett's name will be familiar to many as a writer on wireless subjects, more especially on the subject of wireless telegraphy. In the present work, to use the author's own words, is an attempt to provide the general reader with an account in true perspective of the history and practice of wireless telephony and broadcasting with special reference to the development of these arts in this country. The arrangement of the work is such that general principles and historical data are contained in the first volume while descriptions of actual broadcasting apparatus are given in the second.

By way of an introduction to the subject the first chapter sets out to be a record of wireless achievement and describes the development of wireless signalling in the various Government Services and in the Marconi Company. Among other matters dealt with in this chapter are the wireless organisation of the British Forces during the late war, the Leafield high power station of the Post Office and the Brentwood and Ongar stations of the Marconi Company.

An account then follows of the causes and events which culminated in the formation of the British Broadcasting Company and the inauguration of officially recognised broadcasting in this country.

In succeeding chapters the author deals with the history of wireless telegraphy and of wireless telephony and explains the underlying principles of the subject in an elementary manner by means of mechanical analogies.

In volume two will be found what many will consider the most interesting section of the work, a series of five chapters devoted to descriptions, illustrations and diagrams of broadcasting receiving apparatus supplied by British manufacturers while a succeeding chapter describes the B.B.C. transmitting stations.

Other chapters in this volume are devoted to broadcasting in foreign countries, component parts of receiving sets, and receiving aerials. A glossary of technical terms, biographical notes and index complete the work.

Both volumes are copiously illustrated with excellent half-tones which add greatly to the interest of the work. Another commendable feature is the large number of circuit diagrams in which high frequency, low frequency, rectification and other circuits are distinguished by the use of different colours. In addition there are about twenty-eight portraits of famous physicists, inventors and engineers whose work has contributed to the advancement of the subject.

In view of the fact that the work is intended for the general public it would, we think, have been improved by the exclusion of such of the subject matter as can be described as speculative or unaccepted theory. Instances occur where such subject matter is introduced without sufficient warning as to its doubtful authenticity.

For example, speculations as to the structure of the atom and the arrangement of the electrons therein do not throw much light on the rectifying properties of crystals, they are in striking contrast to the eminently practical hints on the selection and mounting of crystals wherein the author writes from his own practical experience.

With the exception of these comparatively slight blemishes the work admirably fulfils the author's intentions in its scope and treatment of the subject, is very readable and can be recommended to the general reader and student.

E. H. SHAUGHNESSY.

VALVE TESTS.

THE .06 CLASS.

THE development of the thermionic valve has been assisted by scientific workers throughout the world, and important improvements have followed one another in rapid succession. The attention of valve designers has been for some considerable time directed towards improvements in filament emission, which is not surprising when one considers the relatively poor efficiency of the ordinary cathode. It is not our purpose here to trace the gradual reduction in the energy required for filament heating, but it will be obvious that this reduction will be either in the current or in the filament voltage.

Valves in the class we are now considering have an extremely efficient cathode, the current required for normal filament heating being the extraordinary low one of 0·06 ampere, which is but one tenth of that required for the usual bright emitting receiving valve. This small current can, if required, be supplied by dry batteries, and such an advance in valve technique has made possible the use of valves by many to whom they have been previously debarred by reason of accumulator charging difficulties. It should not be thought, however, that these 60 milliampere valves are makeshifts. On the contrary, they are, as will be seen later, perfectly sound electrical and mechanical jobs, and are capable of performing all the functions of their bright emitting counterparts.

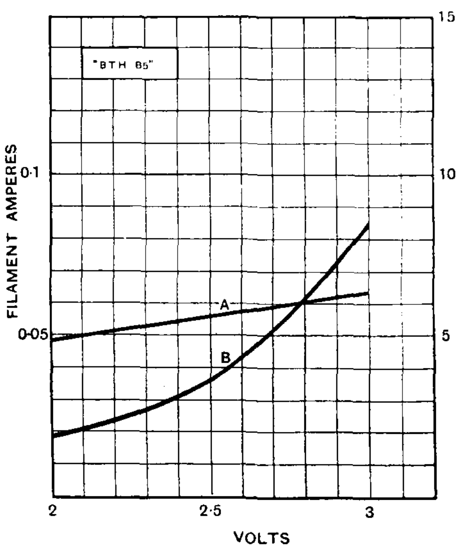


Fig. 1. B.T.H. "B.5" valve. Curve "A" shows filament current obtained with an applied voltage of from 2 to 3. Curve "B" shows the plate current obtainable with similar filament potentials.

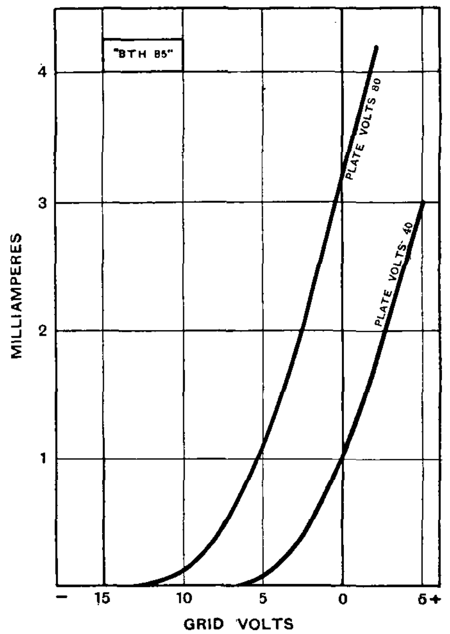


Fig. 2. B.T.H. "B.5." valve. Plate current obtainable with various grid potentials.

In spite of the special filaments fitted in these valves, our experience is that they are not unduly fragile, and, provided reasonable care is taken when handling them, they will give long and good service.

Although dry cells may be used for filament heating, and perfectly good results will be obtained from such a heating source, we nevertheless advise our readers whenever possible, to use an accumulator. There are several reasons for this, but it will suffice if we mention that the discharge curves of a dry cell and an accumulator are very different in form. That of the latter is more regular and therefore less adjustment of the filament rheostat is required.

The four valves of the 60 milliampere class now on the market are the B.5, D.E.3, A.R.·06 and D.F. Ora, and these will now be separately reviewed.

The "B5." (*The British Thomson-Houston Co., Ltd.*)—Two valves of this type have been tested, both giving satisfactory emission for all ordinary purposes at normal operating temperature, 60 milliamperes filament current being obtained when the voltage across the filament is 2·75. Curves showing how the filament current and emission vary for different filament voltages are given by

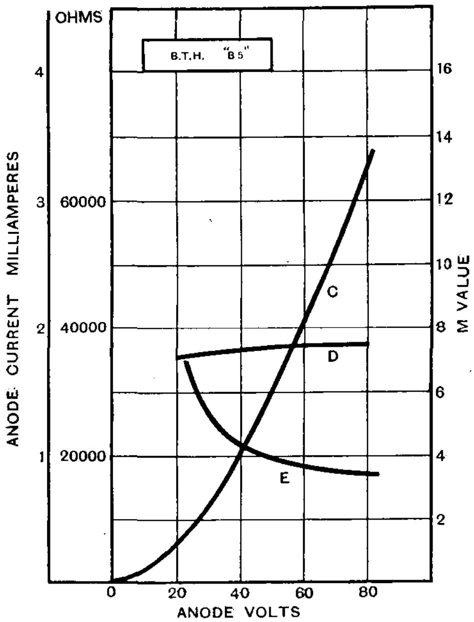


Fig. 3. B.T.H. "B.5" valve. Curve "C," plate current obtainable with various plate voltages. Curve "D," magnification factor. Curve "E" impedance.

A and B respectively in Fig. 1. Plate current grid volts characteristics at plate voltages of 40 and 80 are shown in Fig. 2. These curves are reasonably steep, while that in the higher potential is straight over a fair length of negative grid potential. The valve has a magnification value of about 7·5 to 1, while the plate impedance varies between, say, 25,000 and 18,500 as the plate potential is raised from 30 to 80 (Fig. 3). The indications are therefore, that in the B.5 we have a satisfactory general purpose valve.

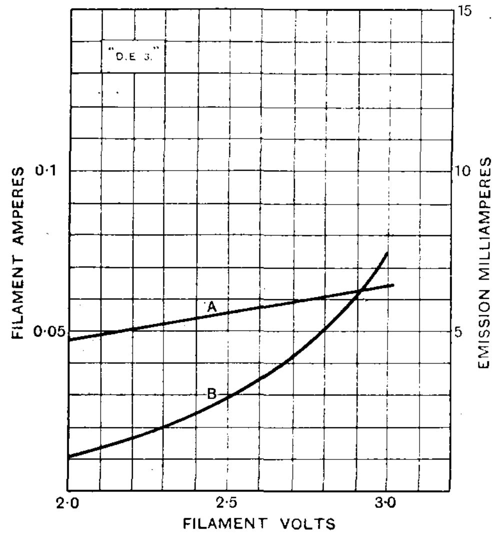


Fig. 4. Filament current (A) and emission (B) curves of Marconi-Osram "D.E.3."

The D.E.3. (*Marconi-Osram Valve Co., Ltd.*)—The foregoing remarks on the B.5 apply in almost every detail to the M.O. Valve Co.'s product, the D.E.3. The characteristics of these two valves are

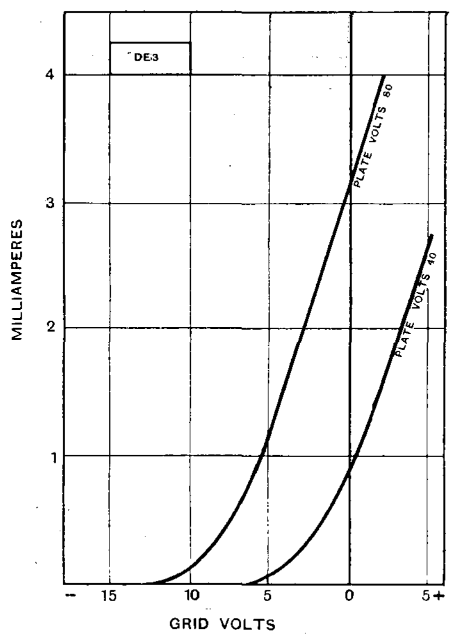


Fig. 5. Plate current grid volts characteristic of the "D.E.3."

strikingly similar, as will be seen by comparing the B.5 curves, Figs. 1, 2 and 3, with their D.E.3 equivalents, Figs. 4, 5 and 6.

The A.R.·06, (*The Edison Swan Electric Co., Ltd.*)—The filament characteristics of the Ediswan ·06 valve are given in Fig. 7, and again ample emission for all average receiving work is obtained at normal filament current.

The A.R.·06 differs from the two previously described valves in that its magnification value is much higher, being over 13 at the higher plate potential, and as usually follows, the plate impedance is also at the same time much higher (see Fig. 9). These factors are reflected in the anode current-grid volts characteristics, and as is seen from

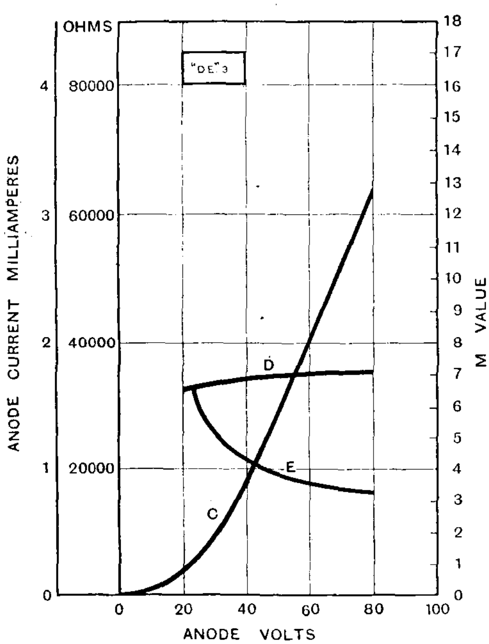


Fig. 6. Anode characteristic (C), magnification factor (D), and impedance (E) of the D.E.3.

Fig. 8, the plate current is lower than in the B.5 and D.E.3. What happens of course, is that due to the higher '*m*' value, the characteristic has been shifted bodily to the right, and therefore, at any given plate potential the A.R.·06 shows less of its characteristic to the left of the zero grid volts line.

As is usual with all Ediswan valves, "fool-proof" pins are fitted, which prevent the accidental application of the high tension voltage across the filament.

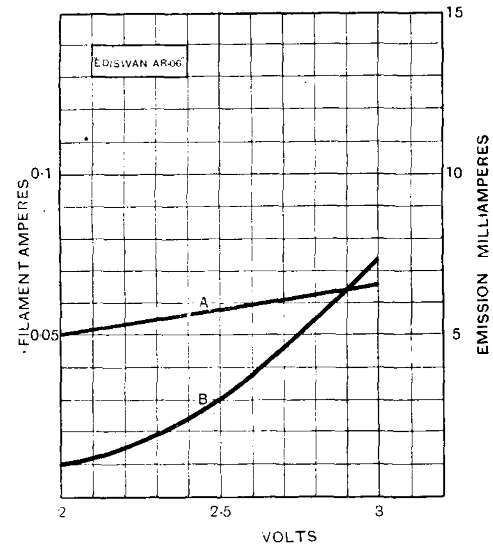


Fig. 7. Filament current (A) and emission (B) curves of the A.R.·06.

One would expect this valve to be particularly good as a high frequency amplifier and as a detector, but its high resistance is somewhat against its being used as a low frequency amplifier.

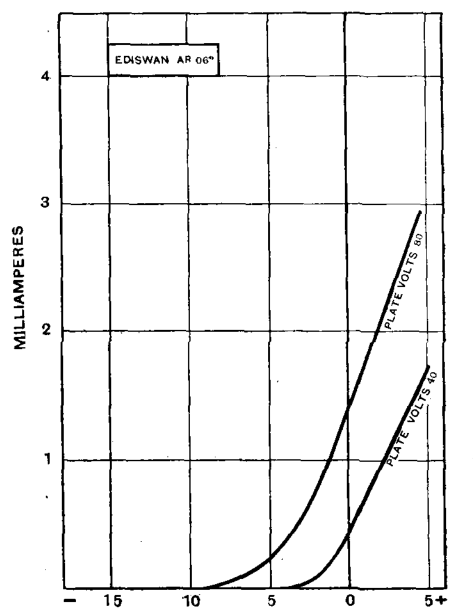


Fig. 8. Plate current grid volts characteristic of the A.R.·06.

The D.F. Ora (*Mullard Radio Valve Co., Ltd.*).—We now come to the last, but not least, of this series, the Mullard product, and one's first impression on opening the carton is that the valve has suffered badly in transit, but one's fears are soon allayed when it is seen that the electrodes have been deliberately set at an angle of roughly 45 degrees to their vertical supports.

The filament characteristics obtained are given in Fig. 10. It will be noticed that the normal current of about 70 milliamperes is required to produce anything like a working emission. Apart from this discrepancy, however, the valve gives promise of good performance. Its magnification is lower than others of

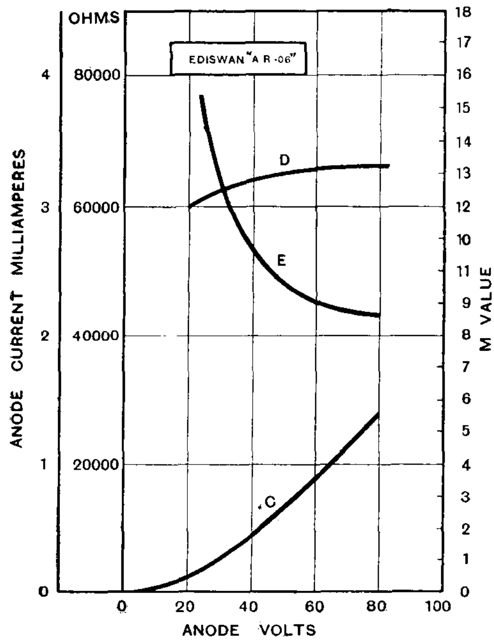


Fig. 9. Ediswan A.R.·06. Plate current, plate volts curve (C). Magnification factor (D). Impedance (E).

its class, being about 4 to 1, but its plate impedance is correspondingly reduced, and works out to be about only 12,000 ohms when working with a plate potential of 60. Particularly good results should be obtained from this valve when operating as a low frequency amplifier, which prediction is confirmed by the 80-volt curve of Fig. 11, which is steep and straight over an exceptionally long range of negative grid voltage.

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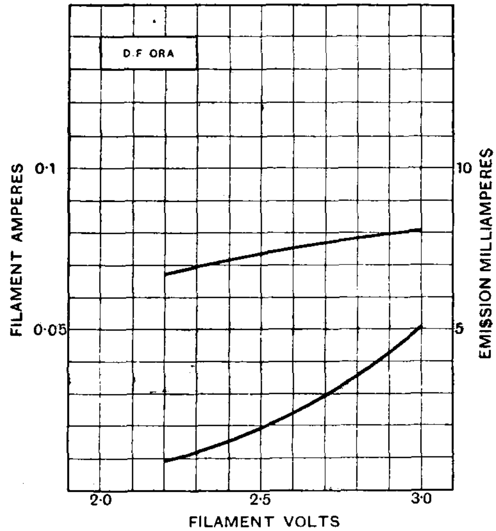


Fig. 10. Filament characteristic (A) and emission (B) curves of the Mullard "D.F. Ora."

To give an individual report on the performance of these valves under circuit conditions would be mainly repetition, and we shall therefore summarise the results of these tests.

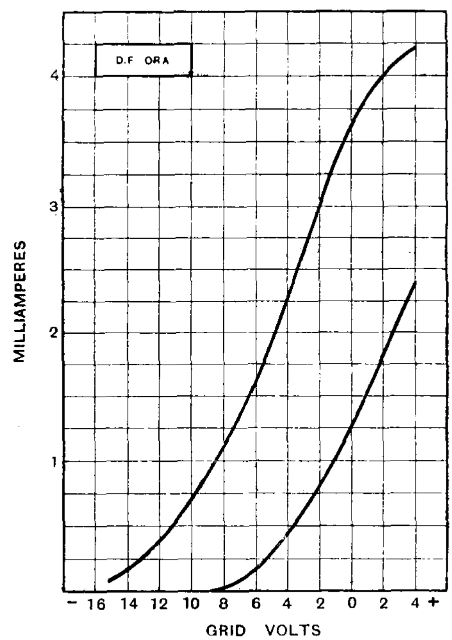


Fig. 11. Plate current grid volts characteristic of the "D.F. Ora."

A.R.·06.—As a detector and on the high frequency side this valve gave excellent results, as was to be expected, having in mind its high magnification value.

B.5, D.E.3, D.F. Ora.—These valves can all be classed as good general purpose valves, and in our hands gave extremely good results, operating in any part of our receiving circuit provided, of course, the various potentials were suitably adjusted according to how the valve was desired to function.

When operating as a high frequency amplifier, 40 volts H.T. seems to be about right, while for low frequency work the plate potential should be increased to 60 or 80, and a small negative bias applied to the grid. The exact figure can be obtained from the plate current grid volts characteristics already given.

All these valves give sufficient emission at normal filament wattage to operate on a medium-sized loud speaker.

When used as a detector it is important to keep the plate voltage low and good results will then be obtained; the plate potential is not, however, critical. Another point to bear in mind when using these valves as detectors is that it is advisable to connect the grid return lead to the positive end of the filament battery.

Finally, we may say that in the 60 milliampere class we have valves which are equal in performance to the bright emitters and, provided reasonable care is taken, they will give the user a long and serviceable life at an extremely low maintenance cost.

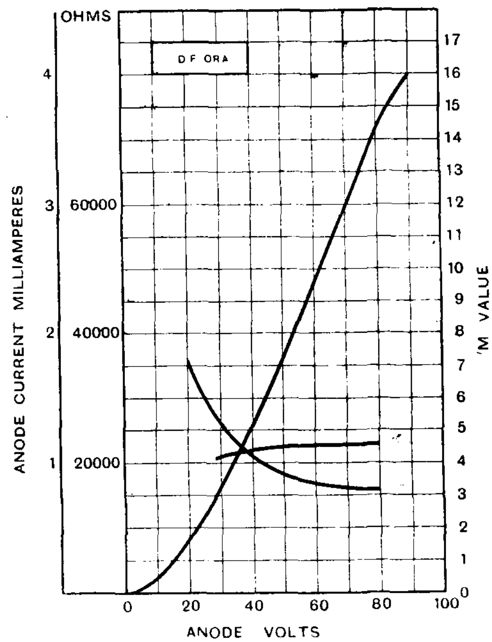
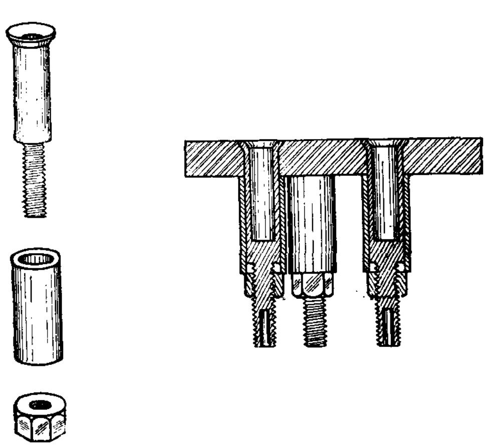


Fig. 12. *Anode characteristic (C) Magnification factor (D) and impedance (E) of the "D.F. Ora."*

Errata: When describing the B.4 valve, made by the British Thomson-Houston Co., Ltd., on page 222 of our issue of May 21st, 1924, reference was made in the title to the "4" of the designation number as signifying that the valve is fitted with a 4-volt filament. This is incorrect as is immediately apparent from Fig. 1 on page 222, where it will be seen that the valve is designed to work with a 6-volt filament battery. The confusion arose owing to the M.O. valve R.5 v., previously described, in which case the 5 does signify the filament voltage, whereas the designation B.4 has nothing whatever to do with the battery potential.



[Courtesy The Redgate Manufacturing Co.

New Ideas in VALVE SOCKET DESIGN.

The mounting of valve legs flush with the face of the instrument panel is becoming increasingly popular. The usual method of flush mounting consists of tapping an 0 BA. hole and driving in a threaded stem, though such a process does not come within the skill or workshop equipment of the beginner, while the junction between the brass and ebonite is not always a clean job.

The design shown in the accompanying drawing consists of an inner stem which is dropped into a countersunk hole and is pulled up tight and flush with the face of the ebonite by means of a tube and nut, producing a valve mounting of low capacity and saving about one inch in the height of the top of a valve when inserted. The hole drilled into the base of the stem provides reliable and neat connection.

TELEPHONE DIAPHRAGM RESONANCES.

In an earlier instalment of this article, published on p. 332 of the previous issue, the author described some experiments of extreme interest to show the nature of the vibrations of telephone diaphragms at different frequencies. In the present article an explanation is given of the effects produced.

By Prof. E. MALLETT, M.Sc., M.I.E.E.

From the photographs reproduced in the previous article, it was seen that the nodal lines (making allowances for small irregularities) are made up of various combinations of diameters and

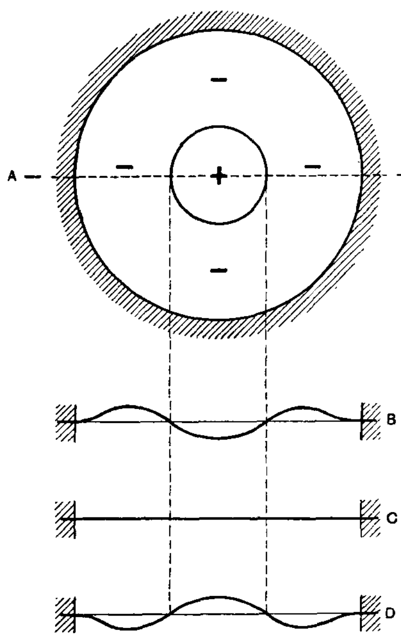


Fig. 12.

concentric circles. That this would be so is predicted by the theory of both plates and membranes.* It appears that the tension in the telephone diaphragm caused by the pull of the permanent magnet is not sufficient to affect the resonant modes, and the diaphragm vibrates as though it were a plate rigidly clamped at the boundary, and the frequencies of the various modes are in very good agreement with those given by the plate theory. Whenever a nodal line is crossed the phase of the vibration is reversed; that is to say while the diaphragm on one side of the line is moving upwards, on the other side it is moving downwards. Thus in the case of the nodal circle, if a section be imagined cut through the line AA, in successive instants the edge of the diaphragm would have the appearance indicated at B, C, D, Fig. 12. This may be made clear by placing + and — signs on the nodal picture, indicating that as the parts of the diaphragm marked + are moving upwards, those marked — are moving downwards.

This is very similar to the motion of the fork which was shown in Fig. 1B, where, while parts of the fork above the nodal points *n* are moving to the left, parts below the nodal points are moving to the right.

Fig. 13 indicates in the same way the relative phases in more complicated modes *a* with one diameter and one circle, and *b* with two diameters and two circles.

The photograph (Fig. 14) is not a sand picture, but is obtained by sprinkling fine iron filings on the diaphragm instead of sand, and indicates the positions of the poles of the magnet. The white dots

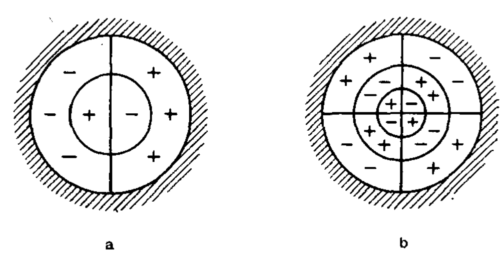


Fig. 13. *Relative phases in complicated modes.*

in the cap, which was kept in the same position throughout, enable the position of the poles to be judged in each of the sand figures previously shown. It is seen, therefore, that in each of the cases where there is one nodal diameter, the poles

* See Rayleigh's "*Theory of Sound*," Vol. I., Chaps. 9 and 10.

lie on opposite sides of the diameter, where the phases of the diaphragm motion are opposed. These types of motion will therefore be more easily sustained if the receiver coils are reversed so that one pole pulls while the other lets go, and as a matter of fact, to obtain the figures containing one nodal diameter the coils of the receiver were so reversed. In all the other cases the phase of the diaphragm above each pole is seen to be the same, and the ordinary connections of the coils were used.

Now it may be asked what influence these various modes of vibration have on the operation of the telephone receiver as a sound generator. We have seen that the volume of sound generated for a given current is far greater at the resonant frequencies than at others, so that if a curve is plotted of sound intensity against frequency, something like Fig. 15 will be obtained. Although the differences between maximum and minimum sounds will be even more marked with the receiver working into the open air, they will be damped when the receiver is pressed against the ear, and may have something like the relative magnitude shown. There will therefore be an unequal response to different tones and amplitude distortion

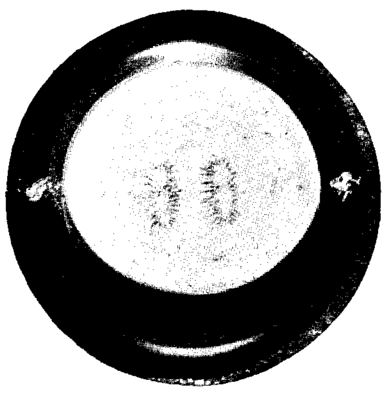


Fig. 14. Position of poles indicated by iron filings on the diaphragm.

must occur. Further, it can be shown† that when currents of two frequencies act together on a telephone, forces are produced of frequency equal to twice each, and to the sum and difference of the two. Thus if currents of frequencies 1,500 and 2,500 pass simultaneously through the receiver windings, there will be forces produced acting on the diaphragm of frequencies 1,500 and 2,500, of double frequencies 3,000 and 5,000, of the difference of the frequencies 1,000 and of the sum of the frequencies 4,000. These latter forces are small compared with the main forces, but if the main force is at a frequency at which the sound response is a

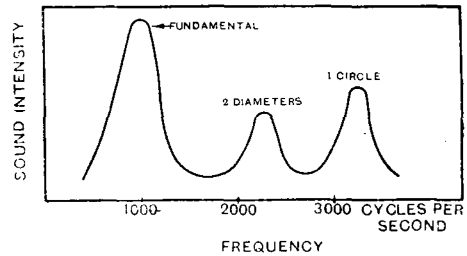


Fig. 15. Sound intensity plotted against frequency.

minimum and the sum or difference force is at a frequency when the sound response is a maximum, it may be that the sum or difference note is appreciable compared with the main notes. That is, a note or notes are introduced which are generally not harmonic, and which therefore may produce discordant effects, and will in any case alter the music to some extent. When the currents are very complex, such as those produced by a band, where there are a very large number of frequencies present, any pair of which produce sum and difference tones which may be of appreciable magnitude, it is seen that the possibilities of distortion are considerable.

But is there another side to the picture? Do the resonances have any beneficial effect? As far as the writer knows, no one has ever had a good word to say for them, but it may be that they serve a useful purpose in improving the articulation of speech. Speech is a very complicated form of sound wave, and considerable work has been done on the nature of speech. In this connection the work of Miller* is of very great interest. He shows that vowels are in general characterised or defined by the existence of vibrations of particular frequencies, and that these frequencies are independent of the particular voice and of the note upon which the vowel is spoken or sung. These characteristic frequencies are generally much higher than

† *Journal I.E.E.*, Vol. 62, p. 374, April, 1924.

* Miller: "*Science of Musical Sounds*," p. 227.

the fundamental pitch of the voice. Some vowels have one characteristic frequency and others have two, a lower and upper. All the lower frequencies are below a thousand cycles per second, and may be regarded as coming within the fundamental resonance of the diaphragm. Some of the higher frequencies are given as follows :—

Vowel Sound	Upper Characteristic frequency	Corresponding Mode.
MA ..	1050	Fundamental.
MEt ..	1953	2 diameters.
MAte ..	2461	
MEEt ..	3100	1 Circle.

In the experiments referred to above, where the frequencies of the resonant modes were measured, it was found for the particular receiver tested (a standard common battery 60-ohm. receiver), that the fundamental was 1,050, 2 diameters 2,250, and one circle 3,000. Thus the fundamental is the best to produce the A in MA, probably the most common vowel sound, the two diameter resonances would accentuate the MET and MATE vowel sounds, and the ee in MEET corresponds almost exactly with the one circle.

The present design of receiver, especially with regard to the cavity behind the diaphragm, and the diameter and thickness of the diaphragm, upon which the frequencies of the resonances depend, has been arrived at by trial and error methods extending over a long period of years. Is it not possible that what has been evolved is the arrangement best suited by its resonances to articulate the most common vowel sounds in speech ?

If this is so, clearly the receiver which has been designed primarily for the intelligibility of speech, is not necessarily the best arrangement for the most natural reproduction of a voice or music, and it is not surprising that the whole question has come into prominence with the advent of broadcasting. When the receiver is producing speech sounds, the diaphragm vibrations take various forms while speech is proceeding, so that could one take continuous records the various sound figures would appear from time to time with different vowel sounds, with beneficial results on the intelligibility, but the reverse on the naturalness. With music, however, where what is wanted above all is an exact reproduction of the sound heard, the effects of the multiple resonances must be undesirable.

CORRESPONDENCE.

Oscillatory Crystals.

To the Editor of THE WIRELESS WORLD AND RADIO REVIEW.

SIR,—With reference to your interesting article on the above subject it should be noted that from the point of view of theory the mode of operation of such circuits is comparatively clear and not quite the same kind of action that takes place during rectification. So far as my own experience goes, crystal rectifiers are not reversible in their operation, *i.e.*, a direct current passing through a single circuit comprising a crystal contact and inductance in parallel will not generate oscillations. It is not only necessary to place a condenser in the circuit but much higher voltages are necessary than those of the critical values required when using an applied potential during reception.

The oscillating circuit in Fig. 2 is a typical arc circuit in which the arc is replaced by the negative resistance of a crystal contact, and the theory of the arc generator is clearly applicable. As pointed out by Mr. Philip R. Coursey eight years ago, some Japanese experimenters found it better to use such crystals as silicon, carborundum, magnetite, iron pyrites, etc., for the electrodes of high power oscillating arcs. (*Vide The Wireless World and Radio Review*, Vol. IV, p. 96, May, 1916.) The use of such a system with a small current as a heterodyne in reception is novel and worth further investigation.

JAMES STRACHAN.

Aberdeen.

To the Editor of THE WIRELESS WORLD AND RADIO REVIEW.

SIR,—With reference to your article, "Oscillating and Amplifying Crystals," allow me to point out that it is the difficulty of making the oscillations sufficiently regular to be of practical use which is the real trouble. The diagrams shown are much the same as those for wireless telegraphy by means of short arcs, with crystals substituted for carbons or metals. It seems impossible to draw any line between the latter and crystals. Till some means has been found of making crystals regular in action as rectifiers, there can be no prospect of their steady action as oscillators. This is not to say that a steady crystal is an impossibility, but merely that it is advisable to build on a firm foundation.

LESLIE MILLER.

PATENTS AND ABSTRACTS

Improved method of Magnifying Electrical Impulses.

This invention* relates to an improved method of magnifying intermittent electrical impulses to enable the messages to be permanently recorded.

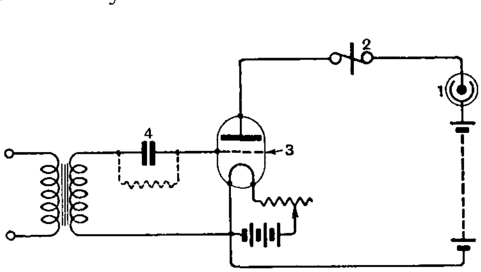


Fig. 1.

One arrangement suggested is shown in Fig. 1. A neon lamp (1) and a vibrating relay (2) are connected in series in the anode circuit of the last valve (3) of the wireless receiver. The sensitivity of the relay is adjustable, as is also the value of the steady current in the anode circuit. By suitably adjusting these quantities, it is said that the relay will vibrate without any difficulty in perfect response to the wireless messages received.

The operation is improved by the addition of a grid condenser (4).

Filters.

It is often desirable to dispense with batteries for providing the current for the anode circuit of valve receivers, and to employ instead the ordinary direct current electric light supply. The voltage of the electric light mains may, however, not be suitable, and it is necessary to smooth the supply fed to the receiver to prevent noise. It has therefore been proposed to provide a unit† which consists of a filter and a potentiometer arranged, for example, as shown in Fig. 2. The mains are connected to the terminals A B, and the current passes through the switches S and fuses F to the potentiometer P. Terminal C is connected through inductances to the negative terminal of the supply, and terminals N and D are connected through chokes G to suitable points on the potentiometer. The condensers H and chokes G are for the purpose of preventing changes in the current which might result in a noise in the telephones.

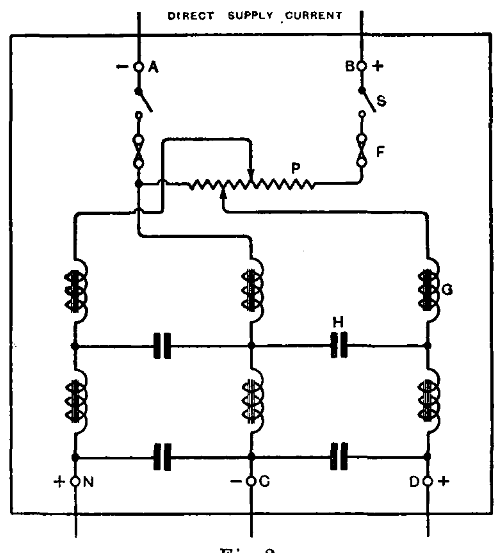


Fig. 2.

The apparatus is contained in a metal-lined container in order to shield the wires from currents due to stray fields, and it is preferable to completely enclose the chokes in iron cases.

* British Patent No. 214,754, by H. St. George Anson.

† British Patent No. 213,395, by Fuller's United Electric Works, Limited.

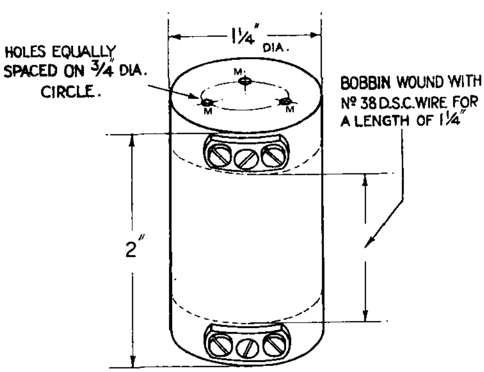
SHORT WAVE RECEIVER.

By F. H. HAYNES.

(*Concluded from page* 336 *of previous issue.*)

Details of the small choke coils are given below. They are made up from 1¼ ins. ebonite rod sawn to length and filed true at the ends if a lathe is not available. There is no reason why the windings of the chokes which feed the telephone receivers should not be wound side by side on one piece of rod to save the trouble of truing up so many ends. The terminal pieces were obtained from the Marconi Scientific Instrument Company and carefully bent to fit the curvature of the rod, though single 4 BA screws tapped into the ebonite may serve the purpose almost equally well.

Now, with all the components ready for mounting, the front panel can be made up. It should be trued up square and to size after the cabinet has come to hand, in order



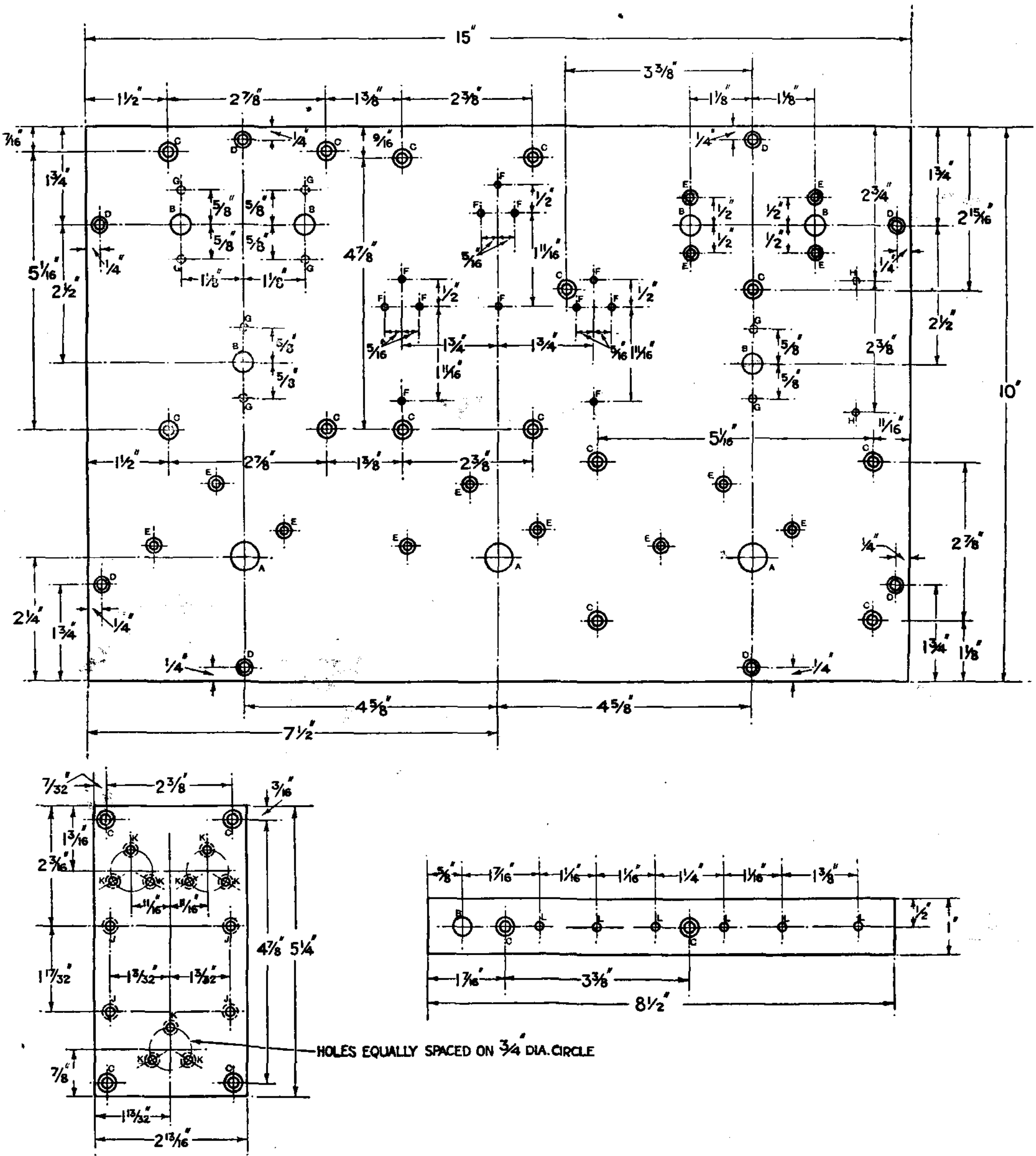
Constructional details of the three H.F. choke coils. The holes are tapped 6 *BA.*

to ensure a good fit. The cabinet is of simple construction and such as can be obtained from Messrs. Pickett Bros. It is 8 ins. deep internally and has a fillet ¼ in. from the top edge so that the panel, which is 5/16th in., slightly projects. The position of the slot in the back should be measured from the inside faces of the box and the wood throughout is planed from ½-in. mahogany.

The drilling diagram, shown on the next page, only suits, of course, components similar to those shown in the photographs and in setting out it is advisable to identify the purpose of every hole and use maker's templates where possible. Those holes which are used to secure the inductance coils should be set out from the finished coils while the positions of the 2 BA tapped holes which are made in the brackets are not marked out until the panel is drilled, so that the coil may be held behind the holes and the exact positions for the brackets marked. The platform which carries the transformer and chokes, and also the terminal strips, should be used as templates for marking the positions of the holes in the panel used for attaching the ½-in. ebonite supporting rods. It may be noticed that the grid and plate contact clips for the valves are located a little lower than is usual, the purpose being to provide improved surface insulation with regard to the top filament clip.

After drilling, the panel is rubbed down in the customary manner with medium carborundum cloth and the black colour restored with the merest trace of oil. The oil is subsequently removed by rinsing with turpentine, which soon dries off, leaving the panel free from smears. The engraving is clearly shown in the photograph which preceded the first instalment of this article.

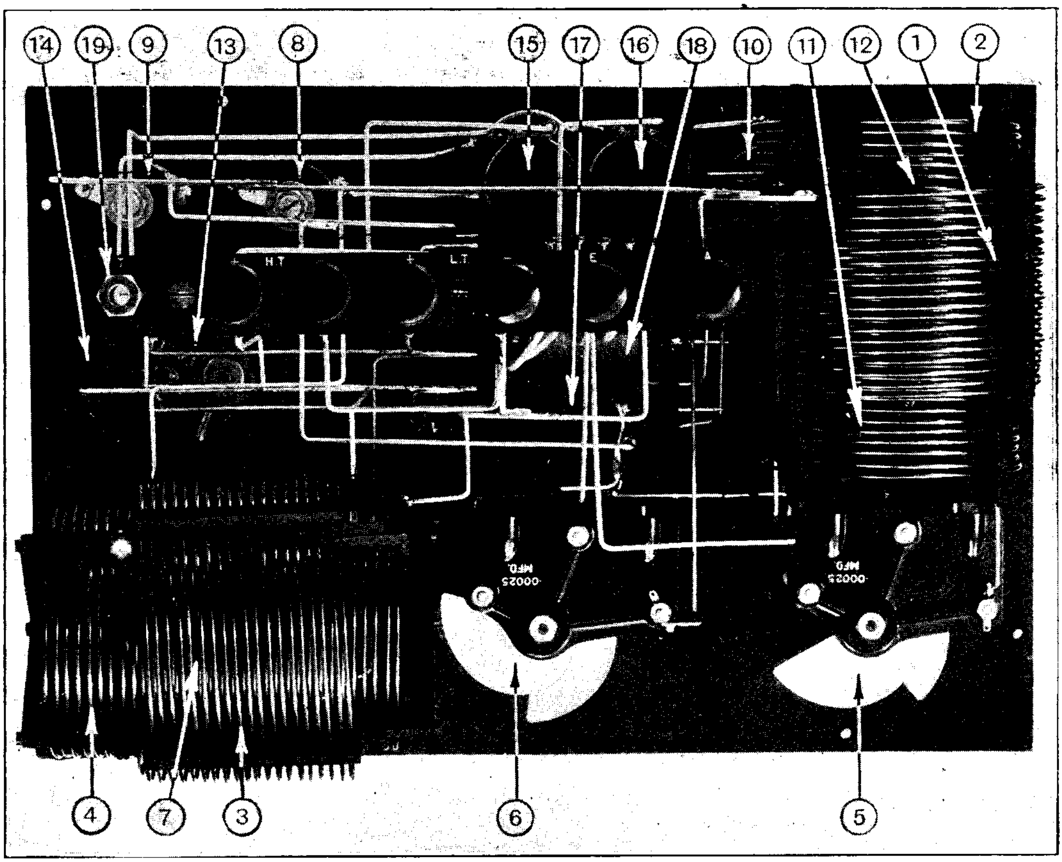
The wiring up should offer no difficulty as most experimenters are nowadays experienced in the use of stiff No. 16 S.W.G. round wire. The valve holders, filament resistances and potentiometer are wired up before the inductances and transformer platform are secured. On fitting the inductances, the wiring of the grid and plate leads of the H.F. and detector valves can be completed. The L.F. valve connections are accessible after the transformer platform is in position. The aerial circuit H.F. transformer is the vertical one, mounted over the filament resistances and the ends of the inductances nearest the top of the panel, go to aerial and grid, with the inner winding as the secondary. The intervalve H.F. transformer is over its tuning condenser with the grid and plate connections taken from one end. Terminals as



Drilling of panel, transformer platform and terminal strip.—A, Drill ½" dia. B, Drill ⅜" dia. C, Drill 7/32" dia., countersink on topside for 2 B.A. screws. D, Drill 5/32" dia., countersink on topside for No. 6 raised headed wood screws. E, Drill 5/32" dia., countersink on topside for 4 B.A. screws. F, Drill ⅛" dia. G, Tap 4 B.A. × 3/16" deep on underside. H, Tap 6 B.A. × 3/16" deep on underside. J, Drill 5/32" dia., countersink on underside for 4 B.A. screws. K, Drill ⅛" dia., and countersink on underside for 6 B.A. screws. L, Drill 5/32" dia.

viewed from the back, starting at the right, are A, E, L.T. —, L.T. +, H.T. —, H.T. + and a jack is used for the telephones so that they are always connected in the circuit in the correct direction.

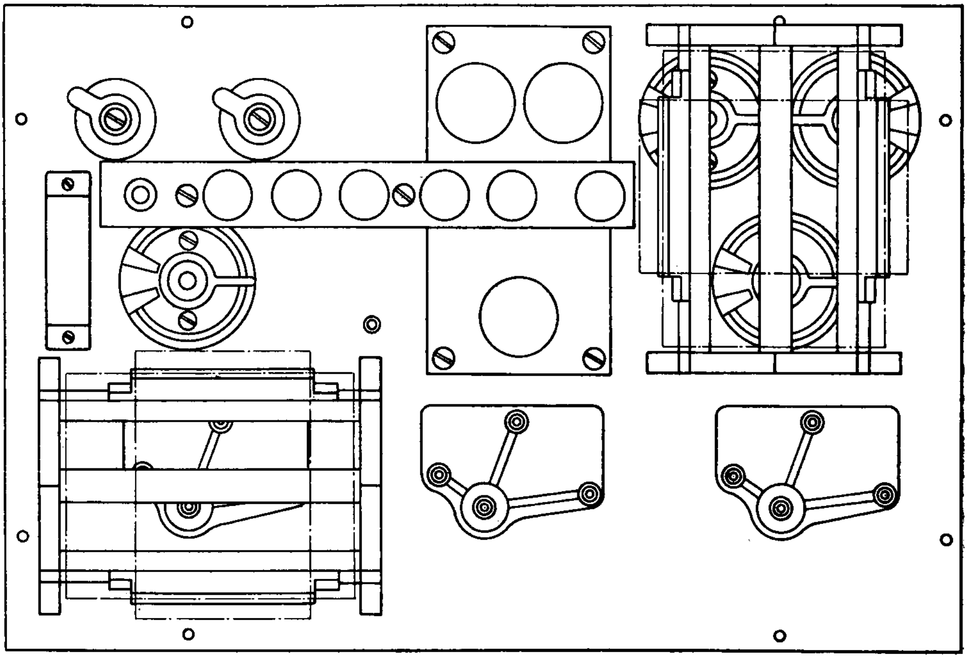
The tuning of the finished receiver is moderately simple. Aerial and closed circuit and reducing the value of the closed circuit condenser that the wavelength may remain unchanged, though the circuit will more readily oscillate. The positive reaction condenser which is connected between the aerial and first valve plate should normally be near its maximum setting when tuning in.



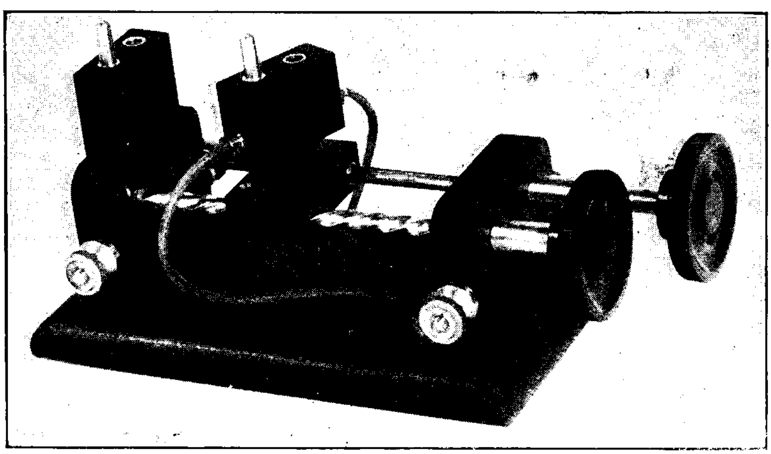
Arrangement of the components.—(1) *Aerial inductance.* (2) *Closed circuit inductance.* (3) *Plate circuit inductance.* (4) *Grid circuit inductance or secondary of H.F. transformer.* (5) *Aerial tuning condenser.* (6) *Closed circuit tuning condenser.* (7) *H.F. transformer tuning condenser, beneath inductance.* (8) *and* (9) *Reaction condensers.* (10), (11), *and* (12) *Filament resistances, beneath inductance.* (13) *Potentiometer.* (14) *Condenser across low H.F. potential ends of transformer.* (15) *and* (16) *H.F. chokes in telephone leads.* (17) *H.F. choke on detector valve lead.* (18) *Intervalve L.F. transformer.* (19) *Telephone jack.*

condensers can be regulated so the point of oscillation on the setting of the closed circuit condenser roughly coincides with the H.F. valve plate tuning condenser. As the aerial and closed circuit inductances are so tightly coupled it will be found that by increasing the setting of the aerial condenser When it is reduced in value and the negative reaction condenser brought into action, the tuning will need slightly readjusting. The potentiometer controlling the H.F. valve will normally apply the full negative potential. As mentioned previously, it is most important to avoid capacity leakage to earth through the H.T. and L.T. batteries, which should stand on a plate of glass or ebonite, supported on small bobbin insulators and connected up with short leads.

On the performance of the set it may be said that within a few minutes of connecting it up that two American broadcast transmissions were heard on 100 metres, the receiving aerial having previously been proved to be not a particularly good one, owing to its surroundings. During the first four hours' listening five American amateur stations were definitely logged, while many distant stations were heard but whose call signs were missed.



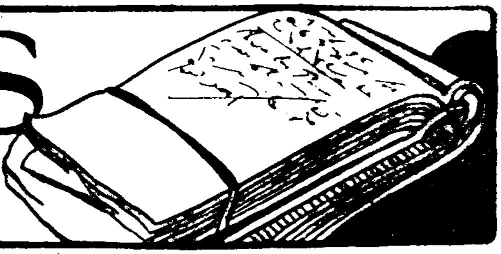
Scale drawing (1/3 full size) showing the assembly of the components.



Courtesy Messrs. N. V. Webber.

One of the handles propels the coil holder at a convenient speed for rapid adjustment, whilst the other gives a rotating motion for critical setting. Particularly fine adjustment can be obtained and either action can be made use of irrespectively of the position of the moving holder.

NOTES & CLUB NEWS



Broadcasting by Celebrities.

It is understood that the speech of Mr. Lloyd George, at the commemoration service in Westminster Chapel, on "Dr. Clifford as I Knew Him," on Monday, July 7th, will be broadcast from **2 LO.**

Mr. Winston Churchill is also to be broadcast on June 27th, when he will speak on "English," on the occasion of a commemoration day of the London School of Economics.

Long Range Achievement.

Following on the successful experiments conducted under the direction of Senatore Marconi, when direct communication to Australia was achieved, a message has now been transmitted direct to Buenos Aires by the employment of similar apparatus, using short wavelengths and some of the principles of the Marconi Beam apparatus.

WLAG, the Twin City broadcasting station, Minneapolis, now has a woman announcer, Miss Eleanor Poihler, who is also executive director, states *Radio Broadcast.*

Wireless at the Prague Fair.

The photograph reproduced on this page shows the Pavilion of the Radiojournal Broadcasting Company at the Prague Fair. By means of the apparatus and loud speaker shown here, nearly all Continental Broadcasting Stations were received and listened to by large audiences. This Company is licensed and supported by the Government.

Netherland Radio Union.

A Union of Radio Societies has been formed in Holland under the title of Nederlandsche Radio Unie, with headquarters at Amsterdam. The Secretary is J. J. Lichtenveldt, Sarphatistraat 160, Amsterdam.

Radio in New Zealand.

Mr. Howard Ninnis, who has recently returned from a visit to New Zealand, gave some interesting information regarding wireless developments in the Dominion at an informal meeting of the Radio Society of Great Britain, held on Wednesday, June 11th. He stated that radio is in a more or less initial stage out there at the moment, but it is probable that an up-to-date broadcast service will be established in the course of the next few months. Even at the present time a number of broadcast stations erected as a result of private enterprise are giving a very creditable service.

Distant Control by Wireless.

Mr. W. A. Appleton, M.B.E., has introduced a novel application for wireless. His motor car is fitted with a 4 ft. aerial along the roof and a small spark transmitter controlled by a switch on the dash-board. When within a short distance of his house, Mr. Appleton can press the switch on the dash-board and the outer gates and garage doors open automatically in response. The transmitter is an induction coil worked off the lighting and starter battery. Transmission from a distance controls an electric motor inside the garage, which opens and closes the gates, these remaining open so long as the switch on the dash-board of the car is closed and the aerial radiating.

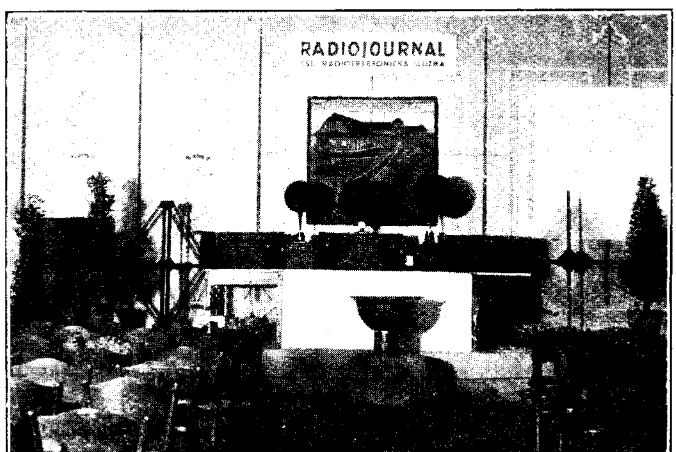
Mr. Appleton is known to many of our readers as the Research Director of the Radio Instruments, Limited.

Propaganda by Wireless.

The annual report of the Executive Committee of the General Council of the League of Nations Union for 1923, mentions that on the publicity side, co-operation has been maintained with the B.B.C. and the National Association of Radio Manufacturers.

A series of talks of international affairs, including talks for children, had been broadcast throughout the country to a listening-in public of over 2,000,000.

This side of the publicity work of the Union is growing rapidly and offers great possibilities for the future.



The Pavilion of the Radiojournal Broadcasting Co. at the Prague Fair.

Wireless in Public Institutions.

An interesting decision has recently been made by the Postmaster General regarding the use of wireless in certain public institutions. In a letter addressed to the Postmaster General regarding wireless sets for public institutions, the Rev. G. Winter Wilson, of Newcastle-on-Tyne, asked the following questions and received from the General Post Office the communication which we reproduce below.

1. If the matron or chairman of a Cripples' Home or Home for Incurables takes out a wireless licence on behalf of the institution, does that licence cover any sets afterwards presented to any particular patient?

2. Does a licence taken out by the master of a Boys' Orphanage cover sets that may afterwards be constructed by the boys for their own use in the institution?

3. Would a licence taken out by the Guardians of a Poor Law Institution cover sets presented to particular aged and infirm inmates by their friends?

SIR,—In reply to your letter of the 27th ultimo, I am directed by the Postmaster-General to say that if one wireless licence were taken out by the authorities of each of the institutions in question, or by some permanent member of the staff on their behalf, no question would be raised, under present conditions, as regards the number of separate receiving sets which were installed in those institutions.

The licence should preferably be one of the "Constructor's" type, since broadcast licences cover only the use of apparatus bearing the registered trade mark of the British Broadcasting Company.

St. Pancras Radio Society.—Change of Name.

At a recent meeting it was decided to change the name of the Society to the Hampstead and St. Pancras Radio Society, as the headquarters are so centrally situated to both boroughs.

A series of weekly lectures have been given throughout the past session of special interest to these amateurs interested in the design and construction of their own experimental equipment and an attractive summer programme is being arranged. The Society carries among its members many well-known experimenters, with Captain Ian Fraser as an active President.

Communications should be addressed to Mr. R. M. Atkins, Hon. Secretary, 3 Eaton Villas, Haverstock Hill, N.W.

Home Constructor Licence to be 10s.

The announcement in the daily press that the British Broadcasting Company recommend a reduction from 15s. to 10s. in the charge made to users of home constructed sets is a step in the right direction. This means the abolition of the special licence fee which authorises the making by amateurs of sets for broadcast reception. Subject to the approval of the Postmaster General, all receiving licences issued from July 1st next will be at the uniform rate of 10s. The cessation of the B.B.C. royalty is also recommended by the Company, which means that the use of the B.B.C. stamp will also be terminated. Attention is drawn to the fact that approximately 300,000 constructor licences were issued during the period that the scheme has been in operation and that at the end of May the total number of licences in force was 804,000.

Obituary.

It is with deep regret that we report the death of Dr. Robert Mullineux Walmsley, F.R.S.E., M.I.E.E., late Principal of the Northampton Polytechnic Institute.

A New Company.

A new company has been registered under the name of Metro-Vick Supplies, Ltd., which is entirely owned by the Metropolitan Vickers Electrical Co., Ltd. The new company has been formed to deal with the sale of electrical supply products.

The Annual General Meeting of the B.B.C.

The Annual General Meeting of the B.B.C. was held at the Hotel Cecil on Thursday, June 19th, at 12 o'clock.

* * * *

Messrs. Fallon Condenser Manufacturing Co., Ltd., have recently opened a City Depot at 143 Farringdon Road, E.C.1.

CATALOGUES RECEIVED.

The Fleet Radio Stores, 143/144 Fleet Street, E.C.4.

North Middlesex Wireless Club.*

A novel receiving circuit called "The Carpet of Baghdad Circuit," because it will take you anywhere, was the subject of a lecture on the 11th inst. by Mr. W. Gartland at the Club's headquarters, Shaftesbury Hall, Bowes Park, N., the President, Mr. A. G. Arthur, being in the chair.

The arrangement described by Mr. Gartland and used by him with very gratifying results, makes use of only a single valve. All the British Broadcasting Stations have been received on this circuit at a point only about a couple of miles from **2 LO,** an achievement which can only be appraised at its true value by those who have used three valves and loose coupled circuits in an endeavour to get the same results.

Mr. Gartland explained that the circuit was difficult to handle and some experience of ordinary radio work was necessary before attempting experiments with the "Baghdad" circuit.

The meeting then proceeded to elect a Sub-Committee in connection with the proposed "Field Day." Mr. J. Bray was elected to serve on the ordinary committee of the Club to take the place of Mr. W. E. Wilman, who has accepted an appointment which prevents him continuing to serve.

Hon. Sec., H. A. Green, 100 Pellatt Grove, Wood Green, N.22.

The St. Pancras and District Radio Society.*

A 100 metre receiving set, built by Mr. F. H. Haynes, formed the subject of a most interesting evening when the Society met at their headquarters in Camden Town on May 29th. The set, 1 H.F., Det., 1 L.F., was designed to work from 90 to 180 metres, without taps on the inductances.

After reviewing the usual methods of reception on short wavelengths, Mr. Haynes recounted some of the difficulties he had experienced in operating a tuned transformer coupled valve on very short wavelengths. He then described the building of certain parts and the testing and gradual assembling of the set and he gave the circuit diagram and the dimensions of each component.

The transmitting and receiving equipment of **5 LP**, *the station of Mr. L. W. Pullman, which is situated in N.W. London.*

Hon. Sec., R. M. Atkins, 7 Eton Villas, Haverstock Hill, N.W.3.

Kensington Radio Society.*

At the June meeting Mr. Phelps commenced his lecture with the elementary principles of static electricity and the effects of charged and uncharged bodies on each other. He gradually led up to the theory of condensers and thunderstorms and explained how the lightning conductor acts. A very full discussion took place afterwards.

The Hon. Sec., Mr. J. Murchie, 33 Elm Bank Gardens, Barnes, S.W.13, will be pleased to answer any enquiries regarding the Society.

Radio Society of Highgate.*

A lecture was given recently on "Accumulators" by Mr. W. Schofield, of the Hart Accumulator Co. After discussing the various possible methods of producing electricity, the lecturer traced the history and development of the chemical method. Examples of some of the oldest as well as of all the newest types of accumulators were explained and exhibited, and the assembling and "forming" of the plates were described.

Forthcoming Events.

WEDNESDAY, JUNE 25th.

The Radio Society of Great Britain. Ordinary General Meeting, 6 p.m., at the Institution of Electrical Engineers. Lecture: "A Résumé of Modern Methods for the Measurement of Radio Signal Strength." By Mr. J. Hollingsworth.

North Middlesex Wireless Club. At Shaftesbury Hall, Bowes Park, N. Mr. F. C. March on "Receiving Circuits without High Tension Batteries."

FRIDAY, JUNE 27th.

Radio Society of Highgate. 8 p.m., at 270 Archway Road. Lecture: "The Neutrodyne Receiver." By Mr. L. Skinner.

MONDAY, JUNE 30th.

Hornsey and District Wireless Society. At Queen's Hotel, Broadway, Crouch End, N.8. Dutch Sale of Surplus Apparatus.

Information regarding membership and the activities of the Society will be forwarded on application to the Hon. Sec. J. F. Stanley, B.Sc., A.C.G.I., 49 Cholmeley Park, Highgate, N.6.

Hampstead and St. Pancras Radio Society.*

Members of the Society spent an interesting afternoon at Marconi House and Savoy Hill when they were shown over the studios, amplifiers and transmitting equipment of **2 LO.** The apparatus was of particular interest as the Society is hoping shortly to build its own transmitter.

Hon. Sec., R. M. Atkins, 7 Eton Villas, Haverstock Hill, N.W.3.

Dublin College of Science Radio Society.

On Friday May 23rd, an interesting lecture was given by the Hon. Secretary on "The Construction of Radio Receiving Sets."

Various circuits and their operation were first explained, and the lecturer dealt very fully with all the component parts and their functions, using a three-valve tuned anode set to illustrate the various points.

The lecturer pointed out the importance of a good aerial system, and also earth switches, and gave many useful hints on the wiring and construction of sets, and explained how oscillation should be prevented.

Hon. Sec., F. R. A. McCormick, College of Science for Ireland, Up. Merrion Street, Dublin.

The Radio Research Society.

At a well-attended meeting at headquarters, 44 Talfourd Road, Peckham, S.E., on Wednesday, June 11th, Mr. J. V. Newson exhibited an experimental Reinartz All-Valve Receiver, and demonstrated its capabilities. Although the circuit was primarily intended for C.W. reception, it gave results equal to a 2-valve set. It was pointed out by the lecturer that with this circuit there was no danger of radiation.

The subject proved of great interest, many questions were asked, and several members announced their intention of making up a set.

For particulars of above Society, apply to Hon. Sec., Arthur H. Bird, 35 Bellwood Road, Nunhead, S.E.15.

Hounslow and District Wireless Society.*

On May 1st Mr. Bevan Swift delivered an excellent lecture before the Society, the title of his lecture being, "The Fundamental Principles of Radio Telegraphy," which proved to be most interesting and instructive.

An interesting evening was spent on May 8th when the President, A. R. Pike, Esq., demonstrated a Fellows loud speaker, with exceptionally good results. Following this demonstration, Mr. Gordon Fryer, L.D.S., R.C.S.Eng., gave a very fine discourse on the action of a single valve receiver.

On May 15th Mr. W. K. Newson thoroughly explained the action of a grid leak and condenser, which was very much appreciated by the junior members. Lieut. H. S. Walker (a Vice-President of the Society) gave a discourse on the action of a valve as an amplifier.

The members thoroughly enjoyed the evening of May 22nd when Mr. C. F. Yates explained the action of his heterodyne wavemeter, and Mr. W. R. Emery explained the action of his buzzer wavemeter. Both these instruments were self-constructed, and afterwards demonstrated in conjunction with the Society's five-valve set.

May 29th being "question night," a list of difficult radio problems were written on the board and were very well answered by Mr. W. R. Emery and were well appreciated by the members. Intending members should write for particulars of membership to the Hon. Secretary, Mr. Arthur J. Myland, 219 Hanworth Road, Hounslow, or make a personal application at the Council House, Treaty Road, Hounslow, any Thursday evening between the hours of 8 and 10.

Woolwich Radio Society.*

During the month of May the Society has maintained its usual full programme. On Wednesday, May 7th, the entries were received for our "Most Useful Wireless Gadget" competition and examined. These ranged from ingenious crystal detectors to 3-valve multi circuit and reflex sets.

On Wednesday, May 14th, we had our President, Captain C. T. Hughes, again with us after his recent illness. He brought with him a 3-valve three-flex circuit capable of working a loud speaker using a small frame aerial and no earth. He gave details of the components and the circuit, afterwards demonstrating its working. He also gave details of a variable condenser he had designed.

On Wednesday, May 21st, Mr. Houghton, our Vice-President, gave his decision with regard to the competition. The first prize (a pair of wireless 'phones) was awarded to Master F. W. Green, for a home-made loud speaker. The second prize (a Phillips double grid valve) was awarded to Mr. A. G. Beeson, for a 1-valve reflex receiver with neutrodyne control working a loud speaker.

The Society resolved to publish a monthly magazine concerned chiefly with the Society's doings. Mr. Frazer was appointed editor and Mr. Henshall sub-editor.

On May 28th the Society held an open meeting.

Meetings are held every Wednesday evening at 7.30 p.m. at the Y.M.C.A., Woolwich, where we shall be pleased to welcome intending members.

Hon. Sec., H. J. South, 42 Greenvale Road, Eltham, S.E.

Hackney and District Radio Society.*

Mr. Cunningham presided at a meeting held on the 12th inst., when Mr. C. C. Phillips resigned the Secretaryship of the Society; this was accepted with regret. Mr. G. E. Sandy was elected Secretary, and Mr. Phillips agreed to carry on as Assistant Secretary.

The evening was devoted to Vest Pocket Lectures, and the following proved very interesting and provided ground for helpful discussion. Mr. D. Wall, "The Care of Accumulators"; Mr. Van-Colle, "Low Frequency Transformer Winding"; Mr. Jenkins, "The Uses of a Dewar Switch"; Mr. Sandy, "Home-made Loud Speakers"; Mr. Jones, "Experiences on American Reception."

Particulars of membership gladly given on application.

Hon. Sec., Geo. E. Sandy, 70 Chisenhale Road, E.3.

Calls Heard

Contributors to this section are requested to limit the number of calls sent in to those heard in the previous three weeks, these being of greater interest and value to transmitters than earlier records. The repetition of the same call sign in consecutive lists is not recommended. Contributors will also assist by kindly arranging reports in alphabetical order. Full address (not for publication) should be given to enable correspondence to be forwarded.

Edinburgh (April-May 9th, 1924).

British: **2 AAD, 2 AGT, 2 AIP, 2 AMF, 2 ON, 2 PC, 2 QC, 2 RB, 2 YR, 5 AL, 5 AW, 5 GL, 5 HS, 5 LF, 5 NN, 5 OC, 5 OR, 6 BY, 6 NK.** French: **8 BM, 8 CF, 8 CM, 8 CN, 8 CT, 8 CZ, 8 EC, 8 ÉD, 8 OH, 8 ZZ.** Dutch: **0 BA, 0 MR, 0 NN, 0 PC, 0 ZN.** Belgian: **PA 9, P 2, PCRR, PCII.** Danish: **7 CZ, 7 QF.** American: **1 AR, 1 AWT, 1 XAQ, 1 XW, 4 XE.** Canadian: **9 XW.** Others: **W2, 4 ZZ, XZ, 1 ER, 1 TU.** (0—v—1, Flewelling, flexible wire loop aerial, no earth.) (Francis G. S. Melville.)

Hastings, Sussex.

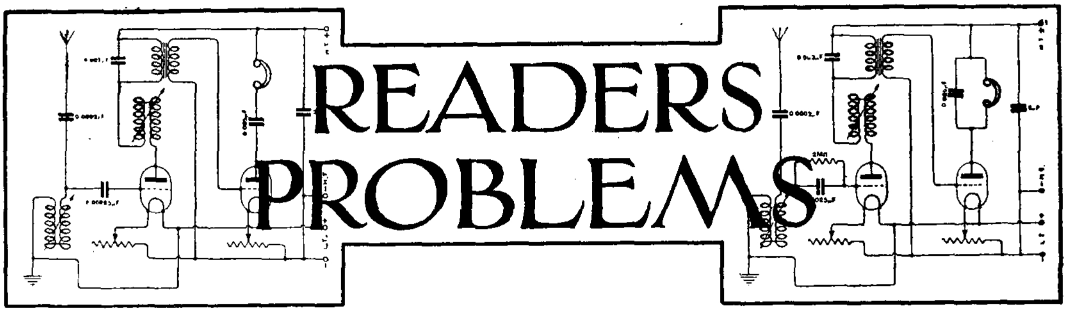
British: **2 AO, 2 AT, 2 CW, 2 DR, 2 DX, 2 FS, 2 JP, 2 KF, 2 KW, 2 LZ, 2 NM, 2 OD, 2 OY, 2 RB, 2 RS, 2 SL, 2 SK, 2 TR, 2 VC, 2 WH, 2 WJ, 2 WK, 2 YM, 2 ZK, 5 BV, 5 CS, 5 DN, 5 DO, 5 FS, 5 HN, 5 ID, 5 IK, 5 JJ, 5 KO, 5 NC, 5 NN, 5 OC, 5 OT, 5 PB, 5 PU, 5 QM, 5 SI, 5 US, 5 UV, 5 XI, 6 FQ, 6 GO, 6 NI.** French: **8 AA, 8 AÉ, 8 AQ, 8 AU, 8 AW, 8 BM, 8 BP, 8 CF, 8 CK, 8 CT, 8 CZ, 8 DA, 8 DI, 8 DV, 8 DX, 8 JC, 8 JD, 8 MM.** Dutch: **0 DV, 0 KX, 0 MR, 0 NR, 0 NY, 0 ZZ.** Danish: **7 EC.** Belgian: **P 2, W 2.** Italian: **1 CF, 1 MT.** (Norman Blackburne, **2 AJB.**)

Brussels (since April 1st).

2 ACU, 2 DF, 2 DR, 2 GG, 2 KW, 2 LH, 2 MO, 2 OD, 2 RB, 2 TO, 2 VS, 2 WJ, 2 WY, 2 XG, 2 XY, 2 YQ, 2 YT, 2 ZT, 5 AS, 5 AW, 5 CC, 5 DN, 5 FS, 5 KO, 5 LF, 5 QV, 5 SI, 5 SO, 5 ST, 5 SZ, US, 5 YI, 6 BT, 6 CV, 6 EA, 6 LV, 6 TM, 6 XC, 6 XG, 6 XX, 8 AL, AU, 8 BF, 8 BP, 8 CA, 8 CC, 8 CF, 8 CJ, 8 CM, 8 CN, 8 DD, 8 DP, 8 DU, 8 ÉD, 8 ÉM, 8 ÉU, XY, XZ. American: **1 XAH.** Canadian: **1 CF.** Italian: **1 ER, 0 AA, 0 BA, 0 DO, 0 KX, 0 MR, 0 NN, 0 NY, 0 QO, 0 XC, 0 XP.** (Rudolph Couppez.)

Kensington, London, W.14 (since February).

2 AC, 2 AH, 2 CA, 2 DY, 2 FX, 2 GO, 2 ID, 2 JU, 2 KF, 2 KG, 2 KT, 2 KV, 2 LD, 2 LE, 2 LI, 2 MF, 2 MO, 2 MT, 2 PZ, 2 QC, 2 QI, 2 SF, 2 ST, 2 SX, 2 TI, 2 TQ, 2 TX, 2 UC, 2 VW, 2 VY, 2 XL, 2 XO, 2 XR, 2 ZA, 2 ZZ, 2 ABR, 2 ABU, 1 ABZ, 2 AGT, 2 AIU, 2 AKS, 5 AQ, 5 AR, 5 AS, 5 AT, 5 BM, 5 BT, 5 BV, 5 BW, 5 CV, 5 DT, 5 FL, 5 FM, 5 FN, 5 GF, 5 GV, 5 HY, 5 LN, 5 MA, 5 OM, 5 OX, 5 OY, 5 PD, 5 PZ, 5 QX, 5 SU, 5 UO, 5 UV, 5 VD, 5 VL, 5 VP, 5 WF, 5 XB, 5 XC, 5 ZO, 6 BO, 6 DW, 6 GT, 6 IV, 6 MB, 6 NH, 6 OB, 6 PS, 6 QA, 6 QB, 6 QV, 6 QY, 6 QZ, 6 RB, 6 RJ, 6 VO, 6 VR, 6 WV, 6 WX, 6 XG, 6 YK, (8 OB ? Telephony on 100 metres). (Reinartz detector-1L.F.) (R. C. Croxton.)



***1.** All questions are answered through the post. A selection of those of general interest is published.* ***2.** Not more than four questions may be sent in at any one time.* ***3.** Every question should be accompanied by a postal order for **1/-**, or **3/6** for four questions, and by a coupon taken from the current issue.* ***4.** A free coupon appears in the first issue of each month, and if this is sent in together with coupons from the three previous issues, the reader is entitled to have one question answered free of charge.*

"*R.H.*" (*Marlborough*) **submits a diagram of a four-valve receiver for criticism.**

The secondary winding of the second L.F. transformer should be connected to – L.T. instead of + L.T. Most receiving valves require a negative grid potential when used as amplifiers, and it is often advisable to supplement the potential due to the voltage drop in the filament resistance by means of small dry cells connected between the secondary winding and – L.T.

"*J.W.M.*" (*Guildford*) **asks questions regarding the adjustment of a Morse recorder.**

To ensure the proper operation of the relay, the anode voltage applied to the last valve should be considerably increased, and cells should be connected in the grid circuit in order that the grid may be given a suitable negative bias. For the purpose of recording, the negative bias is considerably greater than that usually given in the case of L.F. amplification. Voltages up to 30 volts should be tried. The sparking at the contacts of the relay will be reduced if you connect a high resistance between the tongue and the marked contact. The value of this resistance should be adjusted so that the normal current in the local circuit is insufficient to actuate the inker pen. A condenser connected across the relay windings will probably improve the results. The value of this condenser will depend upon the inductance of the windings, and should be found by trial.

"*J.L.S.*" (*Southampton*) **asks for a diagram of a crystal receiver with one stage of H.F. amplification capable of giving a high degree of selectivity.**

The circuit in Fig. 1 includes four tuned circuits, so that if a loose coupling is established between coils A and B in the tuner, and coils C and D in the anode circuit, the receiver will be very selective. Coils B, C and D may be Igranic No. 75 coils for the B.B.C. wavelengths. The size of coil A will depend upon the dimensions of the aerial. You may find it an advantage to connect one side of the telephones to – L.T., as indicated by the dotted line in the diagram.

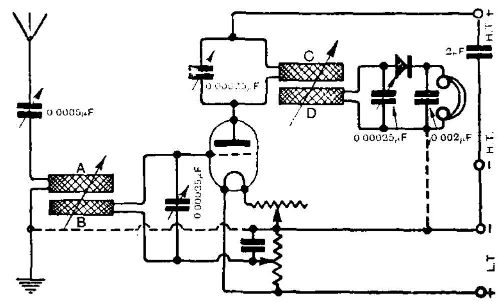


Fig. 1. "J.L.S." (Southampton). A crystal receiver with H.F. amplifier.

"*C.H.*" (*London, W.*12) **submits a diagram of a five-valve receiver, and asks if we can give any reason why the strength of signals obtained on a loud speaker from the local station is very poor, in spite of the fact that most of the Continental stations can be received with ease at telephone strength.**

The fact that you are able to receive long distance broadcasting stations indicates that the H.F. valves are functioning properly, and that the source of the trouble lies in all probability in the L.F. amplifying valves. We note that you are using "Q" type valves for L.F. amplification with a plate voltage of only 45 volts. These valves were primarily designed for rectification, and are not suitable for use in L.F. amplifiers unless an H.T. voltage of 150 to 200 volts is used. A separate H.T. tapping should be provided for the L.F. valves, in order that the H.T. voltage may be increased.

"*J.E.D.*" (*Rotherham*) **asks if there is any difference in the selectivity obtainable with the tuned anode and transformer methods of H.F. coupling.**

From the point of view of selectivity, there is not much to choose between these two methods. In order that the selectivity may be as high as possible, it is recommended that the natural wavelength of the tuning coils or transformer windings should be made only slightly less than the lowest wavelength which it is required to receive, in order that the tuning capacity necessary to tune to a given wavelength may be as small as possible. The wire used to wind the coils should be of as a heavy gauge as possible.

"*W.A.H.*" (*Loughborough*) **submits a diagram of a receiver employing resistance capacity coupling for the L.F. valves. The signal strength obtainable is not satisfactory, and he asks if there is anything in the circuit which would account for this inefficiency.**

We note that the plate of the detector valve is connected through the reaction coil, and a resistance of 60,000 ohms to a 45 volt tapping on the H.T. battery. In a receiver of this type it is necessary to supply the detector valve from the same tapping as the L.F. valves; in your particular case, from the 180 volt tapping. Owing to the fall of potential along the resistance connected in series with the reaction coil, the voltage between the plate and filament of the detector valve will not be abnormally high. If, after making this alteration, you still have difficulty in obtaining reaction effects, you might try the effect of connecting a fixed condenser of 0·001 μF across the 60,000 ohm resistance in the plate circuit of the detector valve.

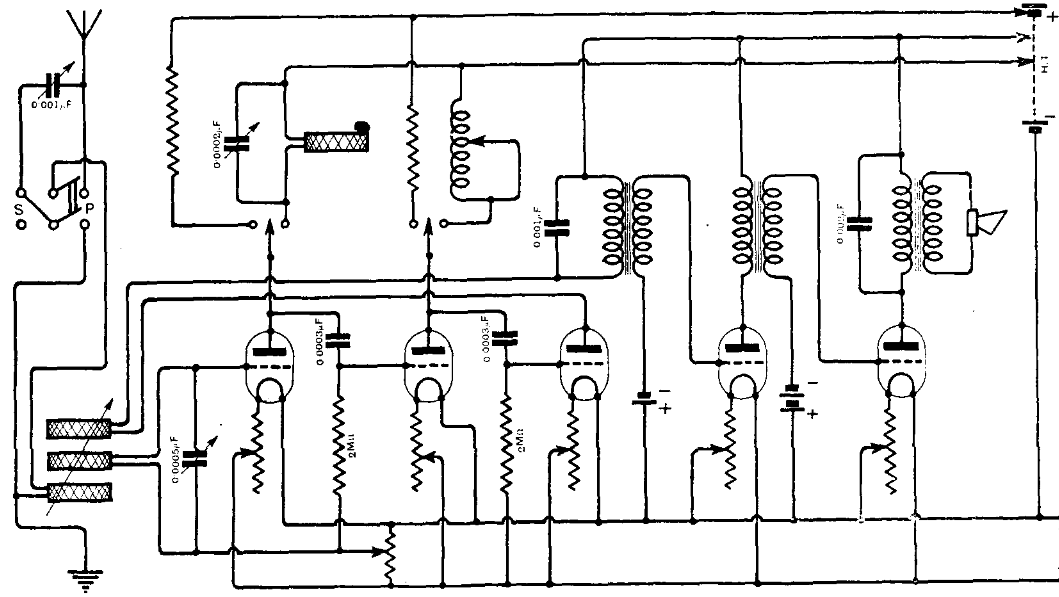


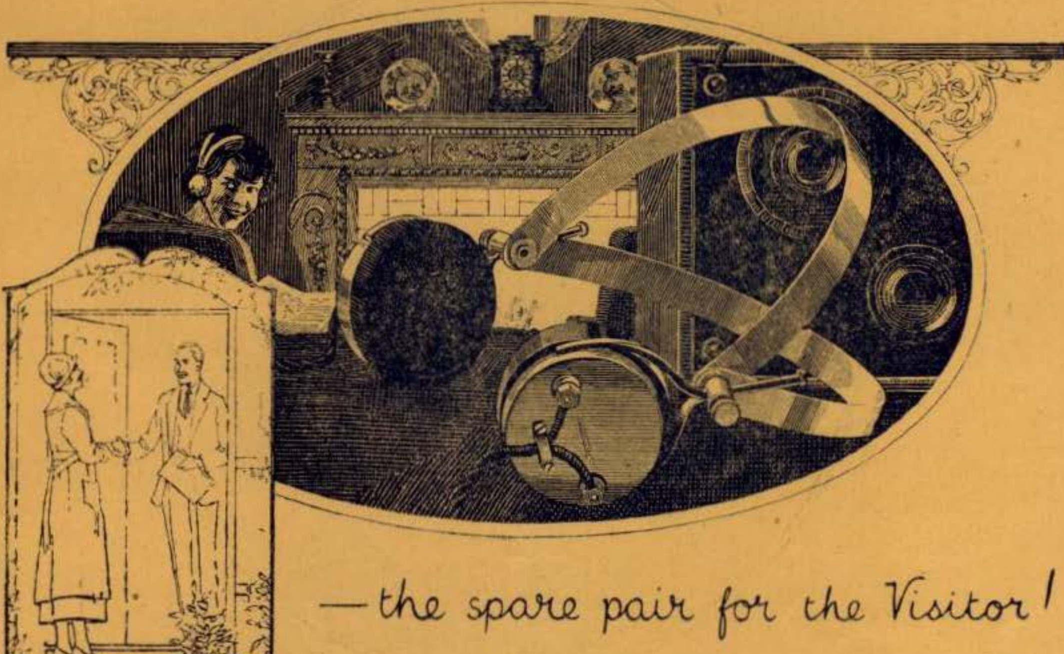
Fig. 2. "*H.C.L.*" (*Chester*). *A five-valve receiver with two stages of H.F. amplification suitable for reception on wavelengths from* 300 *to* 30,000 *metres.*

"*H.C.L.*" (*Chester*) **asks for a diagram of a five-valve receiver, with two stages of H.F. amplification, suitable for use on wavelengths between 300 and 30,000 metres. The receiver will be used in conjunction with a loud speaker.**

For wavelengths between 1,000 and 30,000 metres, the resistance capacity method of coupling will be most suitable for the H.F. valves. As this method of coupling is aperiodic, a loose coupled tuner will be necessary if selectivity is of importance. Below 1,000 metres, tuned anode or reactance capacity coupling may be used. Switches have been provided so that the change of coupling may be rapidly made. If the first valve is tuned anode coupled and the second reactance coupled by means of a semi-aperiodic coil, the tendency to self-oscillation in the H.F. valves will be greatly reduced. Large capacity condensers may with advantage be connected between each of the H.T. tappings and —H.T.

"*H.A.H.*" (*London, S.W.*2) **asks what size of Igranic coils will be suitable for the reception of the B.B.C. stations when used in the circuit given in reply to "E.J.W." (London, S.E.10) in the issue of March 5th, 1924.**

The aerial tuning inductance will depend upon the electrical constants of your aerial, and should be found by trial. A No. 35, 50, or 75 Igranic coil will be necessary for the A.T.I. No. 75 coils will be required for the secondary and tuned anode circuits, while the reaction coil may be a No. 100 coil.



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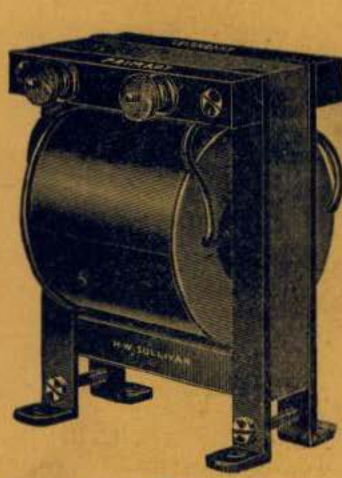

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