The WIRELESS WORLD

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CONTENTS

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THE WIRELESS WORLD

THE OFFICIAL ORGAN OF THE WIRELESS SOCIETY OF LONDON

VOL. VIII. No. 14. OCTOBER 2ND, 1920 FORTNIGHTLY

MULTI-LAYER WINDINGS FOR RADIO RECEIVING

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

THE tendency of the modern high-power transmitting station lies in the direction of the use of longer and longer wavelengths, and the problem therefore arises of the construction of the most suitable forms of coils that may be used at the receiving station for picking up these very long wavelengths. Anyone who has attempted the reception of signals of say 15,000 metres wavelength using single layer coupling coils of the conventional pattern, will appreciate the difficulties inherent to this form of receiving apparatus. Unless the size of wire employed for winding these coils is very much reduced the coils themselves become exceedingly bulky and very unwieldy to handle, while difficulties also arise in adjusting the coupling between one or more of such coils. The limited size of the receiving aerial customarily allocated to amateurs by the Post Office at the present time, renders this problem still more acute, since such small aerials have very small capacity—usually of the order of 0·0003 mfds.—and therefore require very large values of inductance to tune them up to the very long wavelengths.

Apart altogether from the unwieldy nature of such large coils, there are additional factors which must be taken into account when considering their use for wireless receiving purposes. Firstly, the coil itself having such a large size and area, possesses considerable capacity—both self-capacity and capacity to other objects. The effect of this capacity is not only to increase the effective resistance of the winding, and therefore the loss taking place in it, but it may also act as a shunt of no inconsiderable magnitude to the aerial circuit itself, since when the aerial capacity is small it does not require a very large additional capacity in shunt with it to pass off to earth a serious proportion of the incoming energy that should by rights be transferred to the detector. The stray capacity from such coils may also give rise to undesired coupling effects between the coils themselves. There is, however, another point which should be borne in mind, which is somewhat in favour of these large coils, and that is that they themselves may act to some extent as receiving aerials, somewhat after the manner pointed out in an earlier article in this magazine.* This antenna effect of the coil itself may not necessarily assist the signal picked up by the main aerial, and is a point which should be borne in mind when arranging the receiving apparatus.

When receiving continuous wave signals it will often be found that the large area and consequent extensive magnetic field of such single layer coils in addition to their large stray capacity, may render it difficult

*Wireless World, 8, pp. 409 and 441, September 4th and 18th, 1920.

to obtain the best coupling between the various circuits of the receiver unless the aerial and tuned secondary circuits are separated by at least several feet. This again renders the apparatus somewhat difficult to adjust.

As an example of the order of magnitude of the sizes of coil involved, let us take a coil required to tune up an ordinary receiving aerial as licenced by the Post Office, to a wavelength of 15,000 metres. Assuming that the aerial capacity is 0·0003 mfd., the inductance required to tune to 15,000 metres will be about 2×10^8 centimetres, or a fifth of a henry. Assuming, for example, that such a coil were wound as a single layer on a former 12 inches diameter with No. 22 S.W.G., d.c.c. copper wire, the coil would have to be somewhere about 8 feet in length. This would involve a wire resistance of at least 8 or 9 ohms, which, in conjunction with the resistance of other parts of the circuit, would probably be quite high enough for good working, and would therefore prohibit the use of much finer wire than that quoted.

This example merely serves to emphasise the need for the construction of a somewhat more compact form of inductance than that given by the single layer winding. Several possibilities are open to consideration in this respect, the simplest of all being the use of an ordinary multi-layer winding, in which the successive layers are wound on one after the other as is done in the case of an ordinary magnet bobbin. Although this method is practicable, and in fact a perfectly good one for windings which are only traversed by direct currents or by low frequency alternating currents, the construction is not at all good for high frequency work. The chief reason for this is to be found in the very large capacity which occurs between the successive layers. To illustrate this point let us suppose that the long coil previously mentioned was reconstructed in the form of a two-layer winding, the second layer being wound on directly on top of the first one. For this case we can work out, approximately, the capacity that exists between the two layers, assuming for the moment that the successive turns of wire are replaced by two continuous bands of metal separated by the wire insulation—an assumption that will be sufficiently accurate for the purpose in view, although not giving the true capacity of the coil between layers. Making this assumption we find that for a coil 2 ft. long (which would have approximately the same inductance as the 8 ft. single layer coil considered above), the capacity between the layers would be of the order of 0·01 mfd. This, of course, is a very large capacity, and for the case considered, if it were entirely concentrated between the ends of the coil the fundamental wavelength of the whole coil would be of the order of 85,000 metres. It would, therefore, be practically impossible to pass through such a coil currents of any shorter wavelengths. Although several assumptions, which are not fully justifiable in practice, have been made in arriving at this figure, it will, nevertheless, serve to indicate that such a coil would be quite unworkable for reception purposes. As a matter of fact one would not expect that the effective self-capacity of the whole coil would be quite as high as 0·01 mfd., but even if it were considerably less than this figure the fundamental wavelength of the whole coil would still be far too large to enable it to be used for receiving signals of the 15,000 metre wavelength that we have assumed above. Some other construction for the coil must therefore be devised that will enable its self-capacity to be reduced to a more workable value.

One method of reducing the self-capacity of a multilayer coil is by adopting what is known as a "banked winding" of two or more layers. In this case each layer is not wound complete before passing on to the next one, but the wires are arranged to pass from one layer to the other and back again, with the result that the voltage set up between adjacent wires will not be that of a whole layer, but will merely be the voltage across a few turns, and hence the effective capacity and the losses will both be reduced.

Typical methods of winding such coils are indicated in Figs. 1 and 2, which show a two and a four-layer banked winding respectively. The successive turns in these windings are numbered so that their order of winding can easily be seen and the diagrams are thus almost self-explanatory. Slight variations may easily be devised in a winding of this kind by winding two or three turns on each layer before passing to the next one, but this would give rise to a somewhat increased self-capacity as compared with the more correct banked winding illustrated in Figs. 1 and 2. A slight variation on the four layer banked winding of Fig. 2 may be found illustrated on p. 464 of the *Wireless World*, September 18th, 1920.

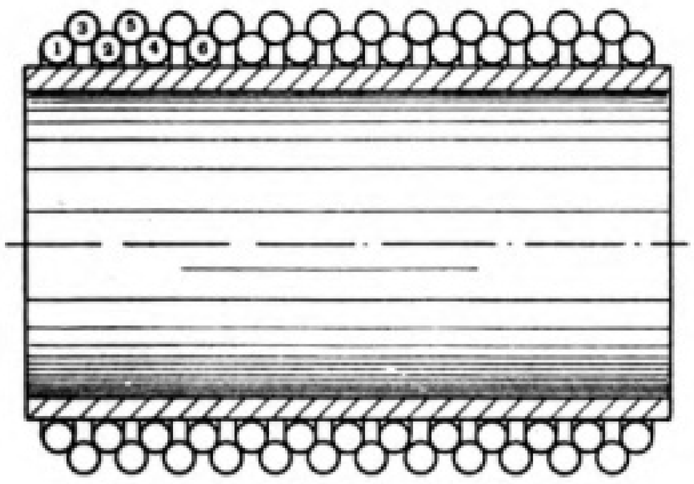


Fig. 1. Two-layer Banked Winding.

The self-capacity of a multilayer winding may also be reduced by dividing it up into small sections, each of which is wound separately after the manner indicated in Fig. 3.

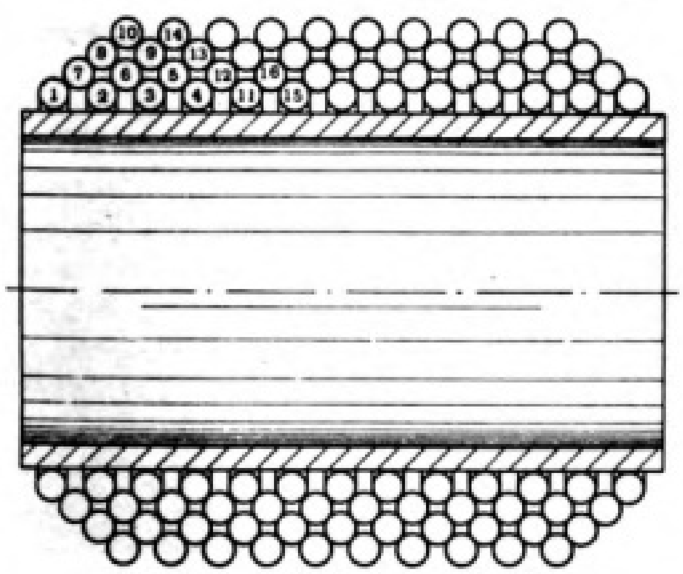


Fig. 2. Four-layer Banked Winding.

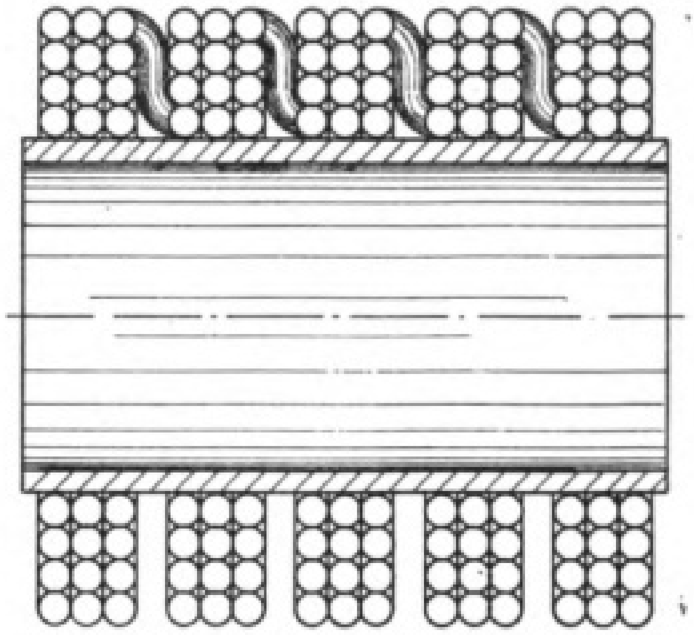


Fig. 3. Four-layer Sectionalized Winding.

All the sections are, of course, connected in series. Incidentally, it may be remarked that such a construction provides an easy means of dividing the coil up into parts for tapping purposes, as, owing to the slight spacing between adjacent sections the dead end capacities are to some extent reduced.

While referring to the effects of the self-capacity of the coil it may be worth while to point out its effect upon the effective resistance of any given coil. The resistance of a coil, and in fact of any wire whatsoever, when carrying high frequency currents is greater than the resistance of the same coil or wire when carrying direct current, the increased resistance arising from what is usually known as the "skin effect"—*i.e.*, the current is carried by the outside layers of the wire, and not by the whole cross section. Further, the effective resistance of a coil to high frequency currents is greater than the effective high-frequency resistance of the same wire stretched out straight owing to the proximity of the several turns of the coil to one another, which causes a further increase in the skin effect. Over and above this rise of resistance when carrying high frequency currents, there is a further increase of effective resistance brought about by reason of the self-capacity of the coil. The self-capacity of the coil may be looked upon for the purpose of illustration as a condenser C_0 connected across the terminals of an ideal coil possessing pure inductance and resistance only as indicated in Fig. 4.

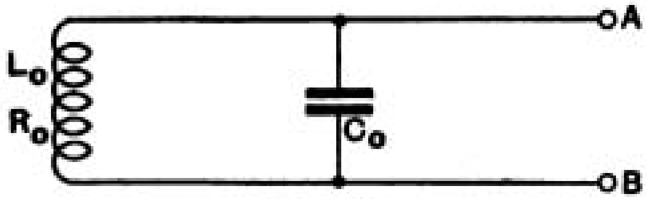


Fig. 4.

It is well known that such a circuit between the points A and B in that Figure can form what is often termed a rejector circuit, —that is to say that at a certain frequency, in this case the natural frequency of the circuit C_0 L_0, the whole circuit behaves as a very large resistance connected between A and B. In the ideal case considered when the coil has no resistance at all, such a circuit at its natural frequency would behave as an infinitely large resistance between the points A and B, and would, therefore, be equivalent to a complete break in the circuit. Under these conditions, therefore, no current from an external source such as the receiving antenna could pass through the coil. When the coil has some resistance R, the effective resistance of the whole circuit even at its natural frequency is less than infinity but is still very large, while for other frequencies than the natural frequency of the circuit it still presents an augmented effective resistance between the points A and B. Expressed mathematically, this augmented resistance is given by the following relation :

$$R' = R_0/(1-\omega^2 C_0 L_0)^2$$

where R' is the effective resistance presented by the coil and R_0 is the high frequency resistance that it would have if it has no self-capacity. ω is $2\pi \times$ the frequency of the oscillations, L_0 is the inductance of the coil, and C_0 is its self-capacity. In terms of the natural wavelength λ of the coil, the above formula may be expressed as follows :

$$\frac{R'}{R_0} = \frac{1}{(1-\omega^2/\omega_0^2)^2} = \frac{1}{(1-\lambda_0^2/\lambda^2)^2}$$

where λ is the wavelength at which the coil is used. The way in which this function varies with the wavelength at which the coil is used is indicated in Fig. 5, which gives a curve showing the percentage increase in the effective resistance of a coil due to its self-capacity. The coil chosen had a natural oscillation wavelength of 500 metres, and it may be seen from the curve that even at 5,000 metres the self-capacity still caused a 2 per cent. increase in effective resistance.

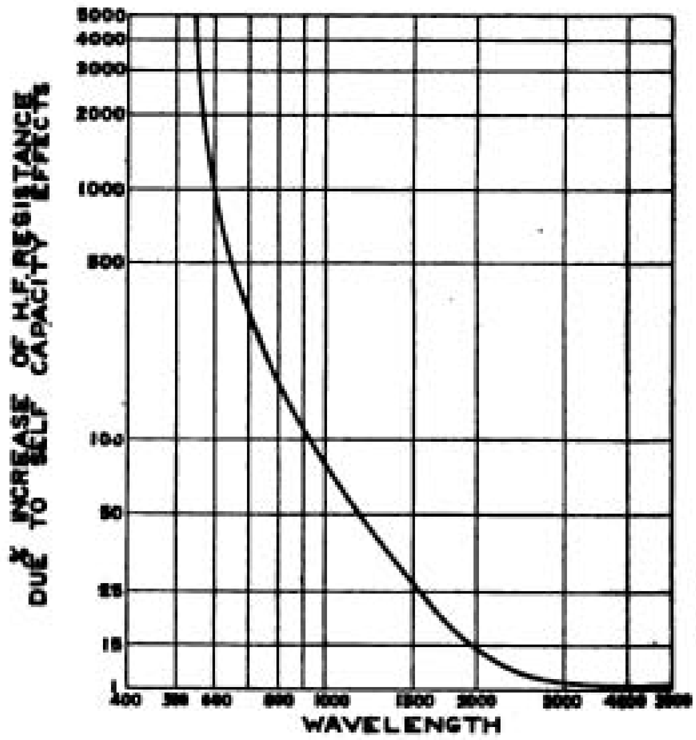


Fig. 5.

If we space apart the two layers in the coil considered above we shall evidently reduce the capacity between these layers. For instance, if the two layers were spaced ¼ of an inch apart we could reduce the figure for the capacity to from 1/10th to 1/15th of the above value, but even this value would still be rather large. In addition to reducing the self-capacity increasing the spacing between the layers would also somewhat reduce the high frequency resistance of the wire itself, as the current would be more uniformly distributed over the cross section of the wire. This effect, however, would not be very large if the successive turns of each layer were closely adjacent as before.

(To be continued.)

A SHORT WAVE RECEIVER

By F. O. Read, M.I.R.E.

THERE are a number of wireless men who possess first-class receiving sets which give excellent results on wavelengths of from 1,000 metres upwards, but when an attempt is made to go lower than this, great difficulty is experienced, especially with tuners which are capable of receiving fairly long wave stations. The usual method is to insert a variable condenser in the earth lead. This is all right in its way, but is far from efficient. The whole trouble is, that so few turns are required on the aerial tuning inductance compared with the number of turns used when receiving such a station as Paris. It will be seen that the dead-end trouble is very real indeed, and it is an indisputable fact that good results cannot be obtained unless a special inductance is used for very short wavelengths. This applies particularly when using the wavelength allowed for transmitting, viz., 180 metres.

The tuner about to be described has been designed for very short wavelengths and will be found most efficient, especially when using a single valve as a rectifier and amplifier by means of the regenerative method. When working with valves it will be found quite unnecessary to use a secondary coil, as an ordinary plain aerial tuning inductance will give excellent results and will be found most selective, providing a fairly good class of variable condenser is used. For crystals it is advisable to use a loose-coupled tuning inductance which, if carefully adjusted, will give better results than a plain tuner.

The following directions will be found to give the wavelengths stated, on the 100-foot single wire aerial allowed by the Postmaster-General, but should the aerial length be a little more or less than the 100 feet, adjustment can be made with the variable condenser.

First obtain a cardboard or vulcanite former, 2½ inches in diameter and 1 inch long. Vulcanite is preferable to cardboard in every way, but if difficulty is found in obtaining it the cardboard will serve, provided it is well shellac-varnished inside and out at least three times, and allowed to dry between each coat.

Now start winding with No. 28 double-silk-covered wire about ⅛-inch from the edge of the former; wind evenly until the twelfth turn is reached, then twist a small loop sufficiently long to enable a flexible lead to be soldered on later; *see* P (Fig. 1). Then continue until five more complete turns are made, and tap off as before; then five more turns, a tapping, and again five turns. This will complete the coil, and will be found more than sufficient for 200 metres; but it is advisable to have slightly more turns than are actually needed in order to locate the exact point of resonance.

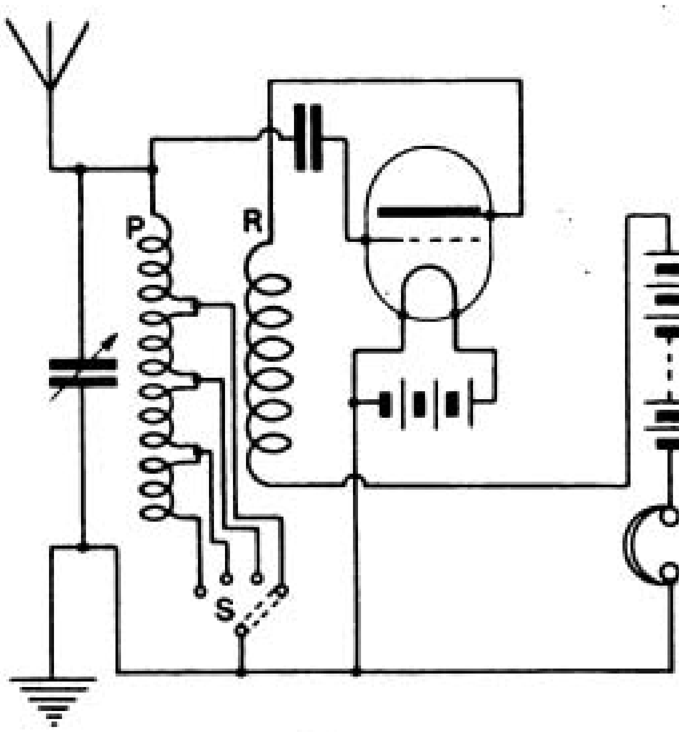


Fig. 1.

The coil can now be mounted on some form of base board, or in any manner that appeals to the constructor. No attempt is made to suggest any particular form of mounting so long as the leads are taken to some form of switch (S in Fig. 1), and provision be made for sliding the reactance coil, about to be described, over the aerial tuning inductance. It is doubtful whether it is advisable to varnish the finished coil, and perhaps on the whole it is better not to do so, as it undoubtedly alters the wavelength considerably.

The reactance coil R is made in precisely the same manner, but has no tappings, and consists of 40 turns of No. 30 double-silk-covered wire, and should be large enough to slide over the aerial tuning inductance, and some provision should be made when mounting for the reactance to slide well away from the primary, thereby obtaining a very loose coupling. If the coupling is too tight the signals will be distorted or heterodyned.

Figure 1 shows the best method of using this coil and is self-explanatory.

The experimenter will observe that a tuning inductance for operating on a 200-metre wave has very small coils, and it will be quite obvious that it is impossible to do justice to this wavelength with a tuner designed for 2,000 metres. The amount of dead wire can be imagined.

Should the above tuner be required to receive 600 metres from ships, about 60 turns will be required, tapped off at every five turns, the corresponding reactance coil having 80 turns.

This tuner will receive both spark and continuous wave signals.

Should the amateur wish to use crystals, a secondary coil should be used in place of the reactance coil, and should be tapped off in exactly the same manner, but should have an additional 25 per cent. of wire.

A variable condenser should be used in every case across the primary from aerial to earth, and where a secondary is used a condenser is also necessary, but not across the reactance unless very fine tuning is required.

If this tuner is wired for receiving from ships, etc., at 600 metres, it can still be used quite effectively for short wavelengths, as the amount of dead wire is negligible and will not affect it sufficiently to decrease its efficiency to any material extent.

Mr. J. G. F. Harris, of Gloucester, and his wireless set, all home made except valve, telephones and power units.

THE ANNAPOLIS STATION

NSS is the call sign of the great radio-telegraph station of Annapolis, United States. This station is situated at about 40 kilometres to the north-east of Washington, in Chesapeake Bay (76° 29′ 12″ W. ; 38° 59′ 00″ N.).

Its powerful arc enables it to be heard easily, in spite of the great difference separating it from Europe (about 5,500 kilometres from Paris) ; furthermore, its very long wavelength (16,300 metres) distinguishes it from the numerous stations which work up to 15,000 metres.

NSS exchanges telegrams almost throughout the day with Lyons, YN ; Nauen, POZ, and Stavanger, LCM ; but it is between 3.0 a.m. and 9.0 a.m., G.M.T., at a time when night prevails over the station and the greater part of the course of the waves, that the station is received with a very clear maximum of intensity.

Its wavelength places it very high in the adjustments of oscillatory receiving circuits. It is necessary, in increasing progressively the length of wave, to exceed the exact "tune" of Lyons. The Lyons station is at first very sharply heard, after which the note becomes more and more flat, until the point of extinction (which corresponds with a wavelength of 15,500 metres) is reached ; the flat note then reappears and becomes sharper and sharper in proportion as the wavelength of the tuning circuit (autodyne) becomes more and more different from the Lyons wavelength. One thus rapidly attains the 1,000 note (sharp sound of German transmissions) on the Lyons station ; one should then perceive, but much more weakly, the transmission of NSS. By increasing the wavelength a little it will be heard properly.

It is, of course, understood that the continuous waves of this station cannot be received merely on galena. One must have either a good aerial and a heterodyne, or a frame and amplifier with heterodyne or autodyne. We have spoken of adjustment by autodyne, because this is the simplest ; but for long wavelengths, heterodyne gives much stronger reception, since this method of reception does not require, like the autodyne, a certain discord of the oscillatory receiving circuit.

The transmission of time signals performed by Annapolis at 02.55 and 16.55, G.M.T., especially the first, at a very favourable hour, enables the station easily to be located. An examination of Fig. 1 will show that the time signal is sent by the aid of pendular

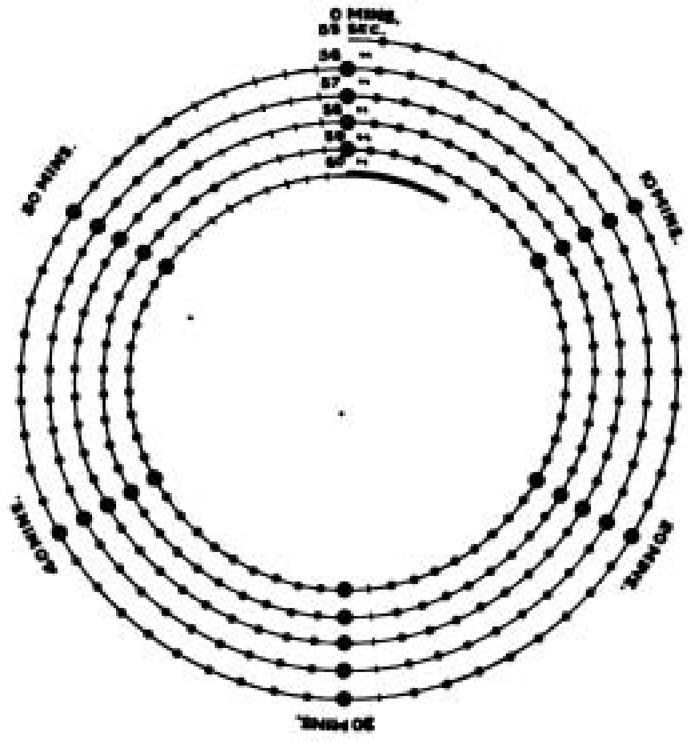


Fig. 1.

beats for five minutes, suppressing, first, the 29th beat of each minute ; secondly, the last five beats of the first four minutes ; thirdly, the last ten beats of the fifth minute. The beginning of a stroke indicates 03.17, G.M.T. The beats are spaced by exactly one second, different from those of the Eiffel Tower, which, as is known, are spaced by less than a second.

The transmission of NSS much resembles that of Lyons, and may be further recognised by the fact that it often sends a continuous dash of long duration.—(*Extracted from* "*La T. S. F. Moderne*," *July*, 1920.).

NOTES AND NEWS

Norwegian Wireless Amateurs.—With reference to a paragraph which appeared under this heading, in Notes and News, of the 24th July issue of the *Wireless World*, correspondence has reached us from Norway seeking our further co-operation. The communicator, Mr. Gunnar Petersen, 30, Industrigaten, Kristiania, is anxious to communicate with wireless amateurs in his country, with a view to approaching the Norwegian Government upon the question of concession and revision in the amateur position as a whole. Will interested readers of this paragraph, who are resident in Norway, kindly lend their aid to adjusting what would seem to us an unfortunate misunderstanding between the Government and the amateurs.

The Bureau of Standards has recently published a paper entitled "An Electron Tube Transmitter of Completely Modulated Waves" (No. 381). In order to utilise a radio-frequency wave train of given power most effectively in a non-oscillating receiving system, it must be completely modulated at some suitable audio-frequency. A convenient way of accomplishing this modulation when an electron tube generator is used, is by supplying the plate circuit of the tube, or tubes, with an audio-frequency alternating e.m.f. An alternator may be used with suitable transformers to supply both the filament and plate circuits. A self-contained transmitting set of this type has been designed and built at the Bureau of Standards. A description of the set, with photographs and diagrams, is given. Copies of this paper may be obtained upon addressing a request to the Bureau of Standards, Department of Commerce, Washington, D.C.

New Telegraph Pay.—The Government of India have been in correspondence with the Secretary of State, regarding the improvement of the position of officers of the Superior Establishment of the Telegraph Department. As a measure of *interim* relief, the Secretary of State, on the 27th January, 1920, sanctioned with effect from the 30th August, 1919, a revised scale of pay similar to that sanctioned for the Public Works Department, and this scale was brought into effect under orders communicated to the Director General of Posts and Telegraphs by the Government of India on the 10th February, 1920. A further and final revision of pay and allowances for the executive grades was sanctioned by the Secretary of State with effect from the 1st January, under his telegram dated 17th February, 1920.—(*The Pioneer Mail.*)

Relativity.—Professor Einstein is so disgusted by the attack made upon him by his scientific colleagues that he proposes, says the *Tageblatt*, to leave Berlin altogether. The newspaper strongly protests against the annoyance to which Professor Einstein has been subjected, which it describes as disgraceful. Einstein himself replied in the *Tageblatt* to his assailants. He ends by saying that it will make a singularly bad impression on his confréres to see how the theory of relativity and its originator are being traduced in Germany.

Wireless Weather Bulletins.—The following alterations to call letters should be made in the list of stations transmitting weather reports, given in the *Wireless World* of July 10th, 1920: Bombay Radio, VWB. Capetown Radio, XNC.

A 1918 Achievement.—On August 21st, Mr. Daniels, the Secretary of the U.S. Navy, received the following message from the Lafayette station, near Bordeaux: "This first wireless message to be heard around the world marks a milestone on the road of scientific achievement." There is little doubt that this message could have been heard "around the world," in that the Lafayette station is equipped with a 1,000 k.w. arc, the most powerful arc yet installed. That the message was the first to be heard round the globe is questionable, in view of the fact that so long ago as September, 1918, Mr. Hughes, Premier of Australia, sent a wireless message through the Carnarvon Station to Sydney, a distance of some 12,000 miles, full details of which will be found in the *Wireless World* of November, 1918, Vol. 6, No. 68.

Mr. A. E. Shrimpton, Chief Telegraph Engineer, New Zealand, is to visit America and Europe to make a series of enquiries embracing wireless telegraphy, automatic telephone systems, multiplex telegraphy and telephony, recent developments in submarine telephone cables and telephonic transmissions over long land lines, and telephonic repeaters for long lines.

Dr. George Clarke Simpson has succeeded Sir Napier Shaw as Director of the Meteorological Office. Dr. Simpson is a great believer in the future of wireless, and is firmly convinced that the business of weather forecasting is still in its infancy. He looks forward to the not distant future when, with the aid of wireless and the reports of airmen, it will be possible to forecast a week's weather with great accuracy.

Lizard Wireless D.F. Station.—An Admiralty notice to mariners states that it is intended to reopen the Lizard Wireless D.F. Station, as from midnight of September 9th-10th. A notification of the closing down of this station was given in the *Wireless World* of September 18th.

Wireless on Lightships.—At the beginning of the war, a wireless telegraphic installation on the Mersey Bar Lightship, Liverpool had to be dismantled, otherwise the craft, as a matter of international law, would have been liable to be torpedoed by an enemy submarine. The installation has been out of operation since, but negotiations are now in progress for the re-installation of wireless on the lightship.

The Experimental Station on Signal Hill, St. John's, N.F., picked up and heard without interruption the transmission of wireless telephone speech, as given by Chelmsford on the occasion of a wireless telephone demonstration to Denmark at 5 p.m., on August 3rd. The distance between Chelmsford and St. John's is approximately 2,673 miles.

The Discovery of Electro-magnetism.—On August 31st and September 1st, the centenary of the discovery of electro-magnetism by Oersted was celebrated at Copenhagen by meetings of Scandinavian scientists.

A Military Wireless Station has been erected on the roof of the Town Hall, Chester. The War Office has agreed to indemnify the Corporation should any damage be incurred.

Wireless Telegraphy in Colombia.—On account of the deficient public telegraph service, a merchant of Barranquilla has entered into a contract to introduce a wireless telegraph service. He has given a bond of 1,000 Pesos, which will be forfeited if work on the installation is not commenced within six months of the signing of the contract. The bond will also be forfeited unless the service is established and working within a period of one year from the date of signing the contract.

U.S. Wireless Stations.—There are 88 shore wireless stations belonging to the Federal Government not including 20 in Alaska, 19 in the Philippines, 3 in the Canal Zone, 2 in Hawaii, and 1 each in Porto Rica, Guam and Samoa, or a total of 135. The Government ship stations number 470.

A New Wireless Telephony Set.—The De Forest Radio and Telephone Company have developed a wireless telephony set which operates without "B" Battery or external source of high potential. The entire output may be easily transported. The transmitter, including two 6-volt storage batteries, weighs 60 lbs. According to the manufacturers this set operates with any suitable type of receiver and audion detector, with or without an audion amplifier. The set is designed to operate an antenna whose capacity to earth varies from 0·002 mfd. to 0·0007 mfd. although it may be used on even smaller aerials.

Why Amateur Wireless is popular. Photograph submitted by Mr. A. B. Day, of Finchley.

Wireless Telephony and Farming.—By means of six wireless telephony transmitting stations the Michigan Agricultural College is inaugurating a system of wireless telephony whereby the farmers of the State may be kept informed of the market prices of their products, receive weather forecasts, and even "listen in" to music, or lectures on practical and scientific topics such as are delivered at the College. Some 50 instruments are installed at the present time around Lansing. A system is being worked out whereby all farmers of the State may eventually obtain instruments from the College to receive these transmissions.

Wireless Communication with Sweden.—According to *Reuter's Service* (Stockholm), direct regular wireless telegraphic communication has been established between the Karlsborg station in Sweden and the San Paolo station at Rome.

Wireless Station for Mexico.—The Mexican

Capt. Paul Brenot, Technical Manager of the S.F.R. and Consulting Engineer to the Cie Générale de T.S.F. Photo taken whilst Capt. Brenot was in charge of FL.

Department of Commerce officially confirms the announcement that the Mexican Government intends to install immediately 30 new wireless stations at an approximate cost of one million dollars.

Admiralty Wireless Stations.—A revision has been made of the regulations governing appointments on the wireless stations in the Royal Navy. The periods of service were recently fixed for 19 stations abroad. The Admiralty has directed that the commanding officers of such stations, together with the chief petty officer telegraphists, and petty officer telegraphists, are to undergo a special course in the type of apparatus fitted at their oversea wireless stations, before proceeding abroad. This course will be at the Signal School, Portsmouth. In order that they may be able efficiently to superintend the works at the station all commissioned officers who are appointed to command wireless stations abroad are to undergo a special course of instruction in oil engines. Warrant telegraphists are not to undergo this course.

Marine Wireless.—The sister ships *Columbia* and *Venezuela* of the Pacific Mail Steam Ship Company have recently established rather remarkable long-distance wireless records. Each ship was equipped with a 2 k.w. C.W. apparatus. When the *Columbia* was 4,100 miles from the coast she established communication with the Inglewood Station. The Inglewood Station is equipped with a 12 k.w. double arc apparatus. The *Venezuela* when about 70 miles from Yokohama and 5,900 miles from the Inglewood Station, also established communication with the last-named and exchanged a number of messages. It is believed that these distances establish a record for low power stations.

France and Germany.—The recent claim of the French Compagnie General de Telegraphie sans Fil, to the Eilvese wireless station in Hanover, has been rescinded. As a result of negotiations the French company has ceded its rights in return for some 3,000,000 marks compensation. The Eilvese station, which will remain in German possession, will be worked by a company bearing the name of "Eilvese, Limited." A further arrangement relates to patents. The Germans will be entitled to use certain French inventions in Germany, and the French in return will use certain German inventions in France.

South African Wireless.—At the meeting at Bulawayo of the South African Association for the Advancement of Science, a proposition was carried to the effect that the Union Government be requested to erect a wireless station of sufficient power to communicate with both Europe and North America.

THERMIONIC MAGNIFIERS

By H. Monteagle Barlow.*

Introductory.

DURING the past few years remarkable strides have been made in the development and practical application of the three-electrode vacuum tube. Already extensive literature exists concerning this device, so that a description of its structural details or an explanation of the physics of its operation would be superfluous.

Mr. Smith-Rose has recently contributed a valuable paper[1] on the subject, and of the early investigators, Lee de Forest, Fleming and Langmuir represent the chief authorities.

The author does not propose to enter into a detailed account of the action and working principles of thermionic valves, but merely for the purpose of elucidation to review those phases of the subject which have a direct bearing on the theory of operation of the thermionic amplifier.

For several decades, physicists have been attempting to solve the problem of the magnification of rapidly-recurring current variations, and yet, until the introduction of the three-electrode vacuum tube, or, briefly, the "Valve," all their efforts were futile.

Devices involving mechanical movement naturally failed because the inertia of the moving masses prevented them from simultaneously following the current impulses. The valve, however, involves none but ionic movement, and for all practical purposes an ion can scarcely be said to be possessed of inertia. It is obvious, therefore, that with such a device the problem is immediately simplified. The valve is still in its transition stage, and improvements and modifications are constantly being made, but it can safely be said that in principle its use as an amplifier must remain unaltered.

Operation of the Valve as an Amplifier.

When the filament of a valve is brought to incandescence it emits negatively-charged particles[2] called electrons. If a positively-charged plate, *i.e.*, an anode, is introduced into the tube it attracts the electrons and produces a current between the filament and the anode. If the anode were insulated its charge would be neutralised after a certain time and the current would stop. But if the charge be maintained, that is to say, if the anode be maintained at a positive potential in relation to the filament (Fig. 1), the current will flow continuously. If the difference of potential is sufficiently great, all

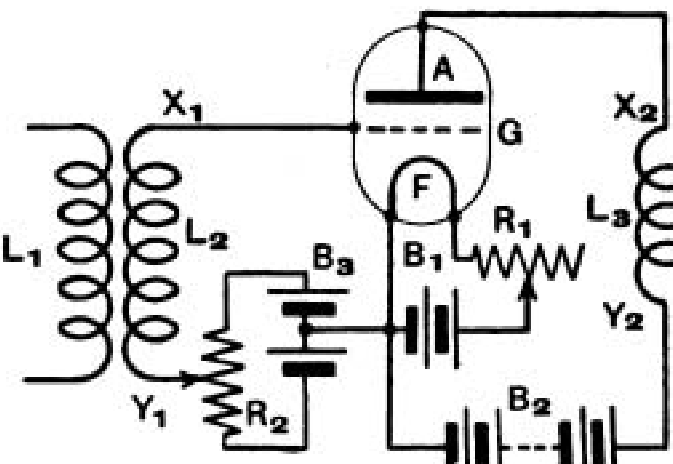


Fig. 1.

the electrons emitted by the filament will reach the anode, and any rise in this potential difference will not increase the current (Fig. 2). Under these conditions the valve is said to be saturated[3]. This limitation of the anode current is due to the "space charge" effect.[4] The electrons carrying the current between

* Paper read before the Students' Section of the I.E.E., December 5th, 1919.

[1] "Proc. Inst. Elec. Eng., 1918." Vol. 50, p. 253.

[2] Wehnelt, "Phil. Mag., 1905." Vol. 10, p. 80. S. S. Thompson, "Conduction of Electricity through Gases," 1903, Chap. 8.

[3] Lee de Forest, "Electrician, 1906." Vol. 58, p. 216. S. S. Thompson, "Conduction of Electricity through Gases."

[4] Irving Langmuir, "Phys. Rev., 1913." Vol. 2, p. 450. C. D. Child, "Phys. Rev., 1911," Vol. 32, p. 492; and I. Langmuir, "Gen. Elect. Review, 1915," Vol. 18, p. 327.

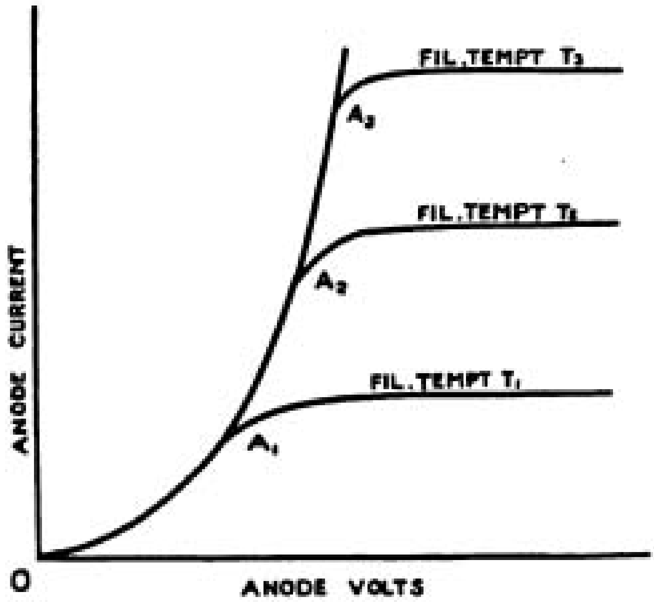


Fig. 2.

the two electrodes constitute an electric charge in the space which repels and prevents any additional emission from reaching the anode. But if saturation is not reached, any variation in the difference of potential between the filament and the anode produces a corresponding variation in the current.

The employment of an auxiliary electrode [5] called the grid, placed between filament and anode, provides a means of setting up these current variations, although to a very small extent they always exist, chiefly as a result of irregular filament emission. If the grid has a positive potential in relation to the

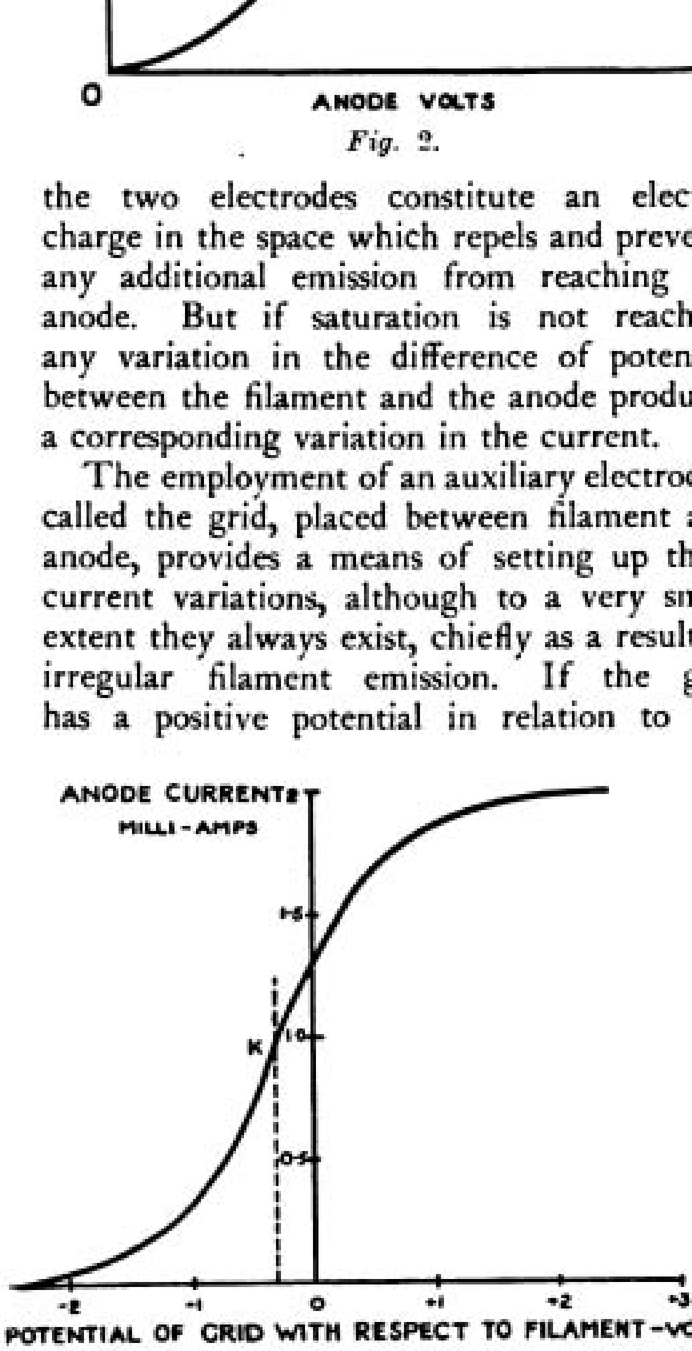


Fig. 3.

filament the electric field produced will be superposed on the existing field, and help to attract the electrons in the direction of the anode. The current between the filament and anode will then be greater than if the grid were neutral, that is at zero potential. If, on the contrary, the grid is negative in relation to the filament, its field will oppose the existing field and the anode current will be less than if the grid were neutral.

With suitable values of the anode and grid potential and filament current, small variations in the grid voltage, *i.e.*, across X_1Y_1 will produce comparatively large variations in the anode current, *i.e.*, between X_2 and Y_2.

This amplifying action is dependent primarily on the relation between anode current and the corresponding grid potential which Haseltine has termed the "mutual conductance" [6]. Fig. 3 represents a typical *Anode Current Grid Voltage* characteristic.

The steady voltage maintained between grid and filament is adjusted to the point K on curve, so that a given change in the grid potential causes the largest change in the anode current, and therefore gives the greatest amplification. If a curve is plotted between grid-voltage and mutual conductance for various applied anode potentials, Fig. 4 is obtained. It will be observed that the mutual conductance reaches a maximum about the point M, and this value is practically independent of the volts applied to the anode for a given valve. But there are other factors which tend to reduce the figure of merit of the device, and of these the magnitude of the current taken by the grid is most important. In the average valve the loss entailed reduces the amplification by about 30 per cent. to 40 per cent. of that which would otherwise have been expected.

Considering a typical *grid-current, grid-voltage* characteristic (Fig. 5), any increase of voltage applied to the grid leads to an increase of current flowing into the grid. Thus at the moment when the current change

[5] Lee de Forest, U.S. Pats. Nos. 841387/1907, and 879532/1908.

[6] L. A. Hazeltine, "Proc. Inst. Radio Engs., 1918." Vol. 6, p. 63.

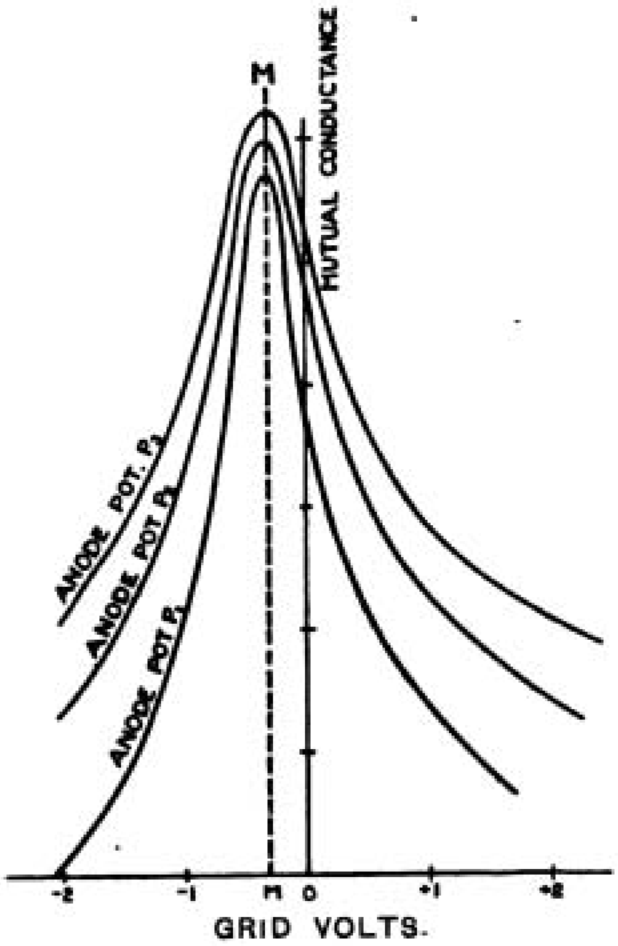


Fig. 4.

to be amplified is positive, an additional current is taken by the grid with the result that the consequent increment of grid voltage is less than would have been the case if there had been no increase of current at the grid. With a very soft valve the state of affairs is somewhat different (Fig. 6). Gas ionisation begins to have a very marked neutralising effect[7] on the "space charge," but the apparent advantages provoke instability, and therefore are of little use under working conditions.

Several attempts have been made to eliminate ionisation and produce a pure electron emission, and a certain degree of success[8] has been attained, but with it all disturbances still prevail in the most carefully designed valves, and they are undoubtedly primarily the result of ionic bombardment.[9]

Generally, it is desirable to use a moderately hard valve for amplifying, and to make the slope of its grid characteristic as small as possible.

As regards the anode circuit, the best results are obtained when the external resistance is about equal to or slightly greater than the impedance of the valve.

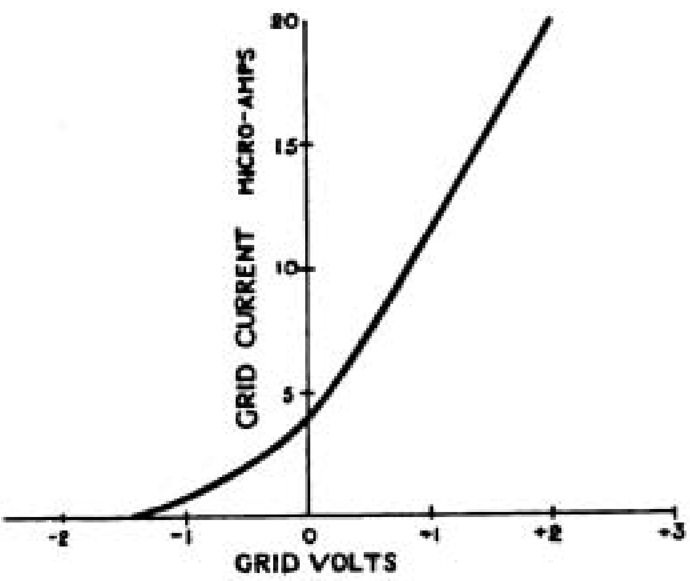


Fig. 5.

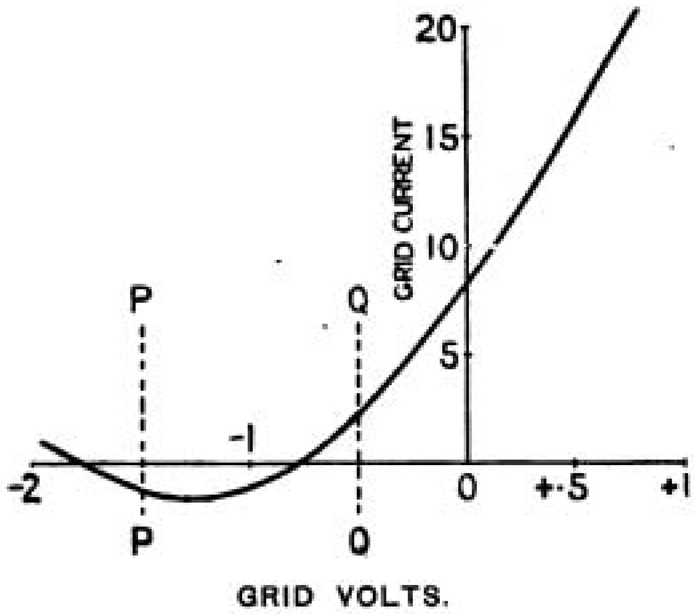


Fig. 6.

It has been shown that the effect of inserting resistance[10] in the output circuit is to straighten out the characteristic, and so reduce distortion, which then becomes practically negligible.

[7] Irving Langmuir, "Proc. Inst. Rad. Eng., 1915," Vol. 3, p. 261.
[8] Irving Langmuir, "Gen. Elec. Rev., 1915," Vol. 18, p. 327; and "Electrician, 1915," Vol. 75, p. 240.
[9] H. J. Van de Bijl, "Proc. Inst. Radio. Eng., 1919," Vol. 7, p. 97.
[10] H. J. Van der Bijl, "Proc. Inst. Radio. Eng., 1919," Vol. 7, p. 97.

THE AMPLIFIER AND MAGNIFIER DISTINGUISHED.

Having reviewed the means whereby a valve may be made to operate as a multiplier of small current variations, we will pass on to consider the circuits particularly adapted to this purpose.

There are two obvious possibilities. Either the radio-frequency oscillations in the aerial are impressed directly on the amplifier and afterwards translated into audio-frequency variations by means of a detector; or rectification is carried out in the first instance and the resulting low frequency variations magnified.

The systems differ in one material feature only; that is to say, the operation is either carried out at high frequency or low frequency. It is quite possible and sometimes advantageous to combine the two,[11] but for most purposes they remain distinct.

In order to prevent any misconception it has been found convenient to distinguish radio-frequency apparatus from audio-frequency apparatus by referring to them as "Amplifier" and "Magnifier" respectively. It is with the latter only that this paper is concerned.

[11] This is sometimes done in the case of very high power amplifiers.

(To be continued.)

A NEW USE FOR VALVES

MANY attempts have been made to devise some satisfactory electrical apparatus that would enable accurate photometric comparisons to be made of different lamps, illuminants or light sources. The advantage of such an apparatus would be that the reading of the candle power of the lamp under test could be made from an instrument scale, with the result that the "personal equation" involved in the usual visual methods of comparison would thereby be eliminated. Selenium cells, which, as is known, are sensitive to light, have on many occasions been used for this purpose, but their employment is not altogether satisfactory, partly on account of their instability and partly on account of their varying sensitiveness to light of different colours.

Quite recently a new electric photometer has been devised in which the sensitive apparatus comprises what is known as a photoelectric cell. The term photoelectric cell is applied to an apparatus containing an electrode which, when subjected to illumination, emits a stream of electrons and thereby enables a current to pass across the space between it and another electrode mounted inside the same containing vessel. The whole apparatus is usually contained in a glass bulb which is highly exhausted. When the light falls on the sensitive surface electrons are emitted, thus enabling a current to flow through a galvanometer connected in series with the cell and a battery. The particular novelty of the arrangement recently described by A. H. Compton.* consists in the use of an ordinary type of three-electrode valve amplifier to magnify up the feeble currents which can pass through such a photoelectric cell. A galvanometer may be connected in series with the plate circuit of the valve, and its normal deflection reduced to zero by means of a simple form of potentiometer connected across it.

When light falls on the sensitive surface of the photoelectric cell the galvanometer gives a reading which is dependent upon the illumination on the cell, and in this manner reliable comparisons can be made between the lamp under test and a standard comparison lamp. Photoelectric cells are almost always much more sensitive to blue and ultraviolet light than to red light, but this inequality in sensitiveness can be compensated for by means of suitably coloured screens permanently interposed between the sensitive cell and the light source. P.R.C.

* "Transactions of the Illuminating Engineering Society," Feb. 10th, 1920.

WIRELESS CLUB REPORTS

North Middlesex Wireless Club.

(Affiliated with the Wireless Society of London.)

The usual fortnightly meeting of the Club was held on September 8th, the President, Mr. A. G. Arthur, being in the chair. An opportunity having occurred for the Club to purchase a Mark III (Converted) Army receiving set, the meeting considered its suitability as regards price, effective receiving range, and general utility. The Chairman pointed out that while there were more suitable sets to be had, many of these were so expensive as to be beyond the Club's means. On the other hand, the particular set under consideration had been tested by one of the Club's experts, and had been found to be a very good specimen of its type. Further, it was of a type that would give very good results on the Club's aerial, and was capable of a certain amount of alteration which would make it capable of receiving long waves.

At this point Mr. C. W. Beckman very kindly offered to give a donation of £3 towards its purchase, provided that the balance was at once subscribed by the members present. The Chairman thanked Mr. Beckman, and in accepting his offer, said that he felt sure that the required amount would be collected without difficulty. It was further decided to purchase the necessary accessories out of the Club funds. Those assembled then contributed 2s. each towards the sum required.

It is felt that the acquisition of this instrument will be a great help towards making the meetings interesting.

On August 29th, the Chairman, Hon. Secretary, and a member of the Committee were invited by Mr. Wm. Le Queux, the Vice-President of the Club, to visit his wireless station at Guildford. The journey from North London was enjoyably accomplished by motor cycle, and a very interesting afternoon was spent examining the wonderful collection of wireless gear belonging to Mr. Le Queux. This gentleman is at present engaged in wireless telephony experiments, and his apparatus is of the latest and most up-to-date type.

Full particulars of the Club may be had on application to the Hon. Secretary, Mr. E. M. Savage, Nithsdale, Eversley Park Road, Winchmore Hill, N.21.

Bristol and District Wireless Association.

(Affiliated with the Wireless Society of London.)

A meeting of this Association was held at 11, Leigh Road, Clifton, Bristol, on Friday, September 10th, 8 p.m., Mr. Davis being in the chair owing to the absence of the Chairman, Mr. W. P. Rigby.

Professor Arthur Tyndall, D.Sc., of the Physics Department of the University of Bristol, was elected President of the Association. Major A. Cousins of the Signals Department, Woolwich, was elected an hon. member.

The Association has lost two valuable members in Mr. Hodgeson, who has been appointed to a post under H.M. Board of Admiralty at Portsmouth, for research in "valves," and Mr. J. Carpenter, who has been appointed to a post at Marconi House. The Association passed resolutions congratulating these members and wishing them every success in their new posts.

The apparatus of Mr. A. W. Fawcett was viewed, and the meeting ended at 9.45 p.m.

The Secretary would like to call the attention of the large numbers of amateurs, now in Bristol and district, to the existence of the Association, and invites application for membership. Communications should be addressed to Mr. A. W. Fawcett, 11, Leigh Road, Clifton.

Some Members of the Wireless and Experimental Association of Peckham.

The Cardiff and South Wales Wireless Society.

(Affiliated with the Wireless Society of London.)

A general meeting and exhibition of members apparatus was held at Headquarters (the Wireless Department of the Cardiff Technical College), on September 9th, 1920, at 6.30 p.m., the President, Mr. W. A. Andrews, B.Sc., in the chair.

The minutes of the last general meeting were read for confirmation and adopted, and questions arising therefrom were discussed at length. Mr. A. E. Hay having tendered his resignation of the Hon. Secretaryship on July 22nd (to take effect as from September 30th), proposed that Mr. W. G. J. Howe be his successor, but Mr. Howe regretted having insufficient time at his disposal to justify taking up the office, whereon the retiring Hon. Secretary proposed that Mr. G. C. Hughes, of 1, Wood Street, Cardiff, be appointed. (This last-named gentleman is the South Wales representative of the Association of Wireless Telegraphists.)

The proposal being carried and Mr. Hughes accepting, he was formally appointed Hon. Secretary as from October 1st.

Resignation of office was read from Mr. A. T. Dudley (the Hon. Treasurer), wherein he stated he felt it necessary for the efficient working of the Society, that the Secretary and Treasurer should be, as hitherto, resident in the same town. The resignation was accepted with regret. It was proposed by Mr. A. E. Hay that Mr. H. F. Abell be elected Hon. Treasurer, and the proposal being carried and the office being accepted, he was appointed. All subscriptions should now be sent direct to him at 23, Palace Road, Llandaff.

We take this medium of publicly acknowledging, with thanks the receipt of correspondence (which was read at the meeting) from Messrs. M. Smith-Petersen, T. B. Humphries, T. J. Callaghan, H. Powell Rees, Sir Joseph Davies, M.P., Sir John Cory, J. C. Gould, M.P., the Hon. John H. Bruce, Mr. E. Blake, *Wireless World*, and the Marconi Company.

The Rt. Hon. Lord Aberdare has been elected a patron of the Society.

Arising out of correspondence received by the retiring Hon. Secretary from ex-colleagues afloat, he proposed that sea-going operators be admitted to membership. Proposition carried. Twelve new members were then introduced. It was decided to hold over till the next general meeting, the appointment of a member to be our delegate to the Wireless Society of London. It was decided to put the Membership List, Rules Book, and List of Patrons into print immediately. (We take this opportunity of stating that it is necessary for those candidates for membership, who desire to appear in the supplement to same, to confirm membership to the *retiring* Hon. Secretary immediately on appearance of this notice, and at the same time, subscriptions should be forwarded to the Treasurer.)

Routine business over, the assembly dispersed for buzzer and workshop practice, Morse inker tests, and "listening-in" with a 9-valve amplifier, etc.

A splendid show of apparatus constructed by members of the Society was on view. A portable valve receiver and pancake coils of very delicate but efficient construction were exhibited by Mr. H. Russell Jones. A highly ingenious and complete pocket set by the brothers F. L. W. Dean and L. L. R. Dean caused considerable enthusiasm.

Among the other exhibits were a valve set by Mr. D. D. Richards; celluloid-encased honeycomb coils of high inductance and robust construction, by Mr. H. S. Lloyd; a loose coupler of quite new design by Mr. Jas. J. Stephenson; variable condensers and light-weight inductances, by Mr. H. F. Abell; a large loose coupler of magnificent finish, by Mr. W. Teague.

Mr. B. Morgan showed a compact valve-panel, and Mr. A. E. Hay a complete valve set for C.W. and spark (400 to 15,000 metres), also wired for use as L.F. amplifier. Smaller pieces of apparatus were shown by Messrs. W. G. J. Howe, P. O'Sullivan, A. W. M. Dyke, W. E. Groves, and others.

The telephony from PCGG was listened to, later in the evening.

The Society is in a thriving condition; there have been over a hundred in attendance, of whom fifty are full members, and it is anticipated that by 1921 the membership will be at least 250.

It is proposed by some of the members, when transmitting conditions become a little easier, to carry out important research work in telephony, duplex working and particularly in directional transmission, as applied thereto. While it is recognised that the Post Office must, of necessity, preserve the efficiency of public communications by preventing interference, it is also felt that much of the caution is superfluous. No interference would be caused if every applicant for a transmitting license were compelled to comply with the following conditions:—That the applicant, be a member of a recognised Society; have a minimum speed of 15 w.p.m., in order to cause no delay should a commercial station give instructions to wait; and have a knowledge of the more important P.M.G. Regulations governing actual transmission. Very rarely would interference be caused by amateurs or experimenters working on wavelengths of 200 metres or less—(plain aerial working should, of course, be forbidden)—and on the rare occasions when experimenters would be in default in this respect, both the G.P.O. and their Society would deal with them. This, alone, should be sufficient deterrent to breaking of regulations. Correspondence from other Clubs on this and allied subjects will be welcomed.

From October 1st all correspondence should be forwarded to Mr. G. C. Hughes (address as above). In the case of additions to the List of Members Supplement only, address to Mr. A. E. Hay, Oxford Street, Mountain Ash, Glam.

Edinburgh Wireless Club.

(Affiliated with the Wireless Society of London.)

The general meeting of this Club was held on September 5th, when arrangements for the winter session were discussed. Judging from the amount of apparatus now available, our ordinary meetings promise to be thoroughly interesting. The Club is willing to enrol new members, and full particulars will be supplied by the Hon. Secretary, Mr. W Winkler, 9, Ettrick Road, Edinburgh.

Sheffield and District Wireless Society.

(Affiliated with the Wireless Society of London.)

Owing to the temporary nature of the Club-room it was not possible to continue the demonstrations and lectures during the summer months, hence there have been few opportunities for members to come together. The enforced vacation, however, has not been wasted, as it has afforded members ample time to perfect their own stations; much good work has been done both in the reception and transmission of Morse signals and speech. The various tests carried out by the Marconi Wireless Telephony Station at Chelmsford have been listened to by most of the members, (thanks to the kindness of the Editor of the *Wireless World*), and stimulated, no doubt, by the success of these experiments, two members have carried out much useful work in this direction; speech being clearly transmitted over a distance of several miles on a 200 metre wavelength with the expenditure of very little energy.

Two outings to the beautiful moors surrounding Sheffield were made during the summer vacation, for experimental purposes, and the results obtained with portable apparatus were very successful. The second of these outings took place on September 4th, when Ringinglowe, some 5 miles out of Sheffield, was visited, and despite a terrific hurricane which was blowing at the time, transmission and reception of wireless speech was maintained with one of the members in Sheffield. A very primitive aerial, consisting of an insulated cable, was slung between two trees, and in a short time the ordinary wireless telegraphic signals from Seaforth, Cullercoats and other coast stations were heard quite distinctly. The most interesting results, however, were obtained later, when a voice from Sheffield was clearly heard in a message of welcome and good wishes for the future success of the Wireless Society. A wireless conversation was then carried on, followed by a concert consisting of songs and gramophone recitals *à la* Chelmsford at his best.

The Society, which now boasts 100 members, commences its second session on the 7th October, when the Annual General Meeting will be held. By the kindness of the University authorities, a lecture room in the Electrical Department at St. George's Square, has been secured, and the weekly meetings will be held there on Friday evenings commencing October 15th.

A comprehensive syllabus of lectures and demonstrations has been prepared, and a very successful session is anticipated.

Prospective members should write to the Hon. Secretary, Mr. Leonard H. Crowther, 156, Meadow Head, Woodseats, Sheffield.

Liverpool Wireless Association.

(Affiliated with the Wireless Society of London.)

A very successful out-door demonstration was held at Bidston Hill, on Saturday, September 4th, when excellent results were obtained.

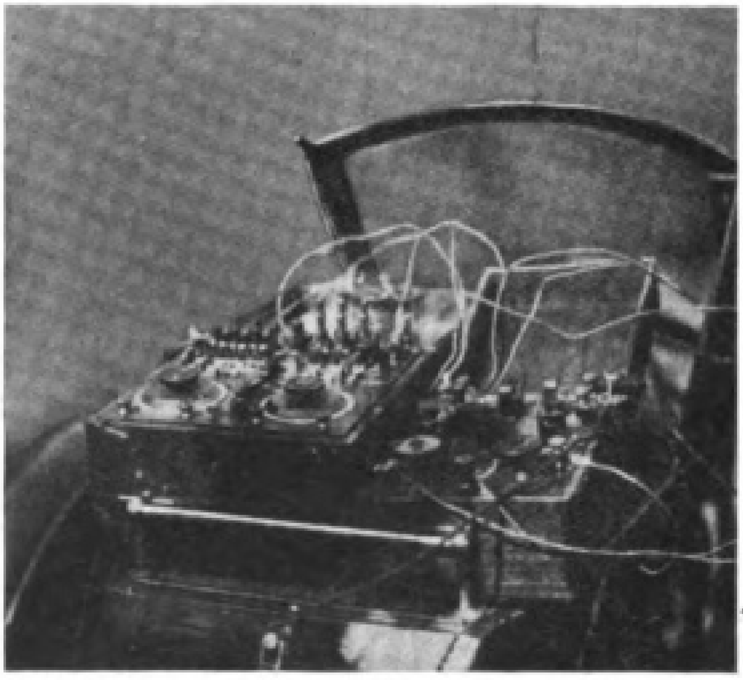
Members of Sheffield and District Wireless Society. President, 4th from right. Hon. Sec., on extreme left.

The usual fortnightly meeting was held at 56, Whitechapel, on September 8th, when the subject of "Indoor Aerials" was discussed.

It was announced that arrangements had been completed whereby the Association had secured a Club-room at the Royal Institution, Colquitt Street, Liverpool.

A cordial invitation is extended to all persons interested in wireless telegraphy, to be present at the Club meetings, held fortnightly at the Royal Institution, Colquitt Street, Liverpool.

The Liverpool Wireless Association caters particularly for beginners, every assistance and advice is given in the designing of experimental wireless stations, and no more fascinating study can be found. All communications should be addressed to the Hon. Secretary, Mr. S. Frith, 6, Cambridge Road, Crosby, who will be also pleased to interview applicants by appointment.



Portable Short Wave Receiver, Sheffield and District Wireless Society.

Manchester Wireless Society.

(Affiliated with the Wireless Society of London.)

The Society held its first meeting for the winter session at the Club-rooms, on September 1st, the attendance being much larger than was anticipated.

The Chairman, Mr. J. McKernan, delivering his address in fine style, outlined the progress of wireless telegraphy and telephony, together with the aims of the Society, in such a clear and non-technical manner, that even those of his audience just commencing the fascinating study of wireless, were able to follow the discourse without difficulty.

Mr. McKernan was ably supported by Vice-Presidents J. Griffin, C. V. Morris, W. G. Phillips, and the Hon. Treasurer, Mr. J. C. A. Reid, each of whom expressed their desire for closer co-operation, with a view to securing more direct benefit from the researches of the Society.

Various sets were exhibited during the evening, including three portable receiving sets, a small transmitting set and a telephony set. Four new members were elected, making the total membership 52. Several applications have yet to be dealt with, including one from Ireland and one from Newfoundland. Hon. Secretary, Mr. Y. W. P. Evans, 7, Clitheroe Road, Longsight, Manchester.

Stockport Wireless Society.

The above Society commenced its winter sessions on September 3rd. The Chairman, Mr. H. C. Woodhall, presiding over a good attendance, opened the meeting with a few general remarks. The Secretary then stated that the desired room of our old headquarters had now been obtained, and asked that members would discuss the situation. The members present examined the possibilities of installing transmitting and receiving sets, also the erection of a permanent aerial; the results were found highly satisfactory. The Society already holding the necessary licences, it was decided to carry out the above immediately, which it is hoped will be completed in time for the Society's next meeting.

The Secretary then put the proposed programme for September before the members; the beginners to form an elementary class, and the remainder who are expert wireless enthusiasts to form an advanced class.

Major Swart was found to be an excellent lecturer by the elementary section, keeping everyone so interested that time passed all too quickly.

Mr. Faure was in charge of the advanced class which embraced some very interesting discussions on the efficiency of various types of wireless gear; later, buzzer practice was indulged in, and it is pleasing to note that everyone is becoming more proficient in telegraphy.

Thanks were conveyed to the Editor of the *Wireless World* for informing the Secretary *re* Chelmsford telephony on August 28th, 29th and 30th.

Arrangements have been made for members to visit the wireless installation at the Aerodrome, Alexandra Park, during the next week.

The Society cordially invites all prospective members to its meetings held every Friday, at 7.45 p.m., at the Foresters' Hall, Churchgate, Stockport, and particulars of membership may be had from the Hon. Secretary, Mr. Z. A. Faure, 3, Bank's Lane, Stockport.

Walsall Amateur Radio Club.

With a view to instructing junior members in the elementary principles of wireless telegraphy, a junior branch has recently been formed permitting boys between the ages of 11 and 16 to membership. Meetings are held on Mondays and Fridays at 7.0 p.m., at the Brotherhood Institute, and all boys between the ages given are cordially invited to attend. Meetings for adult members will continue to take place on Mondays and Fridays at 8 p.m., as hitherto. All particulars of both sections of the Club, together with all other information, may be obtained upon request, from the Hon.

Secretary, Mr. Edgar W. Bridgewater, 46, Caldmore Road, Walsall.

Oxford Amateur Wireless Society.

Owing to unforeseen difficulties the apparatus belonging to the above Society has been installed at 7, Bartlemas Road, instead of at Shotover Hill.

There have been no meetings of the Club during August on account of the holidays.

Communications should be addressed to the Assistant Secretary, Mr. P. R. Bunce, 7, Bartlemas Road, Oxford.

Wireless Club for Exeter.

With a view to discussing and drawing up details for the formation of a Club at Exeter, a number of amateurs held a meeting during the latter part of September. It is proposed to introduce into the Club such effects as a wireless set, a library, a workshop and lathe. Will interested readers and those desirous of joining, please communicate with Mr. H. E. Alcock, 1, Prospect Villas, Heavitree, Exeter.

Wireless Club for Newark-on-Trent.

Mr. Geo. T. Sindall, of 44, Hatton Gardens, Newark-on-Trent, is anxious to form in or about his district, an amateur wireless club. Will those readers whose interest in wireless is centred about Newark-on-Trent, kindly write to the above-named.

The Three Towns Wireless Club.

(Affiliated with the Wireless Society of London.)

The first winter session meeting of the above Club was held on Wednesday, September 15th. As no programme had been prepared, a general discussion was held. Each of the members present had something to report on the progress of his set, and the meeting concluded all too quickly. Our former Secretary (Mr. W. Rose) exhibited a Mediwaver set, and with it good signals were obtained from Pembroke, Cleethorpes, Poldhu C.W. and several unknown spark stations. Three pairs of telephones were in use and the signals were all that could be desired.

The Club is hoping to arrange a very attractive and instructive series of lectures and demonstrations for the coming winter. There must still be many amateurs in and about Plymouth who are not yet attached to the Club, therefore should this report meet their attention, a letter to the Acting Secretary, Mr. G. H. Lock, 9, Ryder Road, Stoke, Devonport, would elicit further information.

Rugby and District Wireless Club.

Interest in wireless matters is taking practical shape in Rugby. The newly formed Club is making headway; its membership is increasing and gentlemen prominently connected with electrical development are coming forward as supporters. Preparations are being made for the winter session. A special committee has in hand the drawing up of the programme, with a view to promoting lectures, discussions, experiments, demonstrations, etc.; several promises have been made to help in this direction. It is also hoped to inaugurate a class for giving buzzer instruction in order that members not familiar with telegraphy may become proficient in that practice.

Considerable satisfaction is expressed by the members that R. C. Clinker, Esq., has consented to become President, and among the Vice-Presidents are:—Sir John Baird, M.P., D.S.O., R. Dumas, Esq. (Works Manager B.T.H. Co.), A. R. Everest, Esq., Dr. C. R. Hoskyn, etc.

An endeavour is being made to procure the rooms of the Rugby Engineering Society for the purposes of the Club, and it is believed that the Society will sympathetically consider the proposal.

It has been decided to affiliate with the Wireless Society of London as soon as possible, and the Secretary of that Society has promised to send the necessary forms.—Hon. Secretary, Mr. Arthur T. Cave, 3, Charlotte Street, Rugby.

Portsmouth and District Wireless Association.

The first meeting of the above Society has taken place, eight members being present. It was decided to obtain a room for the use of the Society, and to keep there instruments for calibrating any parts of members' apparatus. A receiving station will be erected, and arrangements are being made to hold buzzer practice for the members.

The Hon. Secretary, Reg. G. H. Cole, 34, Bradford Road, Southsea, Portsmouth, will be pleased to hear from any wireless people in the district.

Newcastle and District Amateur Wireless Association.

(Affiliated with the Wireless Society of London.)

The Society has now received permission to erect an aerial for reception, and to use valves. An aerial has therefore been erected, which is giving very good results with crystal sets. Applications for membership should be addressed to the Hon Secretary, Mr. Colin Bain, 51, Grainger Street, Newcastle.

Wireless Society of Hull and District.

At the monthly meeting of members held on the 9th inst., Mr. C. Dyson, well known in the city as a keen pre-war wireless enthusiast, gave some instructive advice with regard to the construction of an amateur wireless installation. The speaker pointed out that it was far more interesting and instructive to build up a set than to purchase the completed article. Mr. G. H. Strong (President), who was in the chair, also gave some sound advice to beginners respecting the building up of their sets, and dwelt at some length upon the use of the valve as a detector and amplifier.

Several new members were enrolled, and the prospects of this Society are very bright. The meetings are being held at the Metropole (Marlborough Room), and the dates of future meetings are October 7th and 21st, November 4th and 18th, December 2nd, 16th and 30th. The Hon. Secretary, Mr. H. Nightscales, 16, Portobello Street, Hull, will gladly supply full particulars to intending members.

PAGES FOR BEGINNERS

RESISTANCE AND HIGH FREQUENCY RESISTANCE

NO conductor will permit the passage of an electric current through it without loss. Whenever a current flows through a conductor a certain amount of the energy is converted into heat, and thereby probably wasted. This property of a conductor which obstructs the free passage of the current through it is termed its *resistance*, and is expressed in units termed *ohms*. Thus, if two conductors were stated to have resistances of 5 and 10 ohms respectively, we should understand that the former would conduct an electric current twice as readily as the latter. The resistance of a conductor depends among other things on its length. It is clear that the longer the path traversed by a current, the more energy will be lost. Hence, the resistance of a wire is directly proportional to its length. Also, the greater the path offered to the flow of the current the less is the resistance. If we increase the cross-sectional area of a certain conductor by four times, the resistance will only be one quarter as great.

In order to find the resistance of a certain conductor, therefore, it is necessary to find the volume of metal in the conductor. If we then multiply this by a factor giving the resistance of unit volume of the metal we shall obtain the value of the resistance in ohms.

The resistance of unit volume of a conductor is known as the *specific resistance*, and is usually taken as the resistance in ohms between the opposite faces of a cube of the material, one centimetre each way. Fig. 1 will help to make the meaning of the term clear.

The following list gives the specific resistances in ohms of some of the commoner conductors :—Copper [$1{\cdot}5 \times 10^{-6}$], silver [$1{\cdot}4 \times 10^{-6}$], aluminium [$2{\cdot}8 \times 10^{-6}$], iron [$12-15 \times 10^{-6}$], lead [$19{\cdot} \times 10^{-6}$], mercury [$94{\cdot} \times 10^{-6}$], carbon [4×10^{-2}--4×10^{-2}], water [$26{\cdot}5 \times 10^{-2}$], dilute sulphuric acid [$1{\cdot}3-5$].

The formula for the resistance of a con-

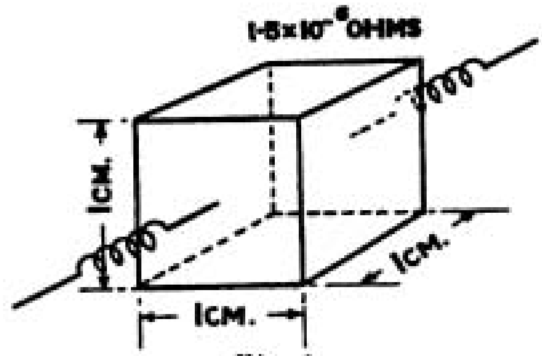


Fig. 1.

ductor may be written down as follows :—

$R = \frac{l \times s}{a}$. Where l is the length of conductor in centimetres, a the cross sectional area in sq. cms. and s the specific resistance.

Let us apply this formula to find the resistance of 100 yards of No. 30 SWG. copper wire.

Referring to a wire table we find that the diameter of No. 30 SWG. is 0·0124" (0·315 mm.), and the cross-section, therefore, is 0·078 square mm.

100 yards is 300 feet or 9,150 cms., and the specific resistance, from the above table, is $1{\cdot}5 \times 10^{-6}$ ohms.

$$\therefore R = \frac{9{,}150 \times 1{\cdot}5 \times 10^{2}}{10^{6} \times 0{\cdot}078} = 17{\cdot}6 \text{ ohms.}$$

As another example, take the following :—1,000 yards of aluminium wire have a total resistance of 65 ohms. What is the diameter of the wire ? Here we are given $R=65$, $l=3{,}000 \times 30{\cdot}5$ cms., $s=2{\cdot}8 \times 10^{-6}$.

$$\text{Therefore } a = \frac{ls}{R} = \frac{3{,}000 \times 30{\cdot}5 \times 2{\cdot}8}{10^{6} \times 65}$$

$$= 0{\cdot}00394 \text{ square cms.}$$

The diameter, therefore, is 0·07 cms. which corresponds to No. 22 S.W.G.

If any number of resistances are connected in series so that the current flows through each in turn, the total resistance in the circuit will be equal to the sum of the individual resistances. Thus, if three resistances, each of 2 ohms, are joined in series with one of 4 ohms, the total resistance will be $(3 \times 2) + 4$ or 10.

When, however, the resistances are joined in parallel the effective resistance of the group is lessened. Thus, if two resistances of one ohm each were connected in parallel, the effective resistance of the combination would be only one-half an ohm.

The formula giving the joint resistance of any number of resistances in parallel can be written—

$$\frac{1}{R} = \frac{1}{r_1} + \frac{1}{r_2} + \frac{1}{r_3} + \text{ etc.}$$

Where R is the total resistance required, and r_1, r_2, r_3 are the individual resistances.

An important application of this rule is found in the calculation of the resistance of stranded wires. The resistance of a stranded wire containing n strands, is $\frac{1}{n}th$ the resistance of a single strand.

As an example :—What is the resistance of 100 yards of cable containing 19 strands of No. 22 SWG. ? 100 yards of single No. 22 wire have a resistance of 3·9 ohms, approximately. The cable, therefore, will have a resistance of $\frac{3 \cdot 9}{19}$ or 0·206 ohms.

It is interesting to note that the laws governing resistances in series and parallel are the reverse of those governing the capacity of condensers in series and parallel, as described in the previous article.

High Frequency Resistance.

When dealing with wires carrying alternating current of wireless frequencies the calculation of resistance becomes too complex to be found with accuracy. This is brought about by the fact that a high frequency current flowing through a wire does not distribute itself uniformly over the whole cross section of the wire. In the case of direct current, the current density in any part of the cross-section of the wire is the same, but an alternating current has its maximum density at the outside layer of the conductor, and decreases very rapidly in density towards the centre of the conductor. Nearly the whole of the high frequency current, therefore, flows on the outside skin of the conductor ; hence, this is termed the "skin effect." As the frequency of the current is increased, the depth to which the current will penetrate becomes less and less. The effective cross section of the conductor, therefore, becomes less, and the resistance rapidly increases.

In the absence of definite formulæ for determining the high frequency resistance of all coils of wire, several methods have been devised by which the high frequency resistance of a coil can be measured experimentally. Results obtained from these experiments show that the resistance of a solid wire to high frequency current is greater than that of stranded wire of the same cross section. In order to minimise losses from high frequency, it is therefore preferable to wind inductance coils with stranded wire.

The high frequency resistance of a coil of several layers of wire is higher than that of a single layer, since the current not only tends to confine itself to the outer skin of the wires, but also crowds toward those wires on the inside of the coil. When designing a coil for a given value of inductance, it is therefore better to increase the length and avoid too many layers of wire. For certain frequencies the resistance of the coil will increase all out of proportion to the inductance if multi-layer coils are employed.

Where stranded wires are used in winding the coil, the "crowding" of the high frequency current can be minimised by twisting the individual conductors forming the stranded wire. In this way each strand of the wire occupies, in turn, the lowest position, and an even distribution of the current throughout the composite wire is enforced.

The CONSTRUCTION *of* AMATEUR WIRELESS APPARATUS

THE CONSTRUCTION OF TELEPHONES

MANY readers who have followed these articles have made up the receiving sets described therein, but have come to a full stop on the subject of telephones. Some have apparently procured second-hand telephones, while others are more ambitious and wish to make their own. In order to assist the latter, we will describe the constructional work required to make either high or low resistance types, and this will also help those readers who have second-hand ones. From enquiries made it seems that it is only minor troubles that are causing worry.

The essential parts of a telephone receiver are the outer case, electro-magnet, field coils, diaphragm, and ebonite cap.

The Outer Case should be made out of brass tubing 2" inside diameter, having $\frac{3}{32}$" walls, $\frac{3}{4}$" deep One end of the tube must be closed up by fitting an accurately turned brass plate just inside the tube, finally soldering it into position. This plate we shall term the base. Upon this base will be mounted the magnet, terminals and fitting for the headgear. The other end of the tube must be threaded in order to take the ebonite cap; about 5 threads will be enough, chased at 25 to the inch. (*See* Fig. 1).

The Magnet.—The most suitable type of magnets are as shown in Fig. 2. These are to be cut out of steel. The hole at the top will be required to fix the magnet to base, the two lower holes for securing the pole-pieces

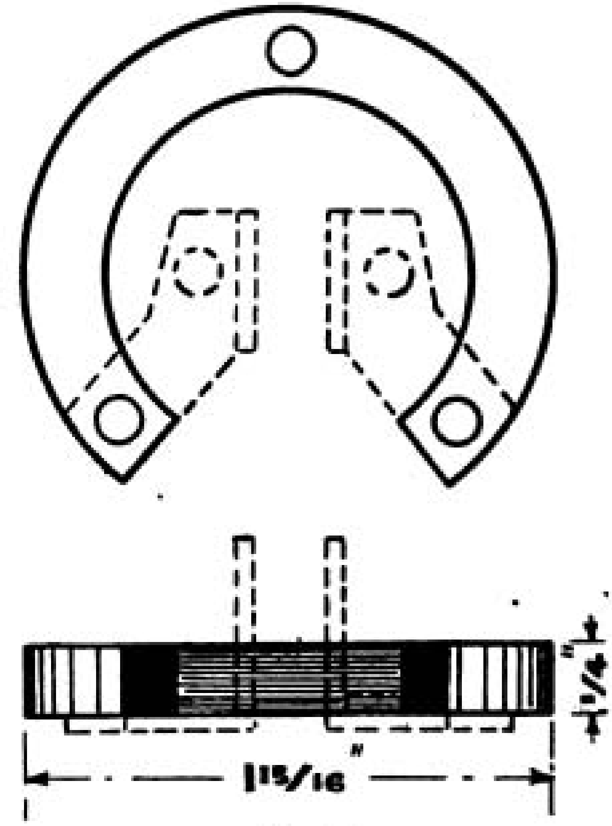


Fig. 2.

to the magnet poles. These holes must be drilled before hardening the steel. The latter process must be carried out to the degree of glass hardness. Magnetising must be done after hardening, and is best carried out by the local electrician. It can, however, be done at home, providing a good source of current is available. Wind 40 or 50 turns of No. 16 copper wire round each end of the magnet so that about one third of the magnet in the middle is left uncovered; wind the wire uni-directionally as though winding on a straight bar. If a current of, say, 20 amperes is passed through the wire several times, tapping the steel during the process, the steel should be permanently magnetised.

Pole-pieces.—*See* Fig. 3. These are made of

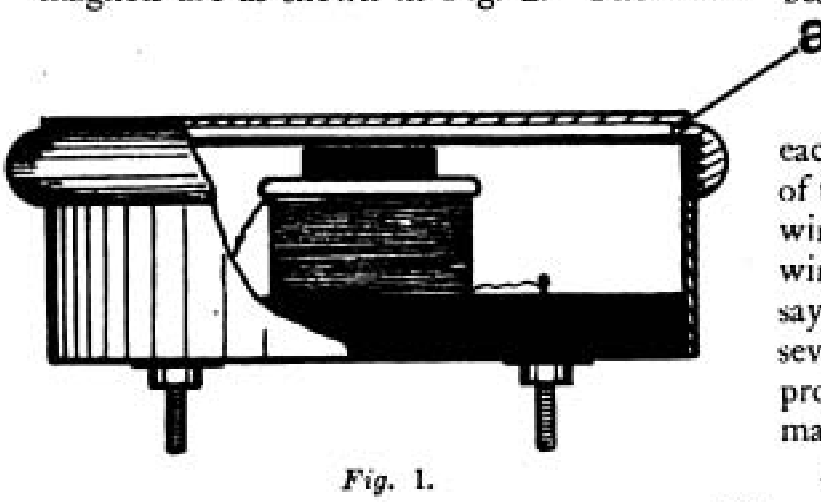


Fig. 1.

soft iron. In order to utilise the very limited space in the outer case we must mount the field coils in the centre ; therefore, pole-pieces shaped as in sketch must be used. The thickness need only be $\frac{3}{32}$" and, if bent at right angles at the dotted line, the section A will be in position, when mounted, to take the coil. Two pole-pieces will be required. C and D are holes required to fix the pole-piece to the outer case and magnet respectively.

Field Coils.—Two coils are required, and will be about $\frac{3}{4}$" long and $\frac{7}{16}$" wide. The core must be just large enough to slip over the pole-pieces. To make the bobbin, wrap a few turns of stiff paper, treated with shellac varnish, round the pole-piece. When dry

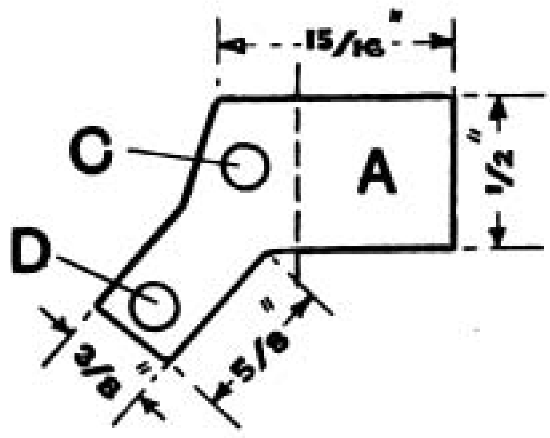


Fig. 3.

slip it off and shellac it on to two flanges cut out of thin ebonite or fibre. The flanges should also have a centre slot to enable the coil to slip over the pole-pieces.

In the case of high resistance headpieces the bobbins must be fully wound with No. 50 S.W.S.

When finished the coils should each have a resistance of about 2,000 ohms., making a total of 8,000 ohms. per pair of telephones.

Low resistance telephones are wound full with No. 38 or No. 40 wire : the resistance of the coils will be about 50 ohms. When winding coils with the fine wire it is a good practice to solder a heavier gauge wire to the fine wire, winding a few of the heavier turns on the coil to start with ; this enables the strain of handling to be taken by the thicker wire. Finish the coil off in the same way. Whilst winding, use a galvanometer and dry battery frequently to detect breakage of wire. This precaution may save a lot of time and trouble.

The Diaphragm is made of thin sheet iron, circular in shape, and may be cut from an ordinary Ferrotype plate. Diaphragms are usually treated with varnish, or are tinned, to prevent rust. The thickness should not exceed 0·01". The diameter must be such that the diaphragm rests on the edge of the outer case and must be perfectly flat. *See* Fig. 1.

Ebonite Cap.—The exact shape of this cap may be left to the individual taste of the amateur ; two important points, however, must be noted. The thread cut on the inside must correspond and screw easily on to the thread on the outer case. The ledge shown clearly at A in Fig 1 must be left when turning the inside of the cap, the use of which is to clamp the diaphragm down to the edge of the outer case : this ledge should only be about $\frac{1}{16}$" wide.

Adjustment.—When assembling, connect the two coils in series, and adjust the height of the pole-pieces so that the diaphragm is only a small fraction of an inch clear of them. Tests can be carried out by connecting a dry cell in series with the headpieces and a crystal. If the telephones are operating, a click will be heard every time the circuit is made or broken.

Small terminals can be fitted, either on the base or in the side of the case at the opening where the magnet is cut away. These terminals must be bushed with ebonite or fibre The fixing of bands to hold the telephones on the head I will not deal with : some prefer two light steel bands, others thin leather straps ; but in either case the matter is easily tackled.

BOOK REVIEWS

RADIO INSTRUMENTS AND MEASUREMENTS.

Being a Reprint of Circular No. 74 of the Bureau of Standards, Department of Commerce, Washington, D.C. New York : The Wireless Press Inc., pp. 330, fully illustrated.

THIS excellent text-book in assuming that its readers are more or less familiar with the elementary theory and practice of wireless telegraphy, gives a list of publications, suitable as an introduction to the theory expounded within its pages, to serve as a guide to those students whose knowledge of the subject may not be within the required standard. This list tends to make the study of wireless more definite in its curriculum, and also serves the engineer as an excellent and handy reference.

A large proportion of the publication is devoted to the treatment of underlying principles, for the reasons that however much the methods and technique of radio measurement may change the same principles continue to apply, and that this present circular will serve better as an introduction to other circulars on radio subjects which may appear in the future.

Familiar as we are with amateurs and experimenters in wireless telegraphy, it is felt by us that there is a need of better understanding of electrical measurements, and when such a book as that under review comes to our notice, still more does the need present itself.

The importance of the three-electrode tube, both as a generator and a detector, is dealt with on page 200, in a manner which brings home to the reader the necessity of familiarising himself with this instrument to the very fullest degree. The theory of the valve is given in simple detail with a marked absence of technicalities. Its uses as a detector of damped oscillations, as a regenerative amplifier, and as a generator, are given with simple diagrams, in consistency with the simplicity of the rest of the publication. How the electron tube may be used as a generator for measurement purposes is also explained in language which every student may follow with ease.

The calculation of capacity and inductance often serves to dishearten the amateur to such an extent that he is inclined to leave the subject of mathematics to his more professional brothers ; yet, after all, the fault is no other than the light in which the subject is often presented. All too often does the amateur rely solely upon experiment for the adjustment of capacities and inductances to be used in his amateur station, yet with a little understanding of formulæ many hours of monotonous experiment could be eliminated. Again, the fact of calculating measurements undoubtedly warrants a better efficiency from the same instruments, in that one knows precisely what one is handling. In this book of Radio Instruments and Measurements the subject of calculation is presented in a manner which will be clear to all : few steps are left out in the examples, and those that are will be obvious.

An attempt is made, not to present all the formulæ available for the purpose of Inductance calculation, but rather to introduce to the student the minimum number required for accuracy and clear understanding.

Such a book as this, if placed in the libraries of the various clubs, would not only be appreciated by every member, but would more often than not be missing from its allotted shelf, thus proclaiming its popularity.

WINTER STUDY.

We shall be pleased to assist any of our readers who wish it, by outlining courses of study in wireless and allied subjects, by recommending books or by obtaining any of the books reviewed in this magazine

QUESTIONS AND ANSWERS

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

BEGINNER (Preston) *asks* (1) *For address of Secretary, or Headquarters, of Preston Wireless Society.* (2) *How are aerials in aircraft earthed.* (3) *Do we think that wireless telegraphy will, in course of time, be entirely superseded by telephony.*

(1) We have no information regarding the Preston Wireless Society. Does it exist ?

(2) As a rule the aerial is earthed to the frame of the machine which forms a balancing capacity. The arrangement is somewhat similar to that of the original Hertzian oscillator.

(3) Hardly ; line telephony has not seriously affected line telegraphy. The two systems have rather different fields of utility.

W.J. (Southampton) *asks* (1) *For criticism of crystal set.* (2) *If two crystal detectors in parallel improve the set.*

(1) Set has two faults. There is no provision for tuning the aerial circuit, and potentiometer is wrongly connected. Capacity of tuning condenser may not be suitable. Consult recent reply to **AERIAL (Golder's Green)**, August 7th, 1920.

(2) Connecting crystals in parallel does not, as a rule, improve results.

J.L.W. (London, S.W.) *asks* (1) *For a suitable circuit to receive U.S.A., with valve or crystal, the valve being for long distances and crystal for short distances and for spark.* (2) *What is the longest earth lead permissible for good results, and would 24′ be too long, as this is the shortest obtainable without using water pipes.* (3) *In constructing a set as described in " Wireless World," can he use enamelled wire instead of* D.S.C. (4) *Will* 2,000 *ohms. (double) telephones need a transformer.*

(1) See Fig. 2, page 249, June 26th issue. You can easily arrange a suitable switch to cut out valves and substitute crystal if required, if you have sufficient knowledge to build a set of this type. A valve receiver will receive spark O.K.

(2) Depends too much on local conditions for us to say. You should get fair results with 24′, but less, of course, is desirable.

(3) Yes, but be very careful not to damage insulation in winding.

(4) No.

D.C.N. (Eastbourne) *asks* (1) *How to utilise a valve in conjunction with a type* 31 *crystal receiver.* (2) *If a coupling transformer is necessary, what type is required.*

(1) You might either (*a*) remove crystal and apply grid and filament across the billi condenser, using valve as rectifier, or (*b*) put one winding of a transformer across the telephone terminals and the other across grid and filament, using valve as L.F. amplifier.

(2) In the event of using (*b*), transformer should be about 4,000/10,000 ohms., step up to the valve and wound with about No. 46 wire.

VALVITE (Peru) *refers to an abstract of a paper by G. Leithauser in the issue of October,* 1919, *and asks several questions regarding the circuit on page* 387, *Fig.* 3, *as to values of condensers, resistances, etc.*

The circuit you refer to is of an unusual type, and we have not experimented with it. We regret therefore that we are unable to give you the information you require. You might be able to get it from the author's original paper.

G.T. (York) *asks* (1) *If a certain circuit would be suitable for spark and* C.W. *and telephony reception, using a coupler as in an enclosed illustration:* (2) *What resistance telephones would be required when inserted directly in the* H.T. *circuit.* (3) *Would better results with* 100′ *single wire aerial,* 35′ *of which would be down-lead, or with* 70′ *of double wire* 6′ *apart,* 35′ *of which would be down-lead.* (4) *What stations or wavelengths would he be likely to pick up.*

(1) Circuit is all right, but coupler shown is unsuitable for the purpose, as the secondary coil has too much inductance for a reaction coil. Moreover, except for big wavelengths, there is no need for so many adjustments.

(2) Preferably not less than 4,000 ohms.

(3) Little difference ; single wire probably somewhat the better.

(4) Any up to about 2,500 ms.

BEGINNER (Essex) *encloses a diagram of a circuit (Fig.* 1) *to be used with a* P.M.G. *aerial, and asks*

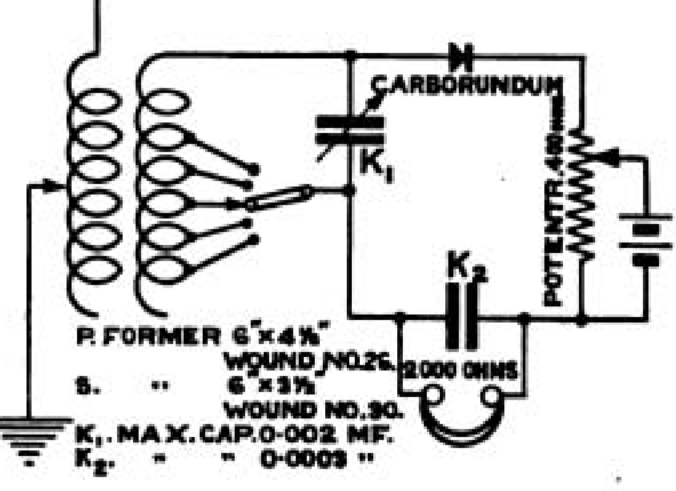


Fig. 1.

(1) For general criticisms. (2) What range of wavelengths could he receive. (3) What distance could he receive from. (4) If he must obtain a licence to have apparatus in his possession.

(1) You should interchange condensers K_1 and K_2. K_1 is more suitable for a blocking condenser (full capacity), and even then your secondary will tune to a longer wavelength than your aerial.

(2) Up to about 2,000 ms. maximum. Another two inches of winding on your primary should increase your wavelength to about 2,500 ms.

(3) We cannot say; it depends entirely on power of transmitting set. You should receive Paris.

(4) Yes. Apply to Secretary, G.P.O.

W.A. (Huntley) *encloses sketch (Fig. 2) and particulars of circuit, and asks (1) For idea of range (minimum and maximum) on full-size aerial. (2) If windings are unsuitable, what are suitable values to tune up to 6,000 ms. (3) If amplifier, as shown in diagram, would be suitable for attaching to telephone transformer terminals. (4) Will the arrangement of amplifier cause any interference due to valve. (5) Would it be suitable for applying to any crystal set.*

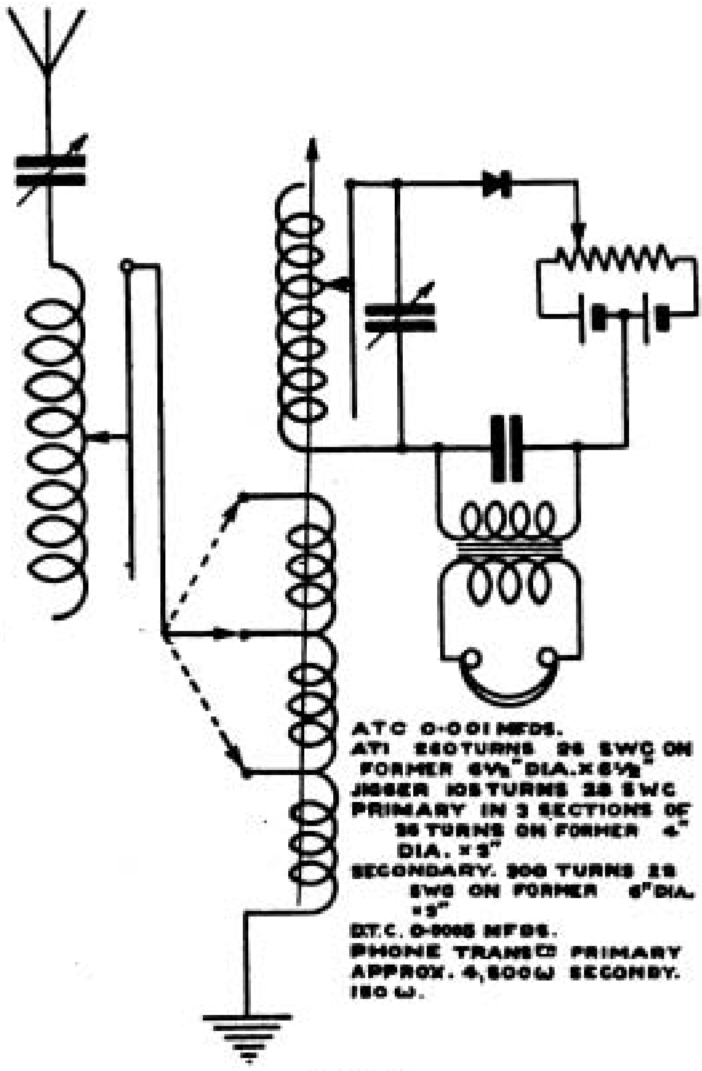


Fig. 2.

(1) Maximum wavelength about 2,800 ms.; minimum uncertain.

(2) Wind A.T.I. to 20″ with same wire and secondary to 10″ with 32 S.W.G. on same diameter formers. It would be advisable to wind both these coils in sections, with some dead-end switching arrangement to get the lower wavelengths with certainty. See *Wireless World*, August 7th, p. 367.

(3) Windings of transformer unsuitable. Should be about 5,000 ohms. in plate circuit and 11,000 ohms. in grid circuit.

(4) Probably not.

(5) Yes, when correctly wound.

(*N.B.*—The rule is *four* questions only).

S.J.R.B. (Ringwood) *asks (1) With reference to Fig. 16, p. 703, Vol. 7 of the "Wireless World," and correction to this subsequently published, how does rectification take place, in view of the fact the grids of the amplifying valves are more negative than that of the rectifying valve. (2) Where he can obtain a P.O. relay, as mentioned in p. 100, Vol. 8. (3) If the relay for W/T, 50 ohms. resistance, marketed by Messrs. ———, is suitable for inclusion in a valve relay circuit of the type referred to in (2), if used with a telephone transformer.*

(1) The method of rectification is the cumulative method. (See Bangay's *Elementary Principles*, p. 119, *et seq*).

(2) Sullivan, Elliott, I.R.G.P. Company, and many other firms.

(3) No. You cannot employ a telephone transformer for this purpose, as it only transforms the A.C. component of the plate current, whereas it is the D.C. component which works the relay.

F.R. (Conisborough) *asks (1) Whether he can construct a two-valve amplifier to work from same H.T. and L.T. battery without altering the "Mediwaver" at all. (2) If so, could we give diagram for same.*

(1) This can probably be done.

(2) We are afraid we cannot do this satisfactorily without a working drawing of the Mediwaver, to which we have not access.

BEGINNER (Launceston) *asks (1) How to make a tuning coil and how to connect it up. (2) If using three Grove cells, 1″ coil, spark gap and tree aerial 20′ high, he could transmit 10 miles.*

(1) Get a copy of *Wireless World* for December last. In it you will find instructions for making a simple receiver, including the construction of the tuning coil.

(2) The apparatus you mention would probably do the distance, but a tree aerial would be very undesirable for transmission.

DOT DASH DOT (Bexley) *asks (1) For information as to construction of telephone transformer, or if previously published where he could get "Wireless World" of that date. (2) If it is possible to introduce valve as amplifier in circuit of ordinary loose coupler.*

(1) *Wireless World*, March, 1920, Vol. 7, No. 84, obtainable from the Wireless Press, 12-13, Henrietta Street, W.C.2.

(2) Not without some modifications of the circuit arrangement; *cf.* diagram on page 650, April 17th issue, which shows a simple amplifier adapted for C.W. as well as spark reception.

W.R.J. (Nunhead) *asks (1) For criticism of enclosed diagram. (2) For respective values of A.T.I. primary and secondary of loose coupler and condenser. (3) Maximum wavelength which could be received. (4) If battery in crystal circuit is suitable (flash lamp battery).*

(1) Receiver is all right, with exception of aerial circuit. You have shown coupler primary and part of A.T.I. shorted. We take it this is a slip. Coupler secondary or condenser, or both, should be considerably increased.

(2) 6,000 mhys., 1,400 mhys., 1,900 mhys., and 0·0001 mfds.

(3) About 700 ms.

(4) Yes.

E.T.M. (Wimbledon Park) (1) *Wishes to make a C.W. and spark receiver with range 600 to 20,000 ms., and asks for data for design.* (2) *Asks what is the effect of joining lengths of wire on aerial, as shown (Fig. 3). Does it increase wavelength.*

(1) We are afraid the design of such a receiver is outside the scope of these columns. (2) Extension would probably increase wavelength slightly, but would probably also reduce the radiation efficiency. We do not recommend it.

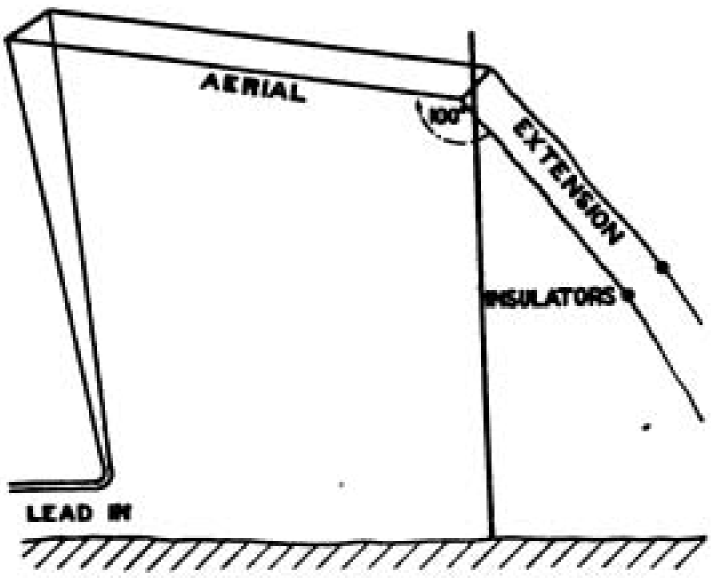


Fig. 3.

H.C.F. (Wolverhampton) *asks* (1) *Whether receiver described in Constructional Articles (one valve, H.F. reactance amplifier) would work equally well with a V24 or similar valve, and if any alterations would be necessary.* (2) *Having regard to the low anode potential, whether a telephone transformer and L.R. telephones would still be desirable.* (3) *Whether good signals could be expected, using above apparatus, and a single-wire aerial 20′ high, 70′ long, somewhat screened on one side by buildings.*

(1) Probably; some variation of size of reaction coil might be found necessary.

(2) *Cf.* other recent replies on this point; under these circumstances there is little to choose between L.R. and H.R.

(3) Yes.

L.O. (Chingford) *asks* (1) *If the design of a set (Fig. 4) is good. If not, why not.* (2) *What would be the values of* C_1, C_2 *and* C_3. (3) *What would the capacity of the aerial be.* (4) *Would he be expecting too much to get Madrid, Lisbon and Nauen at night and under good conditions.*

(1) Yes, quite good, except that variable condenser of tinfoil and paper will be unsatisfactory. C_3 can very well be fixed in value, also interchange the A.T.C. C_1 and tuned circuit condenser (C_2).

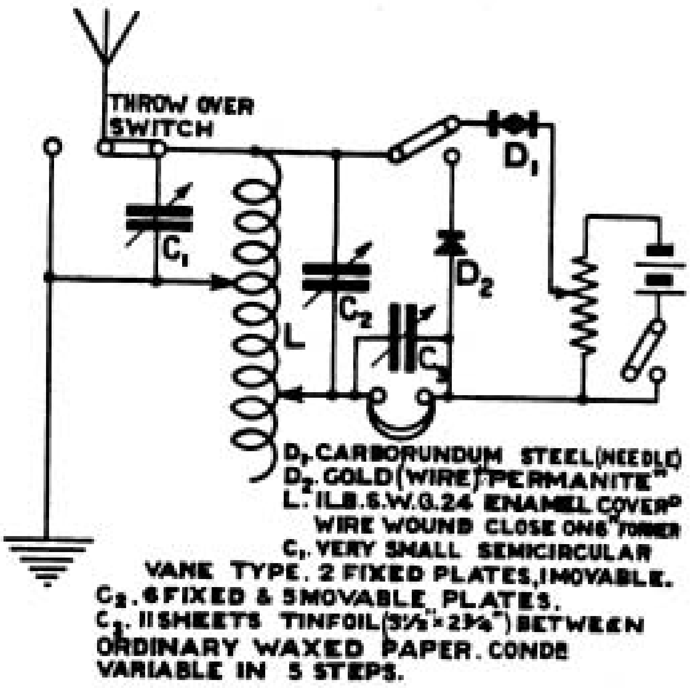


Fig. 4.

(2) $C_1 = 0{\cdot}00095$ mfds. $C_2 = 0{\cdot}005$ mfds. $C_3 =$ perhaps about 0·007 mfds.

(3) Approx. = 0·0002 mfds.

(4) No; you should succeed with these stations at times, under good conditions, except perhaps Lisbon.

AMPLIFIER (Manchester) *asks* (1) *How to use two audio frequency transformers with valves for a L.F. amplifier for addition to a receiver.* (2) *What is function of grid leak or condenser.* (3) *If we consider a circuit as sketched satisfactory.*

(1) On page 406 you will find sketch of a 3-valve L.F. amplifier. You can modify this by omitting one valve and transformer.

(2) See Bangay's "Oscillation Valve," page 119, *et seq.*, and also recent replies in these columns.

(3) Fairly, provided the dimensions of the parts are suitable.

MENO (Plymouth) *asks* (1) *If it is probable I should have permission to instal a wireless telephone capable of sending and receiving messages a distance of 250 miles.* (2) *Approximate cost and simplest type of installation. If an installation for receiving only is likely to be given, would you kindly substitute particulars of same.*

(1) Apply to Secretary, G.P.O., for license; permission to transmit over such a wide range is hardly likely to be given at present.

(2) It is difficult to estimate the least cost for which a set of this type could be built. We should suggest somewhere about £100. If you propose to go in for the subject on this scale you had better get Goldsmiths' "Radio Telephony," or Coursey's "Telephony without Wires," or preferably both. For prices of receivers see our advertisement pages.

NAMTON (Edinburgh) *sends diagram for criticism (Fig. 5). He asks* (1) *If it will receive C.W. and spark.* (2) *Wavelength range, with or without Condenser A.* (3) *Details of Marconi telephone transformer.* (4) *Suitable valve for telephone condenser.* (5) *Minimum H.T. necessary for V24 valve.*

(1) Set is quite good, on the whole. Reaction coil is too small; about 1,000 mhys. Condenser across transformer should be across H.T. battery as well. Set will then receive spark and C.W. (2)

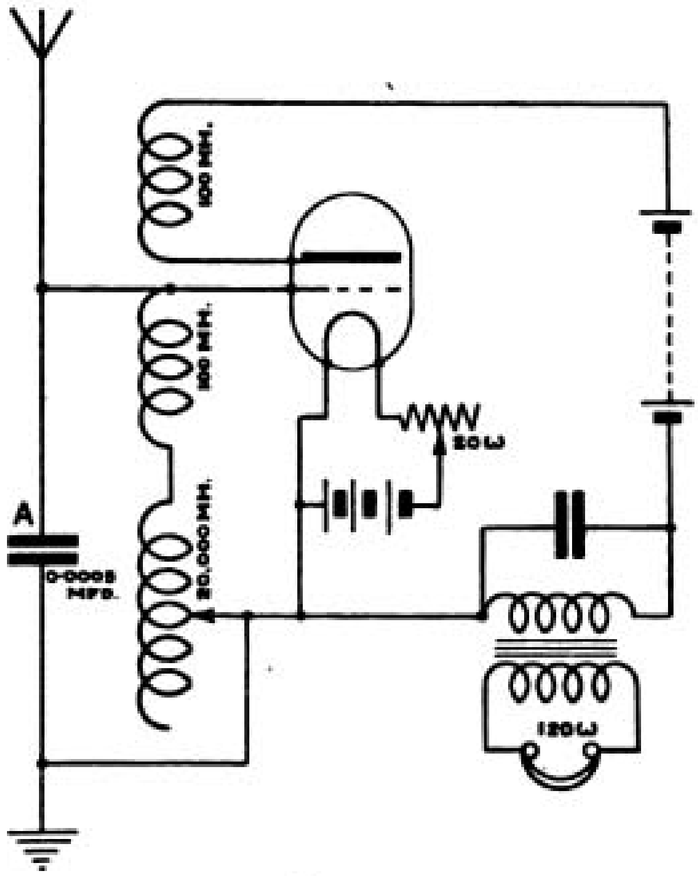


Fig. 5.

4,000 ms. without condenser, and 5,000–5,500 with it.

(3) See page 699, March issue.

(4) In this case, not less than 0·001 mfds.

(5) Under exactly right conditions 4 to 6 volts will do; but you had better allow about 20 volts.

(*N.B.*—Only *four* questions, please.)

E.K.S. (Malton) *asks* (1) *What is the best form of reaction coil* R, *page* 283, *Fig.* 4, *November issue.* (2) *If a variometer would do, and, if so, what would be suitable diameter and gauge of wire and number of turns for same.*

(1) and (2) The most convenient form is a spherical bobbin, such as is used in a variometer. In the latter, of course, the coils on the fixed and moving formers are connected together; here they should be separate, as in the figure. A bobbin 4″ diameter, wound with a single layer of No. 26 D.W.S., should give you enough reaction for your purpose.

H.D. (Willesden) *has a frame aerial and asks* (1) *What would be the best set using two high frequency amplifiers and one detector, to receive* 600 *to* 4,000 *ms.* (2) *Would an iron bedstead near the aerial and instruments affect them.* (3) *Is it necessary to alter the current in the filaments of the amplifier to obtain a good signal while tuning.*

(1) You will probably find resistance amplification as convenient for the H.F. as any other. You could make a good set by modifying the two figures on page 53, April 17th issue, to suit your smaller number of valves.

(2) Probably not seriously but keep as far away from it as possible.

(3) Variation of filament current is often a useful way of adjusting sensitivity, but it is better not to do so while tuning the receiver.

NOVICE (Woburn) *sends a diagram of a circuit and asks* (1) *What size loose coupler to make to get best results.* (2) *Weight and gauge of enamelled wire*

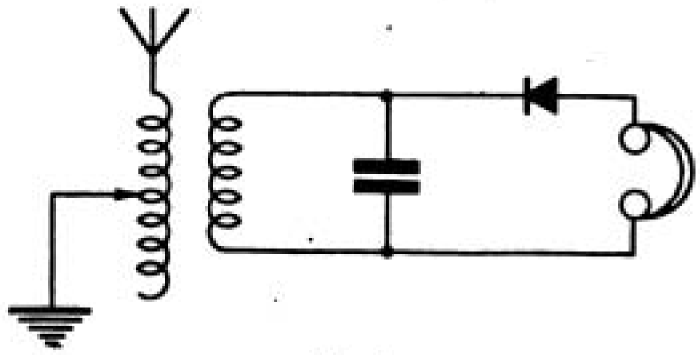


Fig. 6.

for primary and secondary. (3) *If connections of diagram all right.*

For various loose couplers, consult other recent replies.

(1) and (2) We strongly recommend you to start by making a set in accordance with the description in the issue of December, 1919; if you are successful you can easily adapt it for use with a secondary circuit.

(3) Your diagram is wrong; the condenser is shown in series with the crystal and telephones are shunted across the crystal. Connections should be as shown in Fig. 6.

C.H.P.N. (Southend-on-Sea) *refers to Mr. Read's article in the December issue, page* 530. *He asks* (1) *What, exactly, does Mr. Read mean by saying* C3 *is a special condenser.* (2) *What would be the capacity of* C2. (3) *Would an ordinary loose-coupled jigger as per enclosed sketch be suitable.* (4) *What is the name of the station to which Sheerness* (BYK) *sends figure code and weather forecast every evening at* 8.30.

See other replies on this receiver.

(1) Probably special in that it is introduced in an unusual part of the circuit.

(2) Try about 0·00005 mfds.

(3) Yes, this should be quite satisfactory.

(4) Since BYK is a naval station its working is confidential.

W.E.O. (Calcutta) *asks* (1) *Can a three-electrode valve be used on a Type* 31 *Marconi crystal receiver? and, if so* (2) *What connections should be made for best results.* (3) *Can same be fitted with a multiple tuner.*

(1) This can be done.

(2) See reply to **F.J.B.** for one method.

(3) Presumably you mean can a valve be fitted to a multiple tuner; if so, probably yes, but it is not a convenient type of receiver to adapt in this way.

N.B.—The standing orders of the Marconi Company prohibit Marconi operators from altering their standard installations.

RECEIVER (Sutton) *sends description of set (Fig. 7) for criticism. He also asks (2) For resistance of telephones wound with 4 drachms of No. 44 wire, and (3) What will be resistance if wound with same weight of No. 47.*

(1) Set is fairly good but would be improved by connecting as shown. Photographic film is not a good dielectric even for a telephone condenser.

(2) Depends on make of wire; about 400 ohms.

(3) About 2,500 ohms.

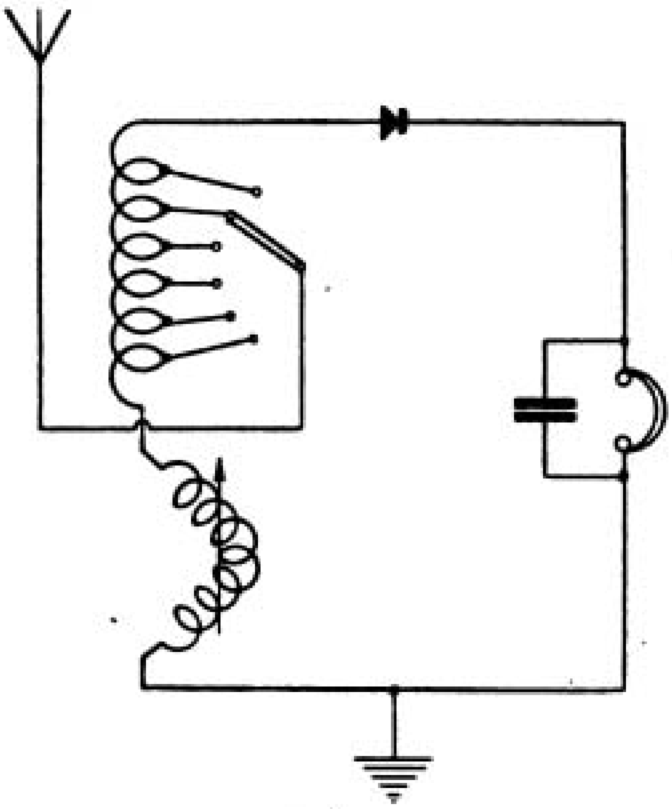


Fig. 7.

NEMO (Watford) *has a licence to transmit on C.W. with power not exceeding 10 watts and asks how to calculate this power and what is meant by it.*

A safe estimate would be the power absorbed by the transmitter, viz., the current in amperes through the valve filament × the volts across them, plus the current in the plate circuit also in amperes × the volts across plate and filament. Owing to the inefficiency of the transmitter this estimate is very unfavourable to the amateur, as the actual power radiated would be very much less than this. It would, therefore, be advisable to get a ruling from the P.M.G. as to how he proposes to define the power of a set. The measurement of power radiated is beyond the powers of the average amateur's instruments.

A.B. (Tooting) *sends particulars of tuning coils and asks for advice re certain modifications, and (2) Whether a 30-volt accumulator battery could be used for* H.T.

(1) We are afraid we cannot give you much help as you do not give us any information as to what your set is like or what modifications in wavelength range you wish to make. Coils 18″ by 3″ and 18″ by 4″, one right inside the other should not be used as a coupler, as they would have too tight coupling. An A.T.I. might possibly be built in this way if you wished to get maximum wavelength for given amount of wire.

(2) An accumulator battery can quite well be used for H.T.

F.J.B. (Enfield) *sends diagram of a crystal circuit (Fig. 8), using a valve as "reactance" magnifier, and asks whether such a circuit will give good results.*

There are many ways of doing this. Your suggestion is quite a good one, but why not connect plate to arm of wave-change switch instead of end of secondary as shown. A condenser across the H.T. battery may improve results.

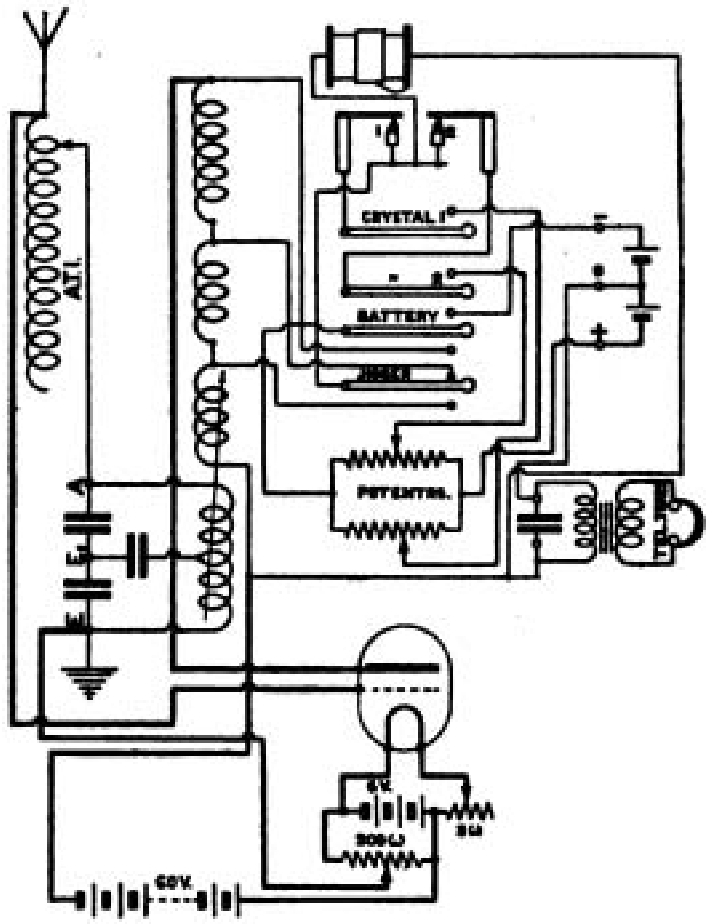


Fig. 8.

C.A.B. (Slough) *asks (1) If bare overhead drawn copper wire, size 14* SWG, *would be suitable for an aerial. (2) Length of wire required to cover the following formers with one layer of enamelled copper wire, leaving half-an-inch each end of each former (a) Former 12″ × 4½″ dia. with No. 30 wire*

(b)	,,	12″ × 3½″	,, ,, ,,	36 ,,
(c)	,,	12″ × 6½″	,, ,, ,,	28 ,,

(3) Can you tell me a better combination of crystals than zincite and bornite for working without a battery (4) What would be his maximum wavelength using a certain specified arrangement.

(1) Yes, certainly.

(2) *(a)* 1,050′. *(b)* 1,350′. *(c)* 1,300′.

(3) This will do as well as most others.

(4) Maximum would be about 6,000 ms.

V.P.M. (Dover) *asks how to instal a second valve for amplification in the circuit as per an enclosed sketch.*

See Fig. 9. This circuit, while not ideal, appears a simple modification which should give good results.

A.W.H. (Watford) *has a pair of ordinary telephone receivers and wants to know what wire to wind them with in order to use them for a valve set.*

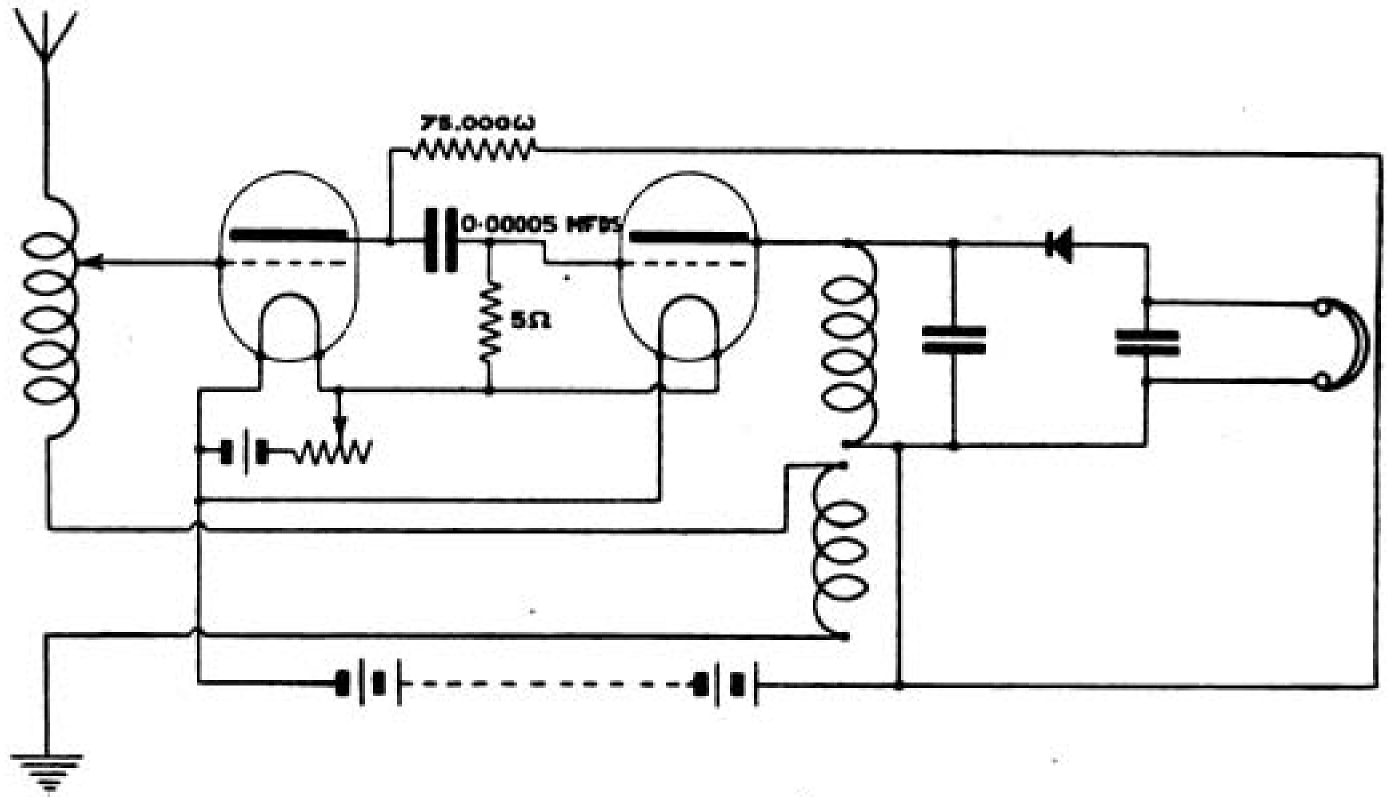


Fig. 9.

For use without a transformer they should be wound with about No. 47 or 50 silk covered wire.

W.H. (Bolton) *asks* (1) *If a former* 10″ × 2″ *wound with No.* 22 *S.C.C. wire would be suitable for the inductance.* ((2) *What capacity of tuning condenser do we recommend.* (3) *What capacity of telephone condenser do we recommend.* (4) *What resistance telephones to use for a simple crystal circuit.* (5) *Would* 18 *gauge copper be suitable for aerial.*

(1) Diameter too small for useful work; 10″ × 6″ would be O.K.

(2) Tuning condenser maximum about 0·0005 mfds.

(3) Try 0·001 mfds.

(4) 4,000 ohms.

(5) 16 or 14 would be better. *Four* queries please.

J.W. (Stepney) *asks* (1) *If it is possible to obtain a certificate on the American wireless system in the British Isles, and, if so, would the American Government recognise it, and also where is it taught.* (2) *How can he connect up certain apparatus so as to receive the highest possible waves.*

(1) Apply to Secretary, G.P.O., London, for definite ruling. The P.M.G. will examine on any well-established system, but we do not think the American Government would recognise a foreign certificate. We do not think any American used system other than Marconi's is taught in this country.

(2) Connect as in Fig. 10; use an 8″ × 5″ coil for secondary. 5,000 ms. will be about the maximum. There is really too much A.T.I. Use a condenser in the tuned circuit.

A.B. (London) *says, referring to the diagram of a high frequency amplifier at the top of page 53. Vol. 8* (1) *The out terminals are connected across the plate and the negative side of the filament battery.* (2) *Would it not be better to connect the grid leaks to the negative side of the filament instead of the positive as shewn.* (3) *In what position were*

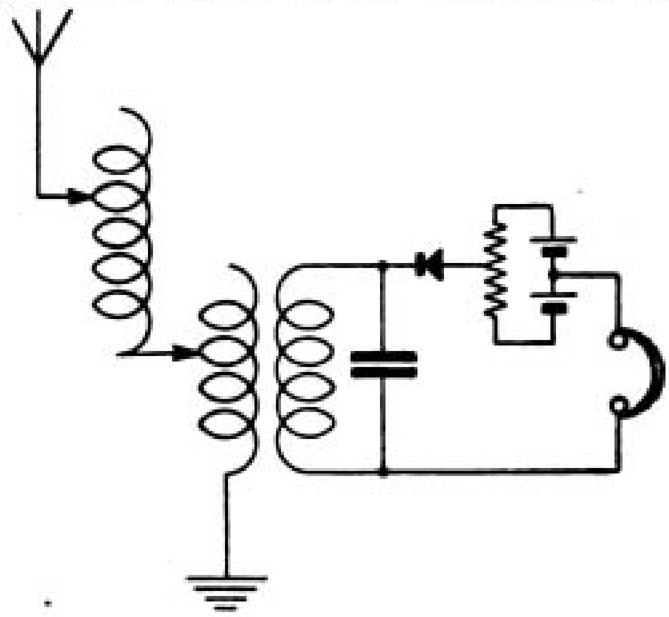


Fig. 10.

the potentiometers connected. (4) *If the connections shewn are wrong would it be asking too much for you to reproduce it correctly.*

(1) We think diagram is probably wrong. An arrangement of the last valve as in Fig. 8 is much more likely to give results.

(2) It is not important which, with this type of amplifier.

(3) Apparently none were used. They are not necessary with this type of amplifier.

(4) As our reference to Fig. 8 covers the only alteration to be made there is no necessity for us to redraw the circuit.

A.I. (Cockermouth) *contemplates erecting a receiver in a cabin 23 yards from his house, and asks* (1) *How he can avoid taking earth wire back to the house to get to the water pipe.* (2) *If a frame aerial would be suitable for a crystal circuit. Or whether an aerial erected between the cabin and the house would be better.* (3) *How he can attain compactness in his set as the coils usually used are rather large.*

(1) Bury a metal plate of as large an area as possible. Results should then be superior to a water-pipe earth, which is only an expedient recommended when a direct earth is impossible.

(2) A frame aerial is useless for crystal work. Make the outside aerial as large as possible.

(3) Compactness is often obtained by limiting the wavelength range and also by using undesirably thin wire. The only satisfactory way in which space can be economised by an amateur is by using pancake coils instead of coils on cylindrical formers. For information about pancake coils see a recent issue.

C.H.L. (South Croydon) *asks if it is possible by any means to use a frame aerial with a crystal set.*

No, quite impossible, as a simple crystal receiver is not sensitive enough for the purpose.

A.W.C. (Highgate) *encloses description of a crystal set which he has made and asks for advice as to any improvements which could be made.*

We recommend shortening the earth lead if possible; if not possible, run thicker wire to it, or several wires in parallel. Also bury a plate of greater area than the pipe. We should prefer a sliding variation of the coupling. We do not like type of condenser you suggest as it appears liable to shorting from the plates buckling.

G.C. (Newburn-on-Tyne) *sends some details of his set, and asks if we can tell him its approximate wavelength.*

We are afraid we cannot say what wavelength as you do not give diameter of formers. It may be between one and three thousand metres. Crystal-phone part of circuit should be tapped off the inductance only, not the condenser as well.

C.G.G. (Rugby) *asks* (1) *What is the maximum value of capacity that may be connected across the* A.T.I. *in order to obtain* 5,000 *metres on a* P.M.G. *aerial without seriously affecting the efficiency;* (*a*) *on single circuit crystal set;* (*b*) *on a two-valve* HF *amplifier.* (2) *He proposes to wind an* A.T.I. *of certain design and asks for criticism of it; and also for formulae for self-inductance and self-capacity of that type of coil, or, if not, for estimated* L *and* C. (3) *With the* P.M.G. *aerial what is the maximum permissible steady current resistance of the* A.T.I. *for efficient reception.* (4) *If any telephone has been designed actuated by the expansion of a fine wire by the heating effect of the received signal. If so, is it more or less sensitive than the magnetic type. Also, if designed and sensitive, please give sketch of arrangement.*

(1) For 5,000 ms. we suggest limit is about 1000, mhys. and 0·007 mfds. with a loose coupler, the same for both (*a*) and (*b*).

(2) This might be fairly efficient. We do not know any formula. We estimate inductance at about 25,000 to 30,000 mhys.

(3) It is difficult to give figures, so much depending on ideas of efficiency; keep as low as possible, say a maximum of 10 ohms.

(4) Yes, various types have been designed but they are very insensitive, not easy to make, and very liable to burn out, as exceedingly fine wire has to be used for the purpose.

T.L.S. (Golder's Green) (1) *Sends sketch of a receiver for a general criticism, asks* (2) *For approximate range of set.* (3) *If the mica condenser shown is suitable for the set.* (4) *If an earth lead 16′ in length is too long.*

(1) Receiver is a single circuit crystal type; the method of connections shown is quite useless, almost every item of apparatus being in the wrong place. Consult diagrams in recent numbers.

(2) We cannot say.

(3) Again, as you do not state the capacity, we cannot say.

(4) The shorter the earth lead the better the result, but 16′ is not unduly long.

W.S.F.B. (London, W.8) *asks* (1) *Would a circuit shown be satisfactory for ordinary wavelengths.* (2) *Is a satisfactory earth connection obtained by connecting to a radiator forming part of a central heating system.* (3) *Is ordinary bell flex sufficiently insulated for connecting up the instruments.*

(1) Type of circuit is OK, but we cannot say much about wavelength ranges possible, as you do not give dimensions of coupler.

(2) This will be all right if, as is probable, the system is in electrical connection with the main water supply system.

(3) Yes, if of good quality. We should prefer to separate the two wires from each other and connect up with all wires a short distance apart.

CARBORUNDUM (Chapel-en-le-Frith) *cannot, owing to the objections of his landlord, erect an aerial, and proposes to use a frame. He asks* (1) *If a circuit shown is suitable. If not, for a suitable one.* (2) *The size of the condenser across* H.T. *batteries, and winding of the inductance marked* A. *If the sizes given for the components are suitable.* (3) *If an enclosed sample of wire is suitable for the secondary winding of a telephone transformer, as described on p.* 440-444 *of our November,* 1919, *issue.* (4) *If the use of a frame aerial entails any danger from lightning, and should it be earthed.*

(1) Not as shown—we have corrected it (see Fig. 11). Your suggested reaction coil position is wrong. Set will not be very sensitive. We should recommend adding a L.F. amplifier, many of which you will find sketched in recent numbers.

(2) Condenser anything greater than about 0·002 mfds.; 14 cms. × 20 cms. of No 30 for

inductance. The sizes seem all right as far as we can tell.

(3) Yes; wire is No. 44.

(4) The danger should be infinitesimal; however there is no harm in earthing the set.

J.S.S. (Liverpool) *asks if a certain method of connecting a valve to a Type 31 crystal receiver will be all right. (2) Referring to diagram Fig. 1, page 65, of "Wireless World" for April 17th, asks if the resistance marked 250 ohms is absolutely necessary with 30 volts* H.T., *if so, would an enclosed sample of resistance wire be suitable and what length would be required. (3) Is there any other simple way of connecting a valve to a 31a crystal receiver without interfering with its construction.*

(1) Connections are not right. Either put plate to the under side of crystal, and filament to *inner* tube of billi; or the plate to top of crystal and filament to *moving* tube of billi. Increase of plate volts to 30 will very likely improve results.

(2) Resistance of potentiometer does not depend on plate volts. Any value that will not run down your filament battery too quickly will do. The wire you send (No. 34) is about right. Use about 80′.

(3) See other recent replies on this matter.

H.V.W. (Putney) *is constructing a crystal set and asks (1) Size of formers; quantity and gauge of wire for loose coupler; range of wavelengths, 500 ms. to 5,000 ms. Would enamelled wire be efficient. (2) If a variable air condenser of 0·0002 mfds. would be sufficient to tune secondary circuit of coupler. (3) Would variable condensers built up of small fixed condensers of different capacities be moderately efficient for tuning circuits in receivers where air condensers would otherwise be used. (4) Is an aerial as per an enclosed sketch likely to prove efficient.*

(1) Primary 12″ × 6″, No. 26 SWG. Secondary 7″ × 4″, No. 30.

(2) Yes.

(3) Fairly efficient but not convenient in use.

(4) O.K., but not allowed by P.M.G.

R.C. (Christchurch) *sends a description of apparatus which does not work satisfactorily, and asks (1) For comments. (2) For the best single valve for C.W. and telephone reception.*

(1) Arrangement of set is O.K. A.T.C. dielectric is shellaced tape; this is probably a very poor dielectric. Capacity of tuned circuit condenser is too small. Except for this we do not see why you do not get good results. Is your telephone condenser O.K.?

(2) All hard valves are about equal. A V24 or similar type is handy, in that it needs few volts.

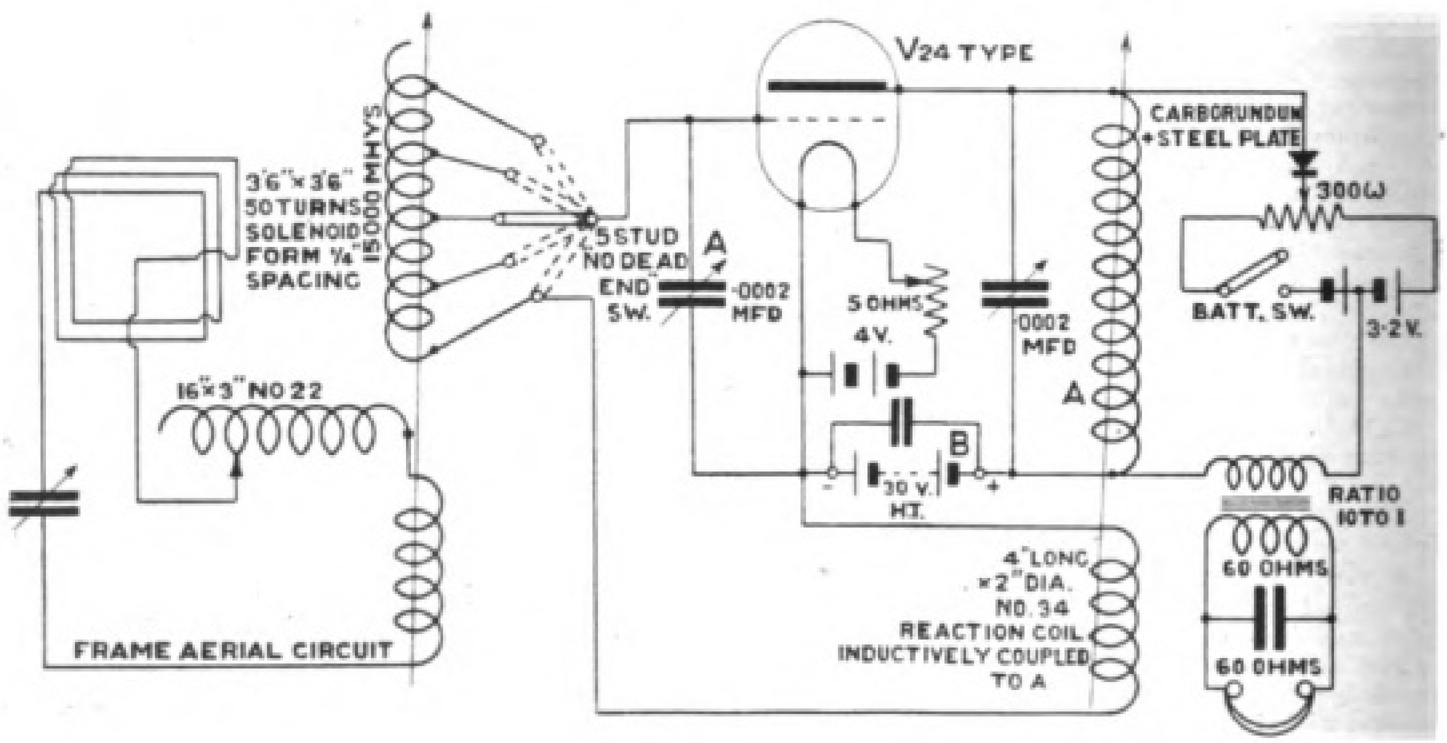


Fig. 11.

SHARE MARKET REPORT.

Since we last went to press business has continued very quiet in the Share Market.

Prices as we go to press (September 25th), are:—

Marconi	Ordinary	2¾
,,	Preference	2½
,,	Inter. Marine	1½
,,	Canadian	10s. 6d.

The WIRELESS WORLD

VOL. VIII. No. 15, NEW SERIES] OCTOBER 16th, 1920. [FORTNIGHTLY

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THE WIRELESS WORLD

THE OFFICIAL ORGAN OF THE WIRELESS SOCIETY OF LONDON

VOL. VIII. No. 15. OCTOBER 16TH, 1920 FORTNIGHTLY

MULTI-LAYER WINDINGS FOR RADIO RECEIVING

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

(*Continued from page* 476.)

A FURTHER advantage may be gained by spacing the turns apart as well as spacing the layers, but this, of course, while reducing the self-capacity of the coil would once more increase its size unless more than two layers are employed. This construction, however, becomes a much more practicable one if several layers are employed with adequate spacing between them and between the successive wire turns on each layer—Fig. 6.

In an arrangement of this kind the most economical conditions will be obtained when the thickness of the spacing between the layers is about the same as the spacing between the turns on each layer. The adjacent turns in the same and in the next layer will then be approximately at the corners of a square, as is indicated roughly in Fig. 6, and also in Fig. 7 (a), at W, X, Y, Z. If the turns on successive layers are staggered, as in Fig. 7 (b), the diagonal spacings WX, and ZY, will be some 12 per cent. greater than the corresponding spacings in Fig. 7 (a), using the same spacing *d* between the layers. Then by increasing the turn spacing WZ and XY in the same ratio, the effective capacity of the coil may be reduced by about the same amount without increasing its size in a radial direction.

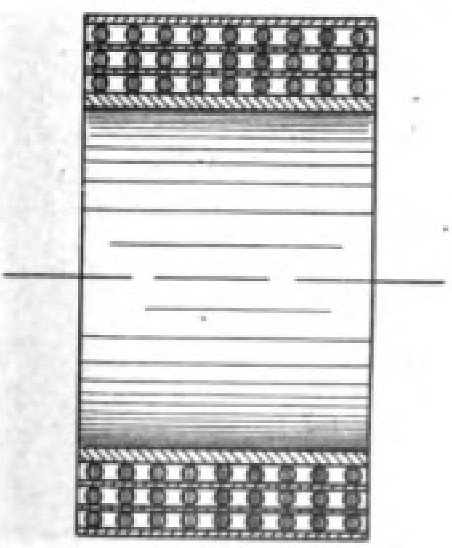


Fig. 6.

The material used to separate the layers should have a low dielectric capacity or the advantages of the increased spacing will in part be lost. A porous material is good in this respect—such as a soft paper or blotting paper—but, of course, dampness must also be rigidly excluded. A thread or string may conveniently be wound between the successive turns of each layer to provide the necessary uniform spacing in hand wound coils. The string should be as nearly as possible the same size as the insulated wire.

The design of these coils to have any given inductance is a much more difficult matter than in the case of single layer coils, and very frequently a method largely consisting of trial and error must be adopted. The calculation of the inductance of a given coil is somewhat simpler, but even then the results are not strictly accurate unless very complicated formulæ are used. In general, however, values may be obtained which are sufficiently good for most practical purposes, using curves which are fairly easy of manipulation. The curves published by the writer in the *Proceedings of the Physical Society of London*,* and reprinted in this magazine,† provide a fairly simple means of working out the approximate inductance of coils of this class, taking account of the diameter, the length and the depth of the winding on the coil. If the turns and layers of the winding are not spaced apart at too great a distance the results given by these curves will be sufficiently accurate for most purposes, but when the spacing is very large a further correction would be required. This correction is not, however, often wanted in practice, and actual measurements on coils of this type have indicated that these curves give very reliable results for all ordinary cases.

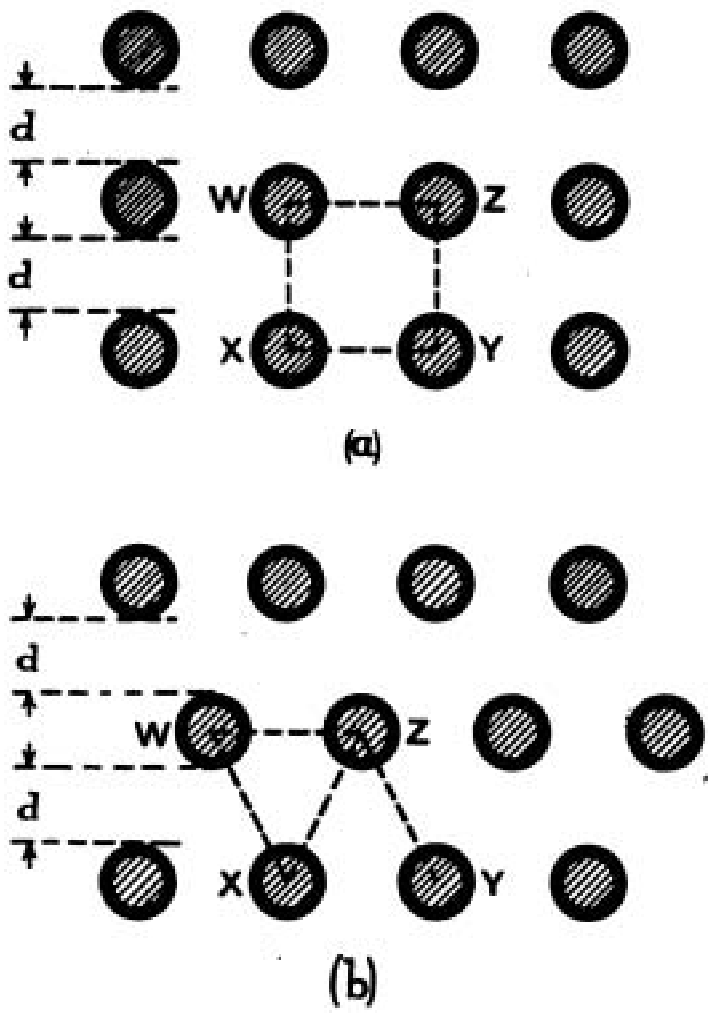


Fig. 7.
Cross Sections of Windings.

As an example of the saving of space which may be effected by using this type of coil, the following figures may be quoted for a winding to have an inductance of much the same value as the 8 ft. coil mentioned at the beginning of this article, and wound with the same gauge of wire, the spacing left between adjacent turns and between layers being equal to the diameter of the insulated wire—

Number of layers = 27.
Length of coil = 5·5 cms.
Mean diameter = 30 cms. (which is the same as that chosen for the 8 ft. coil above).
Diameter of former on which coil is wound = 24·6 cms.
Radial winding depth of coil = 5·4 cms.
Number of turns per layer = 27

The length of wire used on this coil would be less than a third of that required for the long single layer coil considered above, and therefore its ordinary d.c. resistance would be reduced in like proportion. This is evidently a great advantage, apart from the reduction in the bulk of the coil which is effected at the same time, and leads to a more efficient coil giving greater selectivity. The reduction in self-capacity also tends to further reduce the effective high frequency resistance of the coil.

Many variations of this idea can be worked out by the interested experimenter, but to do so to advantage requires the possession of some apparatus to easily measure the effective resistance of the coil when completed, as otherwise it is somewhat difficult to compare the relative merits of the various coils. One simple way of comparing the coils is, of course, to use them in an actual receiver to pick up signals from some distant wireless station and to compare the signal strengths obtained when using the different coils This method, although rather crude, will give results which

*Vol. 31, pp. 156-167, June 15th, 1919.
† *Wireless World*, 7, pp. 380-385, October, 1919.

are perhaps more easily intelligible without the use of complicated apparatus. The consideration of the methods which may be employed for comparing the effective resistances of different coils is rather beyond the scope of this article but may be referred to again at a later date.

In the type of coil considered above, it has been assumed either that successive layers will be wound on to suitable tube formers, which are then slipped inside one another, or that an insulating wrapping of the necessary thickness is wound on over each layer, but the former of these methods is obviously only practicable with spacing between layers of at least a $\frac{1}{4}$ to $\frac{3}{8}$ of an inch, if the coil is going to be mechanically rigid. It is possible, however, to avoid the use of these separate formers for each layer by building up the coil with one central former, and providing suitable insulating supports between the layers. One method of building up such a coil is indicated in Fig. 8, and in this case small pieces of ebonite or hard-wood rod are arranged between the layers to provide the necessary spacing. This may be taken merely as one method of carrying out such an arrangement, and others will doubtless suggest themselves to the reader. It should be noted that the coil built up in this way is really no longer circular but for calculation purposes an equivalent circle and mean diameter may very easily be seen by inspection. The curves referred to above for calculating the inductance may also be used for these coils, giving good results which check up well with measurements made at high frequencies.

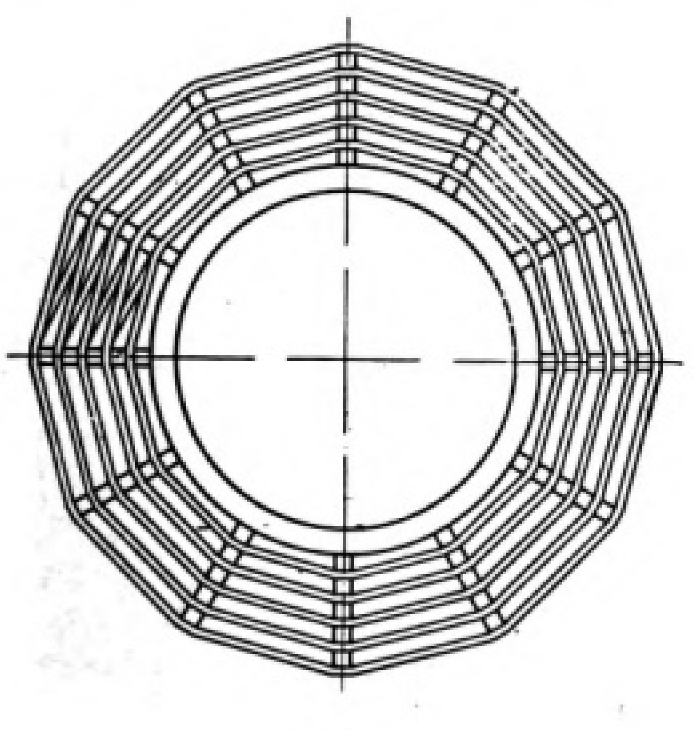


Fig. 8.

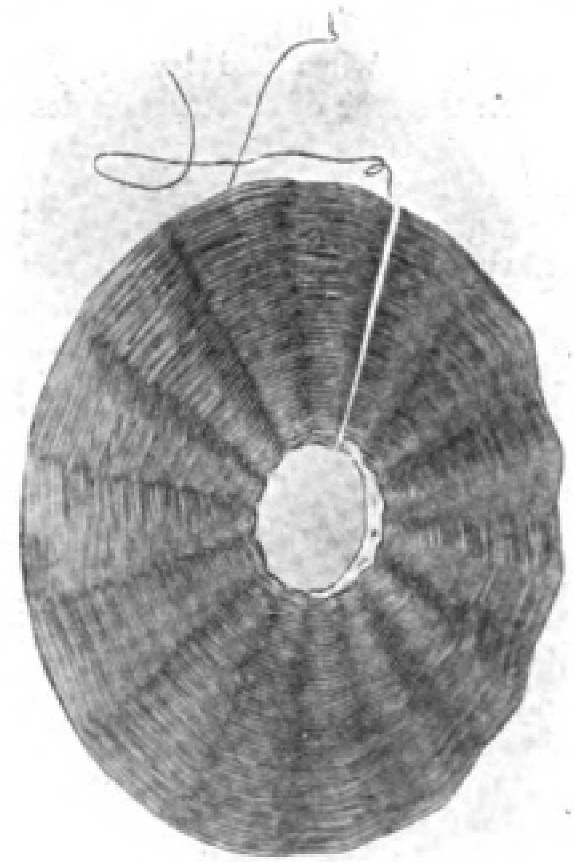


Fig. 9.

It is possible by this and similar modes of construction to build up coils in which the rise of resistance due to self-capacity is comparatively speaking small, and the coil is consequently efficient for use in a receiving circuit. Greater rigidity may be obtained with coils of this kind by immersing them in paraffin wax, which serves to make the wires and supports adhere to one another, but it is preferable to drain out as much of the wax as possible while in the fluid state, as otherwise the self-capacity may be increased if too much wax is present in the final coil.

It is not necessary, however, to retain the conventional shape of coil when using properly designed multilayer windings, that is to say, it is not essential that the length of the coil should be greater than or of the same order of magnitude as the diameter of the coil. When the length is much less than the diameter we arrive at what is more usually called a pancake type of coil, and in this connection some very efficient inductances may easily be constructed if suitable precautions are taken, bearing in mind the proper spacing of the wires and layers. In this connection the type of construction described on pp. 210-211 of the *Wireless World* (June 12th issue), and illustrated in Fig. 9, is quite a good one, but leads to rather bulky coils if very large inductances are required. A coil of greater inductance may, however, easily be obtained by connecting in series several pancake sections constructed in this way, and placing them close to one another. Preferably they should not actually touch but be spaced $\frac{1}{8}$th to a $\frac{1}{4}$ of an inch or more apart, so that the capacity between the pancakes is not unduly increased. The coils should, of course, be connected in series so that their effects add to one another, and the windings all go in the same direction in order to increase the inductance of the whole as much as possible.

A useful feature of this type of construction is the facility to vary the inductance of the whole by moving the separate sections to varying distances from each other. A still greater range is possible by turning round one or more of the sections in the series so that they oppose the remainder. A range of inductance variation from nearly zero up to a maximum where they are all assisting one another is thus possible. Similar remarks apply equally to other forms of flat coil, some of which are mentioned below.*

As a variation on this type of coil it is possible to build up a multilayer pancake coil with only a few turns per layer and each layer properly spaced. The spacing may be effected by small insulating rods as in the case of the coil illustrated in Fig. 8, or by any other suitable means. In extreme cases any special insulating spacing between the layers may be omitted, if the number of turns in each layer is small. In Fig. 10, the former F, of wood or card, is wound with ten layers of three turns each. No additional insulation between the layers is shown, although it would be preferable to insert a thin separator, such as a single layer of silk tape. A number of unit coils of this form may be piled together and connected in series to obtain large inductances for long-wave reception.

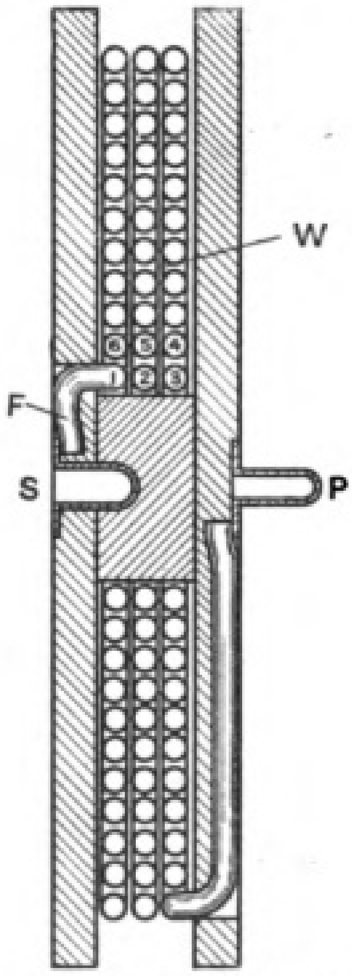


Fig. 10. Multi-layer Pancake Coil.

A very convenient construction for use with coils wound like Fig. 10, with rigid formers, consists in providing each unit with a contact socket and pin on opposite faces, as shown at S and P, Fig. 10, so th t by placing the coils together they are automatically connected in series to assist each other. A large range of inductance for tuning is then easily obtained with no waste wire or "dead-end" capacity to introduce trouble.

(To be continued.)

* A practical example of this method of inductance variation was described on pp. 444-445 of the *Wireless World* (September 18th, 1920.)

RECENT INVENTIONS IN WIRELESS TELEPHONY

We print below two articles descriptive of certain new inventions which have been applied to aircraft wireless telephone sets. Both the devices are due to, and are actually used by, Marconi's Wireless Telegraph Co., Ltd., in their latest portable and aircraft installations.

The Provision of Side-Tone and Intercommunication on Wireless Telephone Sets for Aircraft.

IN modern aeroplanes using high-powered engines it is absolutely essential that the user of a wireless telephone may be able to hear his own speech whilst talking to another station. In the noise that emanates from an aero engine it is absolutely impossible to hear oneself speak, and only those who have tried to speak to another person in an aeroplane can realise how quickly the throat tires when one is shouting at the top of one's voice in order to be heard.

Of course, this equally applies to the user of a wireless telephone. If the microphone is picked up and used without any provision of telephones in which the transmitted speech can be heard, the effect is just like talking to a brick wall and the strain on the vocal organs is immense. Also, it is totally unnecessary, since it is only necessary to speak normally into an aircraft wireless telephone to obtain excellent results, but automatically the operator shouts his loudest, tiring himself out and incidentally transmitting very bad speech.

On aircraft where sets employing note magnification receivers are used, the radiated signals are induced into the low frequency circuits and the speech heard quite distinctly in the telephones. Where, however, high frequency magnification is employed, nothing at all is heard owing to the "swamping" or "wiping out" effect of the radiated waves on the high frequency circuits of the receiver.

The method then employed to produce side-tone or *transmitted* speech in the operator's telephones is as follows :—

In series with the microphone transformer secondary, at the low potential end, is placed the secondary of the telephone transformer of the receiver and a connection made thence to the filament of the transmitter control valve. (*See* Fig. 1.)

It will be seen that on speaking into the microphone M speech current will flow in the transformer primary and be induced into the secondary HA.

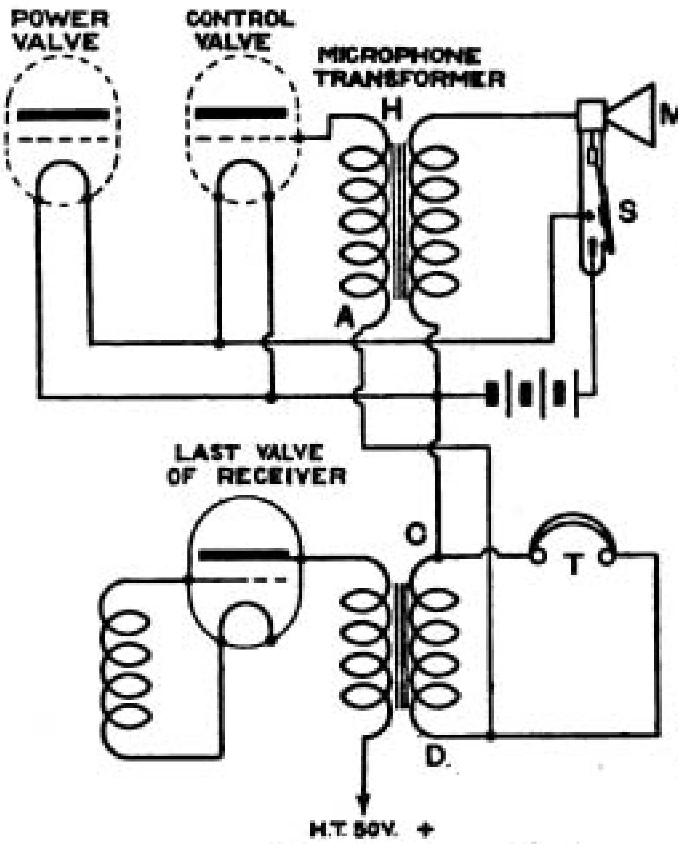


Fig. 1

As this winding is in series with the secondary of the telephone receiver transformer CD speech current will also be induced into this winding. The operator's telephones being shunted across this winding, the speech currents impressed on the grid of the control valve are heard. This gives an excellent idea of the quality of speech being transmitted and also the amount of engine noise being picked up by the microphone. With this arrangement there is, for all intents and purposes, no loss in radiated energy owing to the impedance of the telephone transformer CD and the telephones T in parallel being very low compared with that of the secondary of the microphone transformer HA.

There is also no loss in the strength of the received signals since H, being connected to the grid of the control valve of the transmitter (which is not in action while receiving), the circuit through the control valve is completely broken.

A Useful Addition to a Wireless Telephone Set.

THE little device about to be described serves a triple purpose : it affords the simplest means for an operator to "tune up" his transmitter, it provides him with artificial "signals" of a definite wavelength by which he can tune and test his receiver, and it enables him to hear, while transmitting, his own speech as it leaves the aerial, thus giving him the chance to modulate his voice and adjust his control to give the best results at the distant station.

The device comprises a compact little closed circuit combined with a carborundum crystal-holder, a tiny high-note buzzer and a single-pole, two-way switch. It thus forms what is practically a wavemeter circuit ; but instead of being a separate instrument it is mounted in the apparatus itself, (in a position such that the inductance of the closed circuit is suitably coupled with some part of the aerial circuit), and instead of using a separate pair of telephones, it is so connected that in transmitting, the rectified signals from the crystal pass direct through the working telephones of the set.

When the operator wishes to test and tune his receiver he switches the two-way switch to "buzzer," whereupon the buzzer (driven by the battery which lights the receiver valves), excites the closed circuit to the wavelength to which it is set, thus inducing signals in his aerial circuit and enabling him to tune up his receiver and to adjust his amplifier.

Then, on switching over to "working" position, the buzzer is shut off and the crystal circuit is placed across his telephones.

When the operator is listening to the distant station, his telephones are unaffected by the closed circuit, since the high resistance of the crystal practically insulates them from the circuit. When, however, he changes to "Transmit," signals are induced in the closed circuit from his aerial, are rectified by the crystal and pass through his telephones. They will be loudest when his transmitter is tuned to emit the wave at which the closed circuit is set, so that by adjusting the transmitter till his own speech sounds loudest, he can be sure that he is sending out the wavelength required, while at the same time he can keep a watch over the quality of his own speech as it leaves the aerial.

In sets which work on one fixed wavelength, both for transmitting and receiving, this device finds its simplest and most compact application, for here the closed circuit consists of a fixed condenser and a fixed inductance, adjusted once and for all to the exact wavelength required. In more complicated sets which work on various wavelengths the closed circuit must of course be variable in wavelength (either by a variable condenser, a variometer, or by tappings on its inductance) and must be calibrated.

NOTES AND NEWS

Temporary Warrant Telegraphists, granted temporary warrants during the war from permanent wireless telegraph operators, R.N.R., will be granted permission to retain their temporary warrant rank on demobilisation. According to the *Naval and Military Record*, they will continue to receive payment of the retaining fee of their rating as wireless telegraph operators, R.N.R., until the completion of their current period of enrolment, when they will cease to belong to the R.N.R. Should they desire to re-enrol, they will be required to revert to their previous rating as wireless telegraph operators, which would entail the surrender of their temporary warrant rank.

The Patent Office Library is now open to the public daily, except on Public Holidays, on and after the 1st instant. The hours of opening are from 10 a.m. to 9 p.m.

Sir Ernest Rutherford Cavendish, Professor of Experimental Physics, University of Cambridge, recently lectured before a representative audience in the Hall of Festivities, Copenhagen University, on "The Counting of Atoms"; he will later give lectures on "The Structure of Atoms" and "Isotropes and their Meaning."

Professor Einstein, who a short time ago declared that he intended leaving Berlin, has refused an offer from the University at Christiania and in so doing states that he proposes to remain in Germany.

International Communication Conference.—The U.S. State Department announces that representatives of Great Britain, France, Japan, Italy and the United States will gather at Washington during October to prepare the agenda for the forthcoming International Communications Conference, at which the whole field of electrical communication between nations, as well as the question of what will be done with the German cables, will be discussed. The United States will be represented at the meeting by Mr. A. S. Burleson, (P.M.G.), Admiral Benson, (Chairman of the United Shipping Board) and Mr. Walter Rogers, (Government Wireless Official).

Tungar Rectifier.—This apparatus, which consists of a valve, a transformer, a reactance and an enclosed case with the necessary connecting leads, is suitable for charging accumulators and for the direct operation of various low voltage D.C. appliances. Particulars of this apparatus may be obtained from The British Thomson Houston Co., Ltd.

The International Research Council.—A report of the proceedings of the first meeting of the International Research Council, held in Brussels in July, 1919, has been edited by the Secretary, Mr. Arthur Schuster, and published in London by Messrs. Harrison & Sons.

Elimination of Insulator Failures.—In a recent issue of *Electrical World* Mr. E. J. Kallevang describes methods of detecting faulty insulators, and notes the fact that insulators that have been stored several years are found to have deteriorated. This deterioration may be due to mechanical stresses or to the electrical test that has been applied at the works. It is observed that insulators near railway tracks break down readily. Methods of testing by the oscillator or by the megger are described.

Amateur Call Signs.—We have much pleasure in publishing the following call signs, together with the names to whom they have been allotted:—**2 F G**; Mr. H. L. McMichael, Hampstead. **2 A Z**; Mr. William Le Queux, Guildford. Hours of working, (C.W. and telephony), 3—4 p.m., 8—9 p.m. (G.M.T.). **2 D F**; Mr. H. Heather, Peckham. Hours of working, (10 watts, C.W. and telephony), 8—9 p.m., 10—11 p.m. (G.M.T.); wavelengths up to 180 metres, fixed wave of 1,000 metres. **2 G P**; Mr. W. Gaitland, Highbury, N. Hours of working, (Spark C.W., tonic train and telephony), 8.30—10.30 p.m. (G.M.T.). Mr. Burnett, Sheffield, has three call signs, details of which are as follows: **2 D G**; (10 watts, Spark and C.W.), wavelength, 180 metres. **2 D H** and **2 D I**; portable stations (Spark and C.W., each of 10 watts), to operate within a ten-mile radius of Parkwood Springs, Sheffield, on 180 metres wavelength. Hours of working, Mondays to Fridays, 7—8 p.m. (G.M.T.); on Saturdays, Sundays and Public Holidays hours of transmission are varied. **2 D T**; Barrow and District Wireless Association. **2 G V**; Halifax Wireless Club, (10 watts). Hours of working, 8—10 p.m. (G.M.T.), on 180 or 1,000 metres wavelength. **2 F Z**; Manchester Wireless Society. **2 G Z** and **2 H A**; fixed and portable stations respectively, belonging to Mr. A. L. Megson Bowdon; C.W. on 1,000 metres wavelength and spark on 180 metres wavelength. This information is gathered from replies received in response to our paragraph appearing under Wireless Club Reports in our last issue. We take this opportunity of thanking the above gentlemen and clubs for their assistance, and will be pleased to publish further information which amateurs may supply.

Badges for Wireless Amateurs.—It has been suggested to us that with the increasing number of wireless enthusiasts throughout the country, it might prove of interest if members were to wear some kind of badge, by which one amateur could recognise another. In train, tram, tube or other public conveyance, one badge wearer could open conversation with another. Their interests, so far as wireless is concerned, being so much in common, long journeys would be less fatiguing, whilst the short, hurried journeys of every day might also be advantageously effected. One would suggest a badge designed and submitted for approval, to the Wireless Society of London, subject to their caring to act as arbitrators in the matter, or the whole question could be decided at the conference which we hope will take place in the early part of next year.

King's Patent Agency, Ltd., have recently published another edition of their handbook, "Patents for Inventions, with information respecting Trade Marks and Designs," intended to serve as a guide to would-be patentees.

High-Power High-Speed Radio Station.—According to the *Electrician*, the Amalgamated Wireless Company of Australasia proposes to establish a high-power high-speed radio station near

Photo Press.

Prof. Belin transmitting pictures of the recent Olympic games, from Antwerp to Paris, by means of the process invented by him.

Sydney, Brisbane or Perth, in order to communicate direct with England. There is also to be a medium-power station in each of the other States, to pass traffic to and from the main trunk station. The company is said to have offered to handle all classes of messages at one-third of the present rates, to give the Commonwealth 25 per cent. of the profits and to undertake to have the stations working within two years.

New Wireless Services.—Two wireless connections have been set up by the French Administration of Posts and Telegraphs with, respectively, Hungary and Jugo Slavia.

Wireless Time Service.—A wireless time service from the standard mean time at Hector Observatory, Wellington, was inaugurated a few weeks ago. Hitherto, ships have been able to obtain such information only by request when off the New Zealand coast, but under the new system the time will be transmitted every Tuesday and Friday evening at 8.30 p.m.

Transatlantic Tests for Amateurs.—Since the publication of our note on this subject in the *Wireless World* of September 18th, some further information has reached us from New York relative to the project. It is proposed that the actual tests shall commence on February 1st next, while the intervening period will be occupied in preparing lists of the stations entering for the tests, and in definitely arranging the details of the transmission schedules. In order to facilitate the proper co-ordination of the receiving facilities in this country, it has been agreed with Mr. M. B. Sleeper, of *Everyday Engineering Magazine*, New York, the organiser of the contest, that all arrangements for reception shall be in the hands of Mr. Philip R. Coursey, B.Sc. It is therefore requested that all experimenters in this country who are interested in the project should indicate as soon as possible their willingness to take part, in order that programmes of transmission may be arranged that will be convenient to the workers in both countries. Particulars should be given of the type of receiving apparatus that can be employed.

It is hoped that all the affiliated wireless Clubs will co-operate in this scheme with a view to making it a success. Details of the transmission schedules will be published in these columns as soon as they have been arranged.

All communications in connection with these tests should therefore be addressed to Mr. Philip R. Coursey, *The Radio Review*, 12-13, Henrietta Street, London, W.C.2.

A HOME-MADE TUNING INDUCTANCE

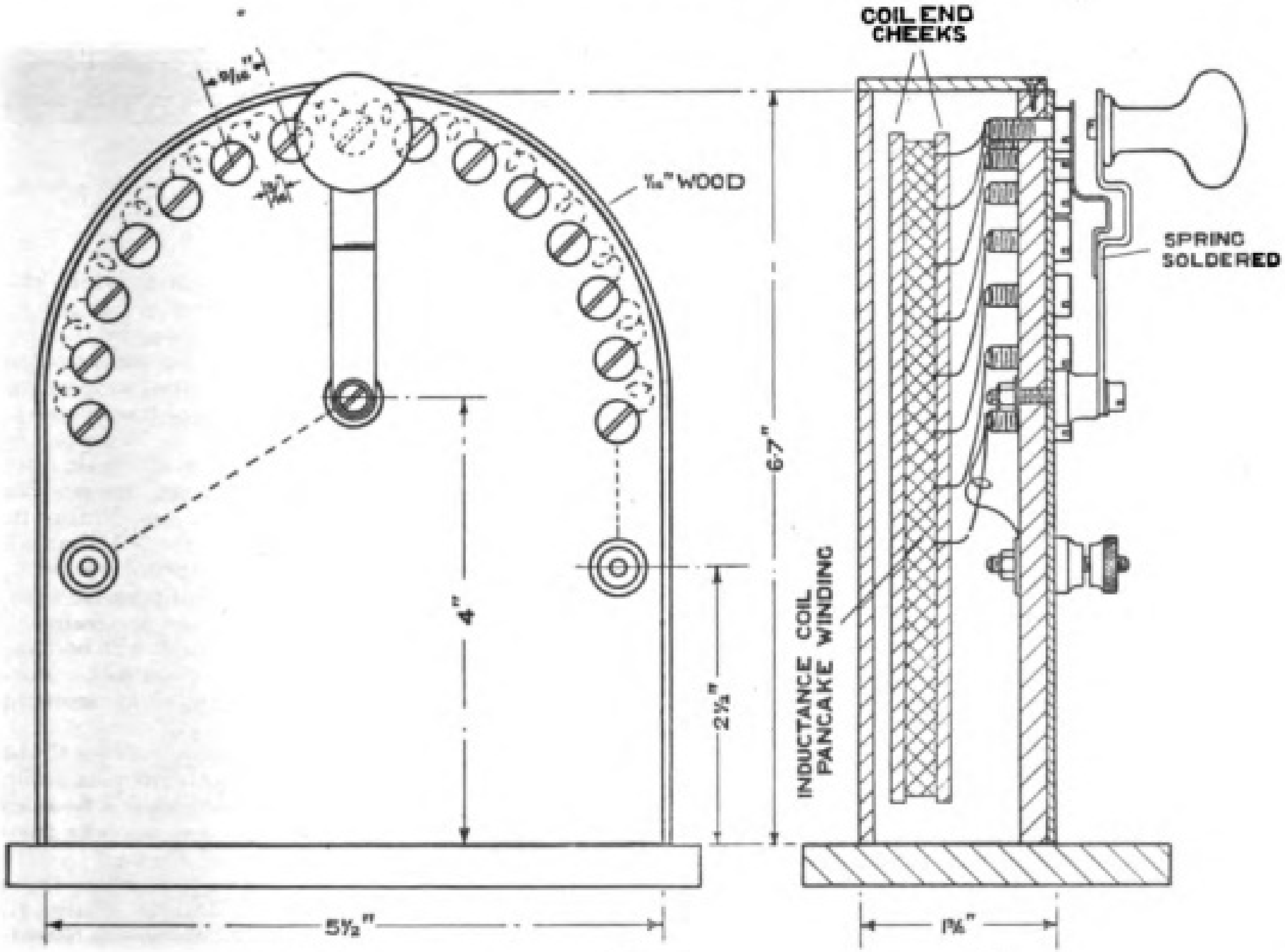
By F. Harding.

A VERY useful inductance may be made as outlined in the following article. The coil in question is intended to be mounted on a baseboard, together with the remainder of the set in the usual manner, not for cabinet use. It has been designed with a view to taking up a minimum amount of space, whilst remaining smart in appearance and thoroughly efficient in action. It is impervious to dust and damp, is inexpensive to construct and gives a good surface contact for the radial switch.

The actual coil used is of the pancake type, and may be of any diameter and winding to suit the needs of different experimenters.

In the instrument described the winding consists of 255 turns of No. 22 enamelled copper wire, wound between coil-end cheeks 5" diameter, with 15 equally-spaced tappings brought through one cheek, to 15 studs on the face of the coil. In its construction, the first thing to be taken in hand should be the front board for the rotary switch. This is of ¼" mahogany 5½" wide by 6½" high, as shown in the diagram (Fig. 1*a*). The top portion is cut semi-circular, as shown. A piece of $\frac{1}{16}$" ebonite sheet is cut to the same shape and size as the board, and the two together are drilled to receive 15, (or number required), cheese-headed brass bolts, ½" long ⅛" diameter, under head, ⅜" diameter across head. These should be friction-tight in the holes and if possible, should have back-nuts to tighten from behind the board.

In my own case I found difficulty in obtaining nuts small enough to eliminate fouling with one another and so "shorting"



(*a*) *Fig.* 1. (*b*)

the inductance. To remedy this, after placing the studs in position as tightly as possible, I poured thick shellac varnish into the holes and allowed it to set hard.

The studs need not be filed, provided all the slots are turned so as to follow the circumference of a circle; this also adds to the appearance and preserves the original lacquer.

To the underside of the bolts the tappings are firmly soldered, care being taken that none of the leads is allowed to touch another. The last lead, or end of the winding, should be taken to one terminal, the other terminal being directly connected to the screw which holds the switch-arm in position. These terminals should be screwed into place, a piece of wood ¾" thick 5½" wide, being secured across the back of the board to take the screws.

For the switch-arm, a piece of brass bar 3" long ⅜" wide ⅛" thick, drilled at both ends, is required.

In my case, I used a U-shaped support for a porcelain pulley on a counterweight electric light fitting, with arms 1½" long ½" apart, and drilled and countersunk ¼" holes in both arms. This I annealed and bent to the shape shown (Fig. 1*b*).

The handle, an ebonite tapping-key knob or the handle of a small rubber stamp, (preferably the former), should be screwed into position through one of the holes, as shown.

A small piece of springy brass is soldered to the underside of the switch arm and bent as required to make a smooth yet firm contact with the studs when the switch-arm is screwed into position, a small brass collar being interposed between the arm and the face, as shown.

It may be mentioned in passing that such a switch may be used for varying the inductance on an ordinary cylindrical former, and is extremely smooth in its action.

At this point the connections of the instrument should be tested with cell and galvanometer in the usual manner, and if all connections are satisfactory the work may be continued.

Attention should now be given to the back board, which, if the coil is not to be inductively coupled to another, may be of ¼" mahogany cut to the same size and shape as the front. If, however, the inductance is to be used as the primary of a loose coupler, or in conjunction with a reaction coil for regenerative circuits, the back board should consist of a piece of wood shaped like the front, but with an inner circle of the same size as the cheeks of the pancake coil, cut out to permit the coupling coil being brought as close as possible to the inductance winding.

A piece of mahogany 1¾" wide and 8½" long should now be planed to $\frac{1}{16}$" thickness (or less), which, after being carefully steamed to the curve of the back and front boards, should be firmly fastened in place with short brass screws. Care must be taken not to touch the switch studs with these screws, otherwise a "short" may follow.

The remaining portion of the sides may now be put into position, and a domed box should result.

Sandpaper, dry in a warm oven, (to remove any steam or water deposited on the wire or studs when bending the top portion), invert the whole box, fill with molten paraffin wax and after allowing the wax to set, fasten the box to a suitable baseboard. The result should be a waterproof, airproof and dust-proof coil, having firm connections and which when French polished and metal parts lacquered, will have a very smart and "professional" appearance.

AMATEUR CALL-SIGNS.

For the guidance of Amateurs, we are endeavouring to complete our list of Amateur Call-Signs. Any information which our readers may be able to supply will be much appreciated

WIRELESS CLUB REPORTS

Wireless Society of London.

The first meeting of the sessions was held at the Institution of Civil Engineers on Thursday, September 30th, the President, Mr. A. A. Campbell Swinton, in the chair. Mr. Child delivered a lecture upon "Some Personal Experiences in Connection with the Construction and Action of a 6-valve, High-frequency, Resistance Amplifier," a report of which will appear in the next issue. Hon. Secretary, Mr. L. McMichael, 32, Quex Road, Hampstead, N.

Glasgow and District Radio Club.

(Affiliated with the Wireless Society of London.)

The Glasgow and District Radio Club, under the patronage of Lord Weir, Sir Henry Jones, Professor A. Gray, Dr. S. Z. de Ferranti, and other distinguished gentlemen, held its opening night of the 1920-1921 session at the Club-room, 206, Bath Street, Glasgow, on Wednesday evening, September 22nd. There was a large assembling of members and friends, seating accommodation being taxed to the utmost.

The authority of the Postmaster-General was obtained for the erection of a special type of small aerial to permit of a demonstration of the latest kind of wireless receiving apparatus.

Mr. W. Scott Hay, one of the Club's members, exhibited and fully explained the construction and working of a neat 3-valve amplifier, and afterwards delighted the audience with loud signals from numerous British and Continental wireless stations. All the apparatus with the exception of valves and telephones, were made at home by Mr. Hay.

Mr. E. Snodgrass, another Club member, explained the construction of a receiver he had made at home. This compact little set is contained in a box measuring less than 10 inches square, and is capable of tuning-in wavelengths up to 15,000 metres.

A varied assortment of wireless gear, including some 1 and 3-valve amplifiers of a new design, were kindly loaned to the Club for this occasion by Messrs. W. A. C. Smith, 236, Argyle Street, Glasgow. Signals from all over Europe were loudly and clearly recorded on this apparatus.

Seven new members were enrolled, and a very interesting and successful winter session is anticipated.

The Hon. Secretary, Mr. Robert Carlisle, 40, Walton Street, Shawlands, Glasgow, will be glad to hear from all interested persons with a view to membership.

Woolwich Radio Society.

(Affiliated with the Wireless Society of London.)

It is with regret we announce the resignation of Mr. P. G. Atkinson as secretary of the above Society, owing to ill health. Mr. Atkinson, during his short term of office, has worked most vigorously to make the Society a success, and it is gratifying to know that his energies have not been in vain.

Mr. W. T. James has kindly volunteered to undertake the arduous duties of secretary and being an expert in direction-finding work some interesting lectures are anticipated.

Will amateurs kindly note that all future communications for the above Society should be addressed to—Mr. W. T. James, 32, Lee Street, Plumstead, S.E.18.

Plymouth Wireless Society.

(Affiliated with the Wireless Society of London.)

On September 24th Mr. W. J. Southard gave a paper on "Hints before and after obtaining the Postmaster-General's Certificate." It was a well thought out paper, giving valuable information to those about to sit for the examination.

Mr. S. V. Branton (Vice-President) gave a most interesting lecture on his experiences as a wireless operator in various parts of the world.—Hon. Secretary, Mr. H. P. Mitchell, Municipal Technical School, Tavistock Road, Plymouth.

Sussex Wireless Research Society.

(Affiliated with the Wireless Society of London.)

This Society, which was formed in May of this year, and which promises to have a very successful future, recommenced its activities on Thursday, September 30th.

Meetings were held every week up till July, Captain E. A. Hoghton, President, giving a series of excellent lectures on the evolution of the thermionic valve, which were plentifully illustrated by experiments.

The Society meets in the Laboratory of Cottesmore School, Brighton, by kind permission of the Principal, Major G. D. Brown, M.A., a member of the Committee. Here, has been installed a very fine collection of apparatus including the latest valve apparatus of British, French, American and German design. There is also a complete set of standard gear for all forms of standardisation, both A.C. and D.C.

Membership is confined to those who have attained the age of 21 years, and who have had at least two years' experience of wireless telegraphy or allied subjects. The entrance fee, is 10s. 6d., and annual subscription 10s. 6d. It is proposed that each member shall undertake some form of research work, in which he is particularly qualified, and that meetings be held at definite intervals to report progress and give or receive assistance.

The officers elected for the year are :—President : Capt. E. A. Hoghton, F.P.S.L. Committee : Major G. D. Brown, M.A.; Mr. J. Cowie, A.M.I.E.E., and Mr. E. Hughes, B.Sc. (Eng.)Lond., A.M.I.E.E. Hon. Secretary and Treasurer, Mr. J. E. Sheldrick, B.Sc.(Eng.), 35, Southdown Avenue, Brighton.

It is earnestly requested that all gentlemen in Sussex who wish to make a more detailed study of wireless than the average amateur, will get into communication with the Hon. Secretary, who will be pleased to give them any further information about the Society.

Liverpool Wireless Association.

(Affiliated with the Wireless Society of London.)

The first meeting of the Association at the new Club-room, The Royal Institution, Colquith Street, was held on Wednesday, September 22nd, when there was a large gathering of members and friends. A demonstration with a 3-valve receiving set and a frame aerial—arranged by Messrs. Grindon and Williams—was very successful, excellent signals being obtained. Mr. S. Lowery gave and explained data with regard to the winding and calculation of Inductances. A number of new members were elected.

Meetings of the Association are held the second and fourth Wednesdays in the month and all are welcomed.—Communications to the Hon. Secretary, Mr. S. Frith, 6, Cambridge Road, Gt. Crosby, Liverpool.

Brighton Radio Society.

(Affiliated with the Wireless Society of London.)

A meeting of this Society was held at "Grassmere," Dyke Road Drive, Brighton, on August 31st, the items of agenda being (1) the election of Mr. Magnus Volk, of Brighton, as President; (2) the fixture of an annual subscription and entrance fee.

The election of Mr. Magnus Volk was proposed by Mr. W. P. Rogers and seconded by the Secretary. The appointment will take effect as from September 1st, 1920. It was decided that an entrance fee of 5s. should be payable upon taking up membership, plus an annual subscription of 5s., payable any time within the first three months of membership. The Committee are at present endeavouring to secure suitable headquarters where it is proposed to shortly open a Morse Class for the benefit of members who may be desirous of improving their receiving abilities.

During the course of the month a visit was paid to the private installation owned by Mr. W. E. Dingle, of Brighton. This gentleman kindly demonstrated his set which proved most interesting, more so by reason of the fact that it was entirely constructed by the owner. It is at present working with one valve only, with which it is possible to pick up practically all stations within a range of 1,000 miles. Mr. Dingle also showed a compact little crystal set. The station as a whole is an excellent display of first-class workmanship throughout.—Communications *re*-membership should be addressed to the Hon. Secretary, Mr. D. F. Underwood, 68, Southdown Avenue, Brighton.

Burton-on-Trent Wireless Club.

(Affiliated with the Wireless Society of London.)

The Burton Wireless Club hope to resume winter operations early in November, when the second Annual General Meeting will be held at the Club headquarters at the offices of *The Burton Daily Mail.* Meetings have been suspended since April last. It is hoped to organise monthly lectures during the coming session.—Hon. Secretary, Mr. R. Rose, 214, Belvedere Road, Burton-on-Trent.

Liverpool Wireless Association at demonstration h[illegible] by them at Calderstone Park, Liverpool, on August [illegible]1st.

Derby Wireless Club.

(Affiliated with the Wireless Society of London.)

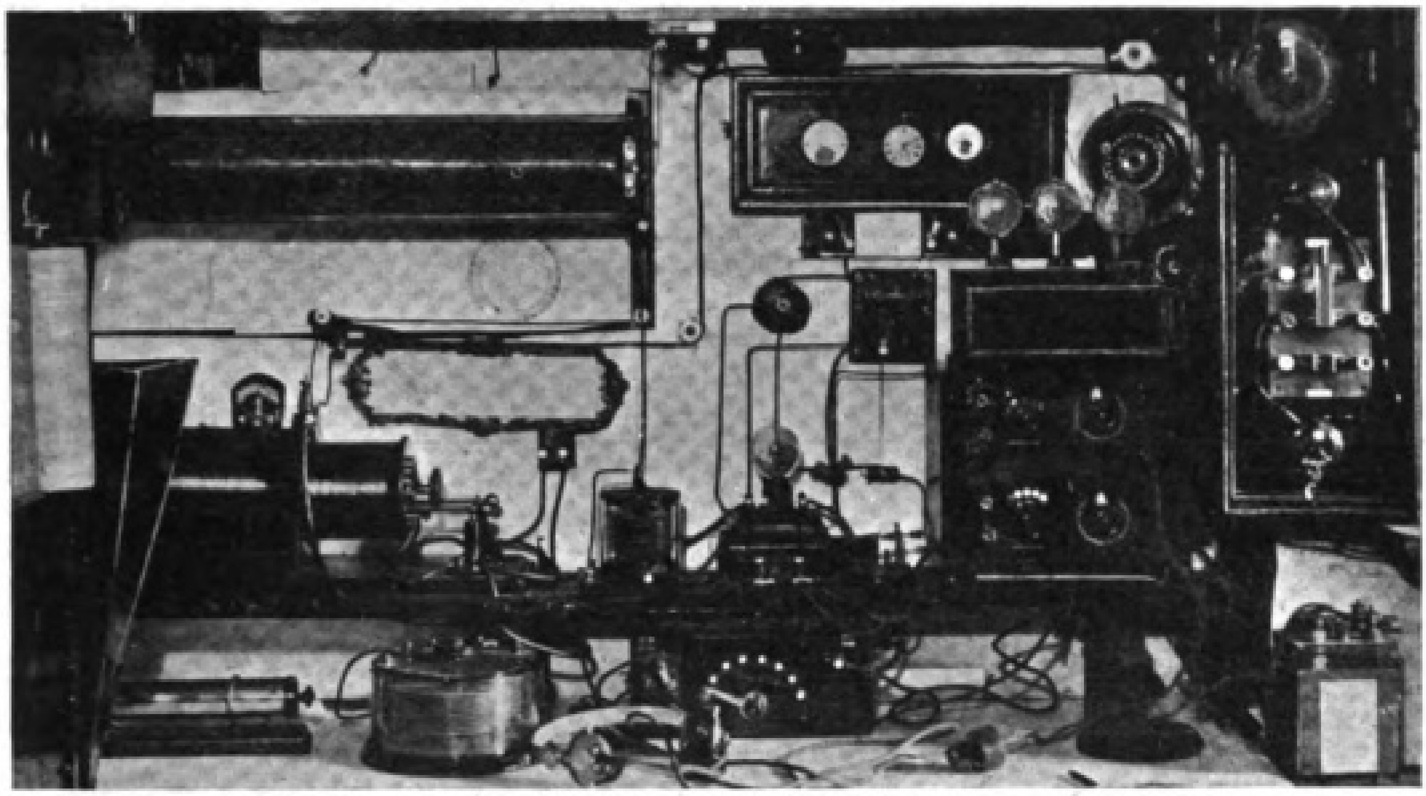
Members will be pleased to hear that, pending other arrangements, Mr. Trevelyan Lee has kindly given permission for the Club to meet in a room at his house. An aerial is in position, and a set of receiving instruments has been loaned temporarily by Mr. A. T. Lee. Members desiring to use these instruments or the room, must first make arrangements with Mr. A T. Lee (Tel.: Alvaston 31).

The following meetings have been fixed:—7.30 p.m., Saturday, October 30th, at Mr. Lee's, The Court, Alvaston. Paper on "The Poulsen Arc," by Messrs. Taylor and Lee. 7.30 p.m., Wednesday, November 10th, at the Techn[illegible]al College, Derby. Paper on "Use of Ultra Violet and Infra-red Rays in Signalling," by Capt. Bemrose. 7.30 p.m., Saturday, November 20th, at Mr. Lee's, The Court, Alvaston. Paper on "Detectors," by Mr. Lowe, 7.30 p.m., Wednesday, December 1st, at the Technical Colle[illegible]e, Derby. Paper on "Inductance and Capacity with Notes on Construction of Transformers and Chokes," by Mr. A. N. McInnes, B.A., 7.30 p.m., Saturday, December 18th. Private exhibition and exchange of apparatus, at Mr. Lee's, The Court, Alvaston.

All meetings will start with ten minutes' buzzer practice. Members are invited to bring interested friends to any meeting.

The Annual Meeting will be held at 7.30 p.m. on January 5th, 1921, at Messrs. Bemrose & Sons' Club-room, 95, Canal Street, Derby.

It is proposed to hold a public exhibition during February or March next, by which time it is hoped that the Club will be able to show a large amount of apparatus.



The amateur station belonging to Mr. R. A. Jago, of Chertsey.

The Committee will be pleased to receive names of proposed new members, and to hear from any member who will read a paper on any interesting subject.

The 46th North Midland Division (T.F.) Signal Battalion, (Royal Corps of Signals), has just been formed, with headquarters in Phœnix Street, Derby, and recruiting has commenced. A number of men with wireless training are required. The Secretary will be pleased to furnish further particulars, or application may be made direct to the headquarters.—Hon. Secretary, Capt. W. Bemrose, Littleover Hill, Derby.

Wireless and Experimental Association.

(Affiliated with the Wireless Society of London.)

At a meeting of the above on September 22nd, Mr. G. Howard, a member, recounted some amusing and instructive reminiscences of signalling by buzzer and lamp during the war, in a volunteer battalion and in the R.E. Volunteer Signalling Section. Mr. N. Kloots described a simply constructed valve panel, with dimensions, showing as an example, one he had made at a very low cost. He went on to elucidate the mysteries of reactance coils and the proportionate windings of the same. A cordial vote of thanks was given to Mr. D. M. W. Cowan, who had performed the secretarial duties in the absence on holidays of the Secretary. Three new members have joined the Association, bringing the membership up to 90.—Hon. Secretary, Mr. G. Sutton, 16, Melford Road, East Dulwich.

Manchester Wireless Society.

(Affiliated with the Wireless Society of London.)..

On Sept. 8th, the Chairman, Mr J. McKerman occupying the chair, Mr. Chas. V. Morris, of the Universal School of Telegraphy, gave his lecture on Valves, followed by practical demonstrations of high frequency amplification.

Mr. Morris handled his subject very cleverly, and after remarking that he felt much in the same position as Mr. Blake, when before the Wireless Society of London (*i.e.* "like a boy teaching his grandmother to suck eggs"), he proceeded to explain very simply how the valve actually worked and enabled the millionth part of an ampere to be so magnified as to record messages on a tape. Mr. Morris dealt with several kinds of valves, explaining that although they all performed much the same functions, there were some with a marked superiority over others. One in particular he mentioned as being super-sensitive was the latest Mullard valve, one of which was being used in the demonstration set, as was also a transmitting valve of the same make in the local telephony set.

Mr. Morris requested that one of his audience would write out a message for transmission from the Society's 10-watt set in another part of the building. A young lady enthusiast having complied, the message was transmitted, and the receiving set being adjusted to the maximum wave-length allowed (180 metres), clearly reproduced every symbol so that all present, conversant with the Morse Code, were able to write down the message as follows :—"2 FZ 2 FZ 2FZ (Society's official call). Congratulations to the Manchester Wireless Society on successful meeting. Best wishes for the future."

Considering that the instruments used were built by amateurs, and the fact that only two Bell telephone receivers were used in conjunction with a small trumpet, the results were highly satisfactory. Efforts had been made to obtain a loud-speaking telephone, but owing to unforeseen circumstances this was not forthcoming. Another disappointment was keenly felt by all present, in the inability of Chelmsford to transmit speech.

Following the musical programme, Mr. Morris invited questions on the subject of the lecture, and during the discussion which followed, one or two members adjusted to various high-power stations, which were given their maximum adjustment. Owing to the progress of time, the Chairman was reluctantly compelled to end the discussion; thereupon he proposed that a hearty vote of thanks be passed to Mr. Morris. This was seconded by the Hon. Treasurer, Mr. J. C. A. Reid, the assembly responding with hearty applause. Mr. Morris then returned thanks for the attention given by his audience, and expressed himself entirely satisfied with the meeting. The meeting was then declared closed.

The success of the evening was chiefly due to the untiring efforts of Mr. Jas. Griffin, M.B.S.C., the Principal of the Universal School of Telegraphy, in preparing for the demonstration and also for arranging the accommodation.

Intending members please communicate with the Hon. Secretary, Mr. Y. W. P. Evans, 7, Clitheroe Road, Longsight, Manchester.

Plymouth Wireless Society.

(Affiliated with the Wireless Society of London.)

The first weekly meeting of this Society was held on September 17th, when the following officers were elected to act in the capacities mentioned for the ensuing year:—Mr. J. C. Andrewartha, Chairman; Mr. H. P. Mitchell, Secretary; Mr. F. E. Allen, Assistant Secretary; Mr. W. C. Bodle, Treasurer; Mr. R. J. Moore, Local Representative; Mr. S. R. Dyer, Librarian. Mr. W. J. Lewarn was unanimously elected Vice-President.

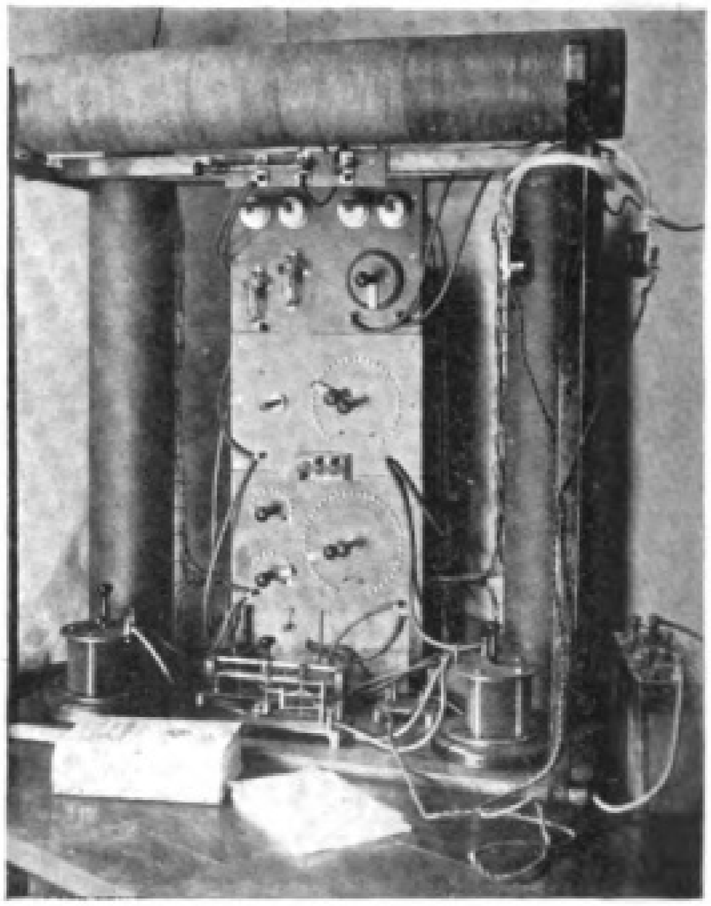
It was proposed that members should in future contribute towards the interest of weekly meetings by giving short lectures, etc., on subjects likely to prove beneficial to all concerned in Wireless telegraphy.—Hon. Secretary Mr. H. P. Mitchell, Municipal Technical School, Tavistock Road, Plymouth.

Stockport Wireless Society.

Mr. H. C. Woodhall presided over a meeting of the members of the Society on August 10th. A letter was read from Général Ferrié announcing his acceptance of the invitation to become an honorary officer of the Society. The General expressed both his good wishes to the Society, and his desire to assist the members in every possible way. After the close of the general business the Secretary called upon Major Swart, M.C., to give his demonstration on wireless telegraphy. Major Swart has constructed very successful transmitting and receiving sets and explained to the members the way in which he had accomplished their construction. The transmitting set was installed with a frame aerial in the meeting room; the receiving set, also with a frame aerial, being installed in another room of the Club. The Major upon being heartily thanked, then lectured to the Elementary Class on Crystal Detectors. Mr. Faure took the Advanced Class, starting his lectures on the Oscillation Valve, its discovery and developments in practical application. After the lectures buzzer practice was taken.

On August 17th Mr. H. C. Woodhall again presided, and after discussion of general business, Major Swart lectured to the Elementary Class on Reaction and Honeycomb Coils in practice. He illustrated the windings by exhibiting two coils he had commenced to build, letting each member take a turn in winding the coils.

Mr. Faure took the Advanced Class and continued his lecture on the Oscillation Valve. After the lectures the usual buzzer practice ensued and the meeting closed. Anyone desirous of joining the Society should call at the Foresters' Hall, Churchgate, Stockport, any Friday between 8 and 10 p.m., or full particulars can be obtained from the Hon. Secretary and Treasurer, Mr. Z. A. Faure, 3, Bank's Lane, Stockport.



Set belonging to Mr. A. E. Mitchell, made largely from designs given in the "Wireless World."

East Kent Wireless Society.

This new society has recently been formed at Dover with a view to aiding the advancement of wireless telegraphy and telephony. The Acting Secretary is Mr. H. A. Gothard, Richmond House, 26 Marine Parade, Dover, who will be pleased to supply all information.

Co-operation wanted at Wigan.—With the object of forming an amateur Wireless Club at Wigan Mr. G. W. Hall, of 135, Scholes, Wigan, Lancs., is seeking the assistance and co-operation of other amateurs in the district.

Bradford Wireless Society.

A meeting was held in the Club-room on September 17th, the chair being taken by the President.

The minutes of the previous meeting were read and accepted as correct. A letter from the welfare officer of Messrs. Thwaites Bros., was read, asking if apprentices of that firm might attend the lectures and discussions of the Society. This matter was discussed, and it was decided that all apprentices should be eligible to one meeting, and if they found themselves sufficiently interested, they might join the Society as associate members at a subscription of 1s.

A programme for the winter session was discussed, and, so far, four papers have been promised. Hon. Secretary, Mr. J. Bever, 85, Emm Road, Bradford.

Co-operation Wanted at Hindhead.—It is desired that wireless amateurs in the neighbourhood of Hindhead will communicate with Mr. G. A. Hutchinson, c/o Mrs. Rashly, Maguncor, Grayshott, near Hindhead, with a view to forming an amateur Wireless Club.

Nottingham and District Wireless Society.

The fifth meeting of the above Society was held on Wednesday, September 22nd, and although the attendance was not as satisfactory as might have been, a pleasant evening was spent, Mr. Shepherd giving a demonstration of bank-winding.

At the previous meeting Mr. Garthwaite (our Chairman) gave a very interesting and instructive paper on "Resistances," showing some very finely made apparatus.

A movement was started for forming a receiving station at the Club-room for the use of the Society, the necessary apparatus being promised by various members as soon as a licence is obtained. Steps have been taken to arrange the Society's affiliation with the Wireless Society of London, and it is hoped to settle this matter at the next meeting.

New members are urgently needed, and should communicate with the Hon. Secretary, Mr. J. H. Gill, 18, Fourth Avenue, Sherwood Rise, Nottingham, when he will be pleased to give all information required.

Portsmouth and District Wireless Association.

The second meeting of the above Association has been held, when it was decided to ask members for an entrance fee of one guinea and 5s. monthly subscription. It was also decided to form a library for the mutual benefit of the members.

Arrangements are being made to acquire some wireless gear for the use of those wishing to experiment in valve research work, and as the majority of our members are professional wireless men, it is expected that the opportunities for study and research work thus afforded will be of great benefit. —Hon. Secretary (*pro tem*), Mr. Regby H. Cole, 34, Bradford Road, Portsmouth.

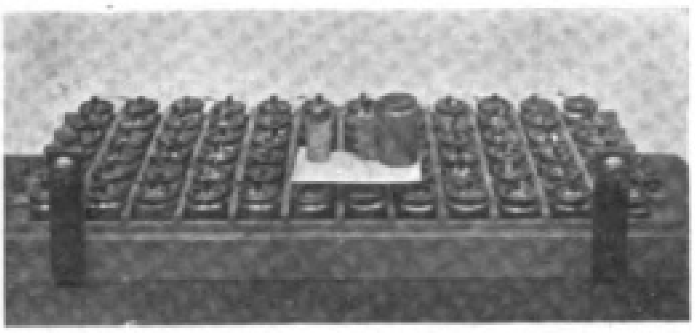
A USEFUL HIGH TENSION BATTERY

By A J. Yeates.

THE following description and illustration of a high-tension battery will, no doubt, be of interest. The battery comprises seventy-two cells of the sack Leclanché type. The outer jars are brown glazed stoneware 7/8" inside diameter and 1¼" deep. They are a standard article and known in the pottery trade as "3d. poison pots."

The negative elements (positive pole) are the same as used in the three-cell type pocket flash-lamp battery, and were supplied by a dry battery manufacturer, complete with brass cap on carbon rod and two rubber bands on sack to separate the elements from the zincs.

The zincs were cut from 22 gauge sheet, a lug being left on to facilitate soldering the connections. The electrolyte consists of a solution of 3 oz. sal-ammoniac to one pint of water. The cells are enclosed in a tray measuring 21" long by 11" wide.



The complete battery, showing 1 cell in parts.

The output of the battery is 104 volts 4 amperes.

The author will be glad to furnish any further particulars.

THERMIONIC MAGNIFIERS

By H. Monteagle Barlow.

(*Continued from page* 486.)

The Electro-Magnetic Cascade Magnifier.

SINCE the three-electrode vacuum tube is a potential operated device its scope as a magnifier can be enormously increased by arranging a number of valves in cascade, so that the work of one is multiplied by the next (Fig. 7).

The inter-valve coupling may be electro-magnetic, electro-static, or both, although in practice it is almost impossible to make it exclusively the one or the other. The transformer naturally presents itself as being particularly suitable for this purpose, and, as it is in general use, it deserves special consideration. It is necessary that the voltage impressed on the grid of any one valve is as high as possible irrespective of the value of the current, and therefore the impedance of the secondary of the inter-valve transformer must be high compared to that of the primary. Experience shows that the transformation ratio should be of the order of 1 to 4, and that the primary inductance should be about 10 henries.

Now, under any circumstances, such a coil would require several thousand turns of wire, but with an air core its size would be out of all proportion to its work. Laminated iron is, therefore, used to form a part or the whole of the magnetic circuit, and even though the frequency is comparatively low it has to be carefully prepared if efficiency is to be obtained. The behaviour of iron in alternating fields of audio-frequency has been the subject of a great deal of investigation during the past few years.

Dr. McLachlan has shown [12] that its use at high frequency is more economical and gives even better results than at low frequency, provided it is worked under suitable conditions.

It is now well known that iron responds to cyclic changes at radio-frequencies, and retains its magnetic properties throughout. Hysteresis and eddy-currents will naturally play an important part, and the greater the periodicity, the more erratic will be the behaviour of the iron. The established laws of magnetism will still apply, and when allowance has been made for disturbing factors, the relation between flux density and magnetising force, termed permeability for static magnetism, is probably similar if not equal to its low frequency value. McLachlan goes still further,[13] inasmuch as he states that this apparent permeability is greater for iron under the influence of an alternating field than a

[12] N. W. McLachlan, "Year Book of Wireless Telegraphy and Telephony, 1918," p. 880.

[13] N. W. McLachlan, "Jour. Inst. Elec. Eng., 1915," Vol. 53, p. 809.

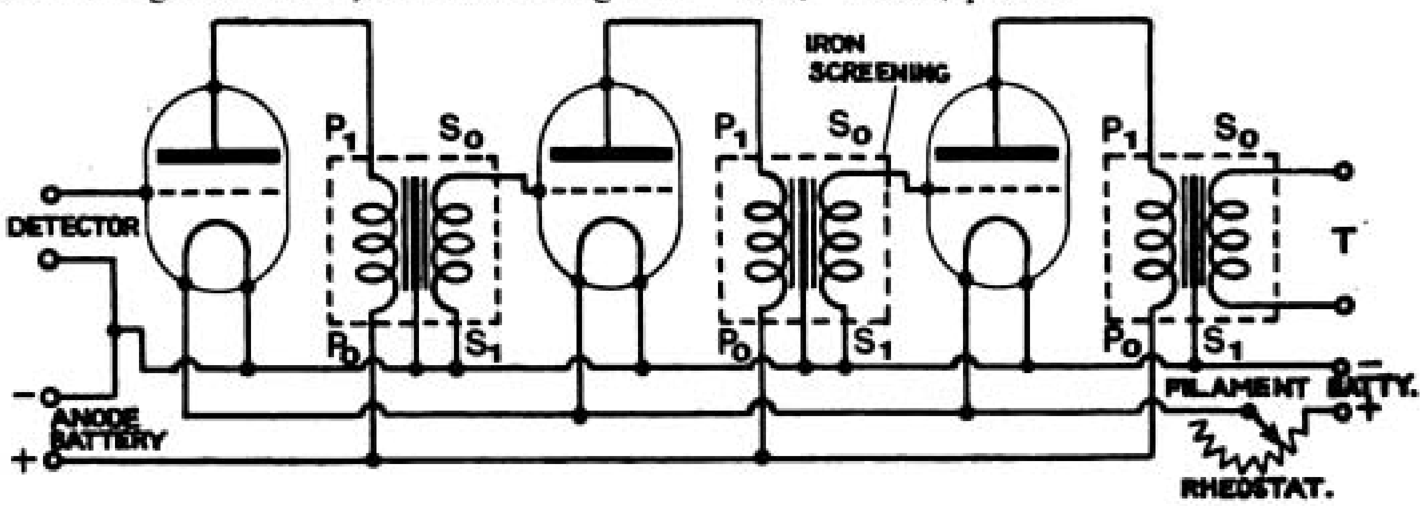


Fig. 7.

static field, provided the alternating field is of sinusoidal wave form. This, however, is not true of transformers used for thermionic magnifying, since the magnetising current does not follow a sine curve, and it is generally represented by a wave of the form shewn in Fig. 8. The amplitude of this current is

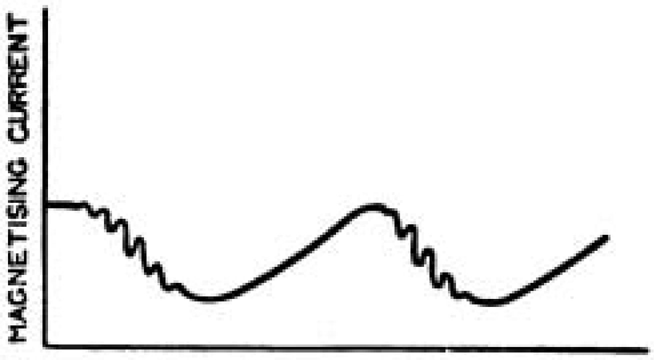


Fig. 8.

also exceedingly small, and, of course, it varies with the conditions under which the transformer is being used.

At high frequencies it has been shown that the greater part of the loss is in the winding, and even at 1,000 cycles per second or thereabouts, it is necessary that the wire be carefully insulated.

Another factor which is of great importance is the self-capacity[14] *of the winding, that is to say, the equivalent capacity which, in conjunction with the inductance of the coil, would give a natural period equal to that of the coil.* This capacity must be kept as low as possible, and it has been found that only cotton or preferably silk insulated wire will give satisfactory results, and then paraffin wax must not be used except for external protection. A convenient method of measuring the self-capacity, and incidentally the inductance and effective resistance of an audio-frequency transformer coil, is represented in Fig. 9.

Many attempts have been made to establish a simple and yet effective means of ascertaining these quantities with a fair degree of accuracy, but the following, which is a development of the original ingenious arrangement[15] devised by Dr. Howe, has been found exceptionally useful. An oscillatory current is supplied by a valve generator[16] or a Pointolight,[17] shunted by an inductance L in series with a capacity S, which may be varied so as to give

[14] F. A. Kolster, "Proc. Inst. Rad. Eng., 1913," Vol. 1, p. 19.

[15] G. W. O. Howe, "Proc. Phys. Soc. of London, 1912," Vol. 24, p. 251.

[16] L. A. Hazeltine, "Proc. Inst. Radio. Eng., 1918," Vol. 6, p. 63.

[17] Edison & Swan Patent Tungsten Arc.

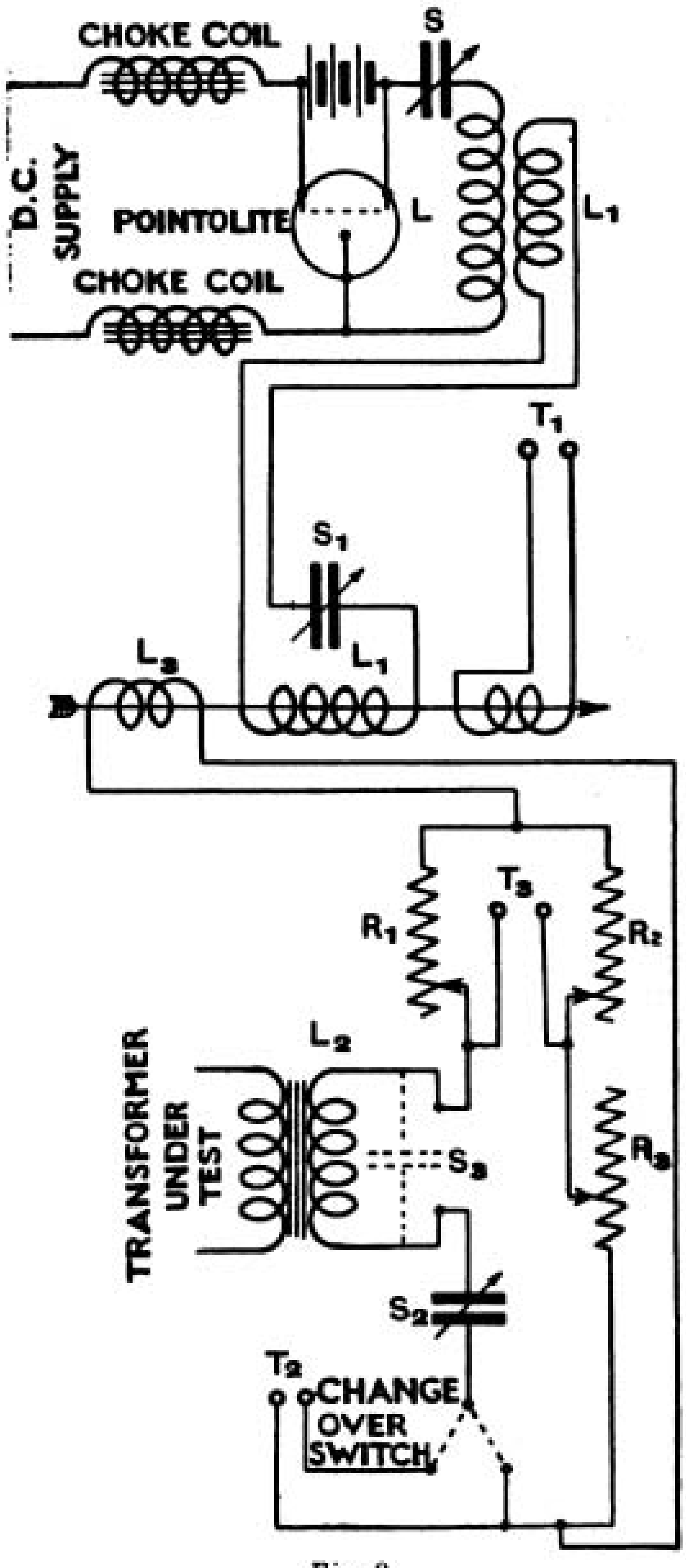


Fig. 9.

frequencies from 250 periods upwards. To this is coupled a rejector or sifter circuit L_1S_1 which, although not absolutely essential, is advisable since it considerably increases the selectivity. The tuning is effected by means of the low resistance telephones T_1, and the inductance L_1 is a known fixed quantity of the order of 0·25 henries, whilst the condenser S_1 is a known variable. The pure oscillatory current is then transferred to a bridge arranged as shown, three arms of which are variable non-inductive resistances of about 10,000 ohms, namely R_1, R_2, R_3, and the fourth the transformer coil under test in series with a known variable capacity S_2.

In this fourth arm is also inserted a changeover switch so that low resistance telephones T_2 may be connected in series or shorted out at will, whilst the mutual L_3 is made as small as practicable so as not to interfere with the balance.

Silence in the telephones T_3 indicates when the effective impedance of the two sides is the same. The action of the circuit is easily understood. With the telephones T_2 the bridge in conjunction with its parallel circuit is roughly tuned to the rejector by varying the condenser S_2. Having approximately obtained the maximum signal in the telephones T_2, these are cut out and the final balance made by adjusting the resistance R_3 and the condenser S_2 simultaneously to give silence in the telephones T_3. Under these conditions—

$$R_1 \times R_3 = R_2 \times \textit{(Effective impedance of transformer coil + impedance of } S_2\text{)}.$$

That is to say: if $R_1 = R_2$ as is usually arranged, then at a given frequency R_3 represents the effective resistance of the transformer winding since the capacity impedance is negligible.

If now a curve is plotted between S_2 and S_1, namely, between the capacity in the bridge and rejector circuits respectively, something of the form shewn in Fig. 10 (full line) is obtained.

The self-capacity of the transformer coil (S_3) is given by the negative value of the bridge capacity (S_2) when the rejector capacity S_1 is zero. This, of course, assumes that L_1 has no capacity in itself, and it is practically true if the winding is properly spaced.

The effective resistance R_3 may also be plotted against S_1, which corresponds to frequency, Fig. 10 (dotted line). It will be observed that the height of the asymptote to this curve should represent the resistance of the transformer coil as measured by direct current. Thus the chief factors governing the efficiency of an intervalve transformer may be readily ascertained

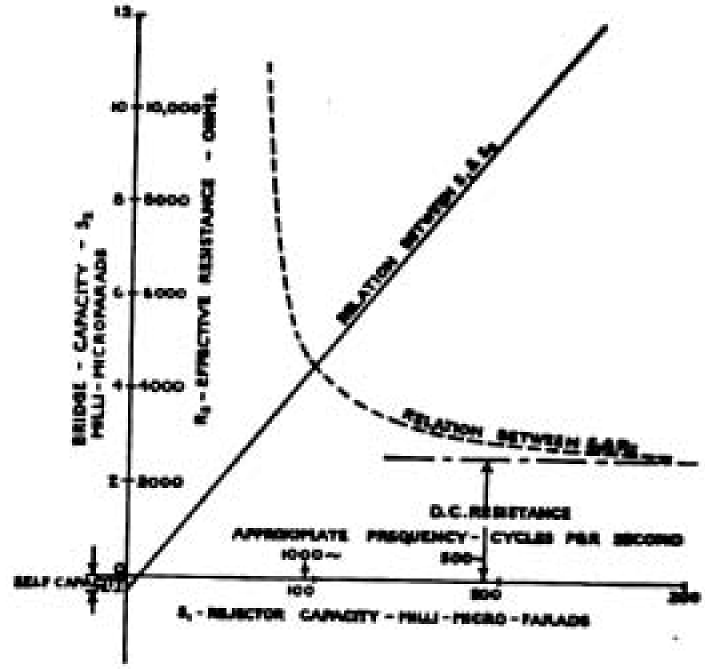


Fig. 10.

with sufficient accuracy for all practical purposes. It is important that the natural period of oscillation of the two transformer windings should not be identical. Leon Chaffee in an interesting study[18] of the "Amplitude relations in coupled circuits," concludes that the maximum effect in the secondary is not obtained when resonance occurs between the windings. Others confirm[19] this fact experimentally, and in addition shew that it is generally not practicable to work under such conditions, as there

[18] E. Leon Chaffee, "Proc. Inst. Rad. Eng.," Vol. 4, 1916, p. 283.

[19] H. E. Hallborg, "Proc. Inst. Rad. Eng.," Vol. 3, 1915, p. 107; Fulton Cutting, "Proc. Inst. Rad. Eng.," Vol. 4, 1916, p. 157; John Stone Stone, "Phys. Rev., 1911," Vol. 32, p. 398.

is a very marked tendency for *the coils to generate persistent low frequency oscillations.*

The author's experience dictates a further qualification to these deductions. Not only must the natural periods of the two coils differ, but they should be such that the one is *not* a near harmonic of the other. In practice, of course, this rarely happens, but to overcome these oscillations, which cause howling in the telephone receiver, is one of the chief difficulties in the design of electro-magnetic cascade magnifiers, and therefore it is well to avoid all resonance conditions whether partial or otherwise.

A small capacity in parallel with either coil, preferably the secondary, will eliminate the tuning effect, but there are other reactions also tending to set up undesirable oscillations for which it does not compensate. Considering the diagram of connections (Fig. 7), it will be observed that the primary winding is connected in the anode circuit of one valve and the secondary in the grid circuit of the following valve.

Now at very low frequencies the inductive coupling provided by the transformer becomes inadequate, and *it is necessary to assist the transfer of current variations by means of a capacity.* But at audio-frequency the electro-magnetic coupling alone is quite sufficient, and any appreciable electro-static coupling in conjunction with it will lead to excessive linkage, force a damped reaction and produce howling. It is important, therefore, that the capacity between the high potential points of an intervalve transformer should be reduced to a minimum. If the transformer is wound with primary and secondary coils alternately along the length of the core, the distance between the two pairs of ends will be much the same, but if the secondary coil is wound on the outside of the primary so that the core is common to both, then the arrangement of the ends must be expressly observed. That is to say, the inside of the primary should be connected to the anode and the outside of the secondary to the grid. It is also expedient to earth the iron core to the negative end of the filament which is normally at zero potential.

In this connection it is understood, of course, that the outer plate only of the insulated laminations or one of the clamping screws is coupled to the earth point.

The behaviour of a transformer in response to impressed current variations has been very carefully studied [20] by Dr. Hallborg, and the discussion [21] of his paper is equally interesting. The work is confined to transformers used in the low frequency circuit of radio transmitters, but the net result indicates that generally highest efficiency is obtained when the frequency of the impressed current is greater than the period of oscillation natural to either coil.

The frequency usually recognised as being most conveniently audible is about 600 cycles per second, although for continuous wave reception something of the order of 1,000 cycles per second is sometimes preferred.

It has been stated that the inductance of the transformer primary should be about 10 henries. Such a coil provides a suitable impedance for the external anode circuit, but does not ensure that its natural period is less than the frequency of the incoming signal.

Thus Dr. Hallborg's theory appears to advocate an increase in the self-capacity of the winding, but it is questionable if *his* conclusions will apply in this case. The compensative fact remains that *internal interference becomes inaudible by sufficiently increasing the natural period of the transformer coils.*

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[20] H. E. Hallborg, "Proc. Inst. Radio. Eng." Vol. 3, 1915, p. 107.

[21] Particularly discussion by Julian Barth and A. N. Goldsmith.

(To be continued.)

WIRELESS TRANSMISSION PHENOMENA

By R. A. Humphries.

The following is an article giving further information upon the subject of "Physical Features and Wireless Transmission."

IT was intimated in the August 21st issue, that it would be interesting to know to what extent Port Sudan experienced Aden's fading away.

My own experience in this connection, while stationed at Port Sudan, was that the high-power station at Aden was very erratic and varying in its transmission.

This was attributed either to the prevailing atmospheric conditions, or losses through overheating of the transmitting instruments, as similar fading was never experienced on the low-power installation, excepting during those periods when atmospheric conditions were unfavourable, although, of course, the position of the low power set is entirely different from that of the high power.

One peculiarity of BZF's transmission, (after considering the foregoing, which applies to the 600-metres wave,) was that the strength of his signals did not vary nearly as much on his long-wave (2,000 metre) transmissions, as on the 600 metres. If there is, and I suppose there must be, an explanation for this, I should be very glad to know to what this might be ascribed.

With regard to communication between ships or stations in the Red Sea and those in the Persian Gulf, I would say that I have on several occasions communicated with R.I.M. ships off Basrah, and farther south in the Persian Gulf, and everything pointed to the fact that our signals were as easily read by the ship stations in the Persian Gulf as their's were by us.

Also very interesting and important phenomena, were the continual "drifts" of atmosphere across the northern part of the Red Sea, one class of which seemed to assist disturbances in the aether and another to oppose them—at least, this is the only explanation to which I can attribute the regular fading away and coming up of signals in that portion of the Red Sea, viz., Abu Zenima, Akaba and Tor. I would mention that this was the theory accepted by most of the naval wireless fraternity.

AN AMUSING EXPERIMENT WITH STRONG SIGNALS

By C. H. Gardiner.

WHILST listening to BYC on a 3-valve receiver, (one rectifier and two note magnifiers), I was trying the effect of replacing the telephone head-gear with the secondary winding of a 1-inch spark coil. I was wondering at the time if any signals would be audible by connecting the 3,000 ohm telephones across the 4-ohm primary of this coil, and after making connection, was greatly surprised to hear BYC quite loud, although the head-gear leads were not connected to the wireless apparatus in any way.

On investigation I found this to be due to mutual induction, and signals could be heard in this manner even when the head-gear was placed quite 3 feet away from the spark coil.

It is necessary, of course, to place the windings of one receiver in the same plane and, if possible, about the same level as the winding of the coil. Though of no practical use, this furnishes quite an interesting experiment in induction.

PAGES FOR BEGINNERS

THE TRANSFORMER

THE induction coil was shown to depend for its working on the fact that an E.M.F. is induced in a wire which is cut by magnetic lines of force.

In order that an E.M.F. may be continually induced in the secondary winding, it is necessary that the lines of force should be continually moving past the coil, and hence the current inducing the lines of force should be continually changing.

In the case of the induction coil, the current was caused to change its magnitude by means of an interrupter. With a transformer, however, the primary coil is supplied with alternating current, which by its very virtue, so to speak, causes the lines of force to continually change.

The magnetic lines of force act in a manner similar to an electric current, choosing the path of least resistance. If we surround the primary coil by a ring of iron, the lines of force will crowd into the iron, since it offers far less resistance to the magnetic field than the air, Fig. 1.

If we arrange the secondary coil so that it is also near, or surrounded by the iron, we shall ensure that the maximum number of lines will cut the secondary coil.

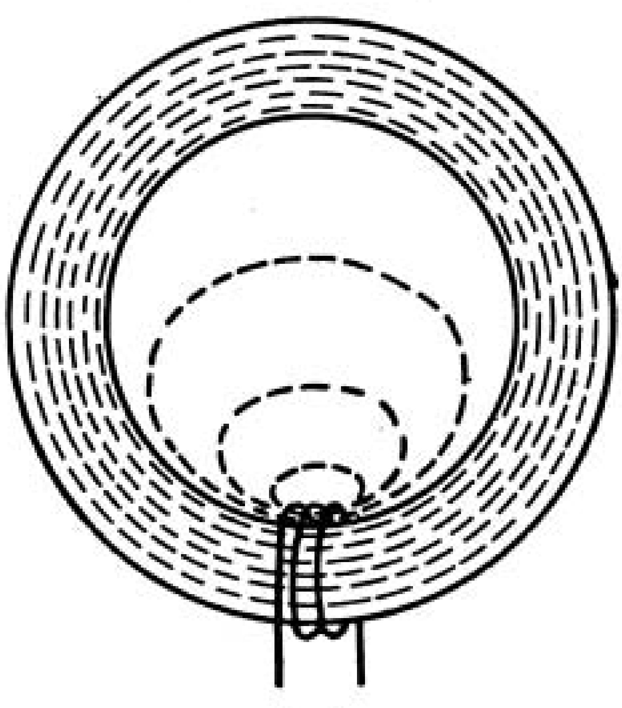
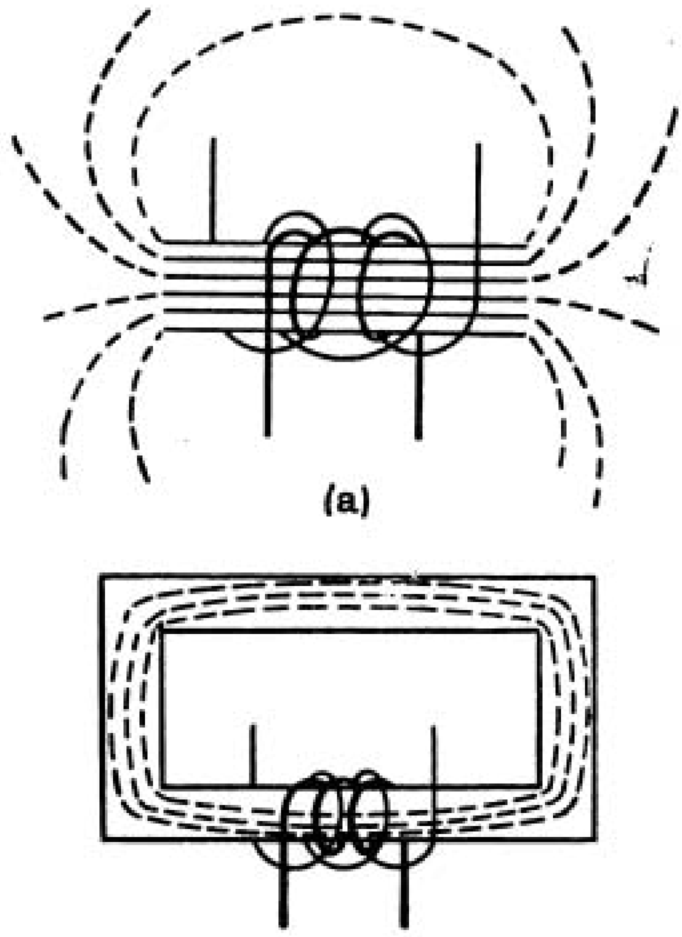


Fig. 1.

Compare the two transformers shown



(a)

(b)

Fig. 2.

in Fig. 2. In the first it will be noticed that although the iron core assists the magnetic flux threading through the centre of the coils, there is no easy path for the lines past the ends of the coil. They are not concentrated in the neighbourhood of the secondary winding, and thus the maximum effect is not obtained.

With the second type, both the windings are threaded on a closed rectangle of iron. The extra number of lines of force will crowd into the path of the iron and in so doing, will cut the turns of the secondary coil. The induced effect will therefore be much greater than in the first case. Transformers of the second type are spoken of as having a *closed* magnetic circuit.

We can also imagine a closed iron circuit as being a secondary winding, of a single turn only, but of considerable thickness, and consequently of low resistance. The primary winding, therefore, will induce currents in the iron core itself, which will be of great magnitude but will do no useful work. The only effect of these *eddy-currents*, as they are termed, will be to heat up the iron core, and thus waste a great proportion of the energy supplied to the primary circuit. Fig. 3 shows the formation of eddy currents by the lines of force threading the iron core.

In order to make the energy wasted as small as possible, these eddy-currents must be kept down. This is accomplished by replacing a solid iron core, with one composed of a number of thin sheets of iron, each insulated from the other by thin paper or shellac varnish. A core made up in this manner will not hinder the passage of the magnetic lines since they flow in the same plane as the sheets, or *laminations*.

The direction of flow of the eddy-currents, however, is at right angles to the path of the magnetic field, and thus the paper insulation acts as a considerable resistance in their circuit.

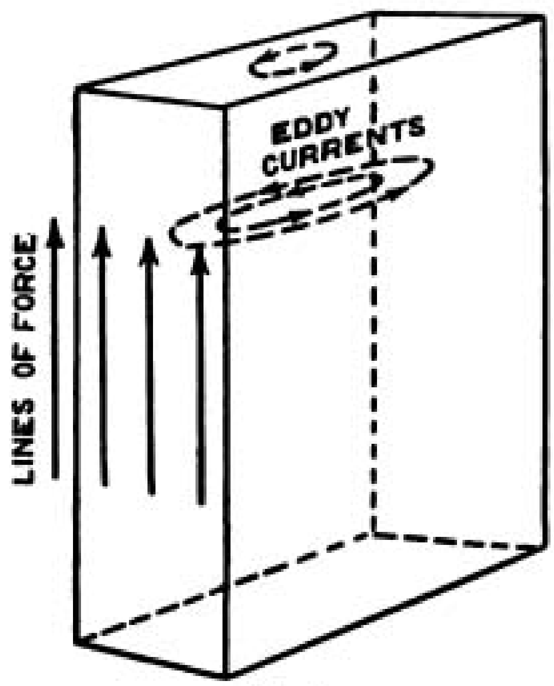


Fig. 3.

On the other hand, in assembling the laminations to form a core, great care is taken to avoid unnecessary air gaps. At the same time the core must be made so that the coils can be slipped in position easily. A usual method of providing for this is to make the

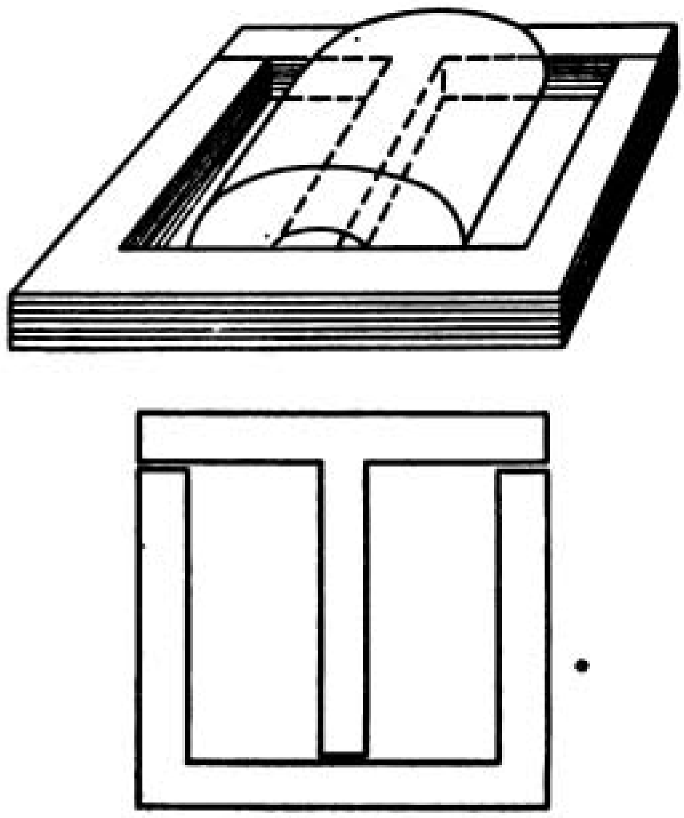


Fig. 4.

core plates of two or more different shapes which are then fitted in the coils so as to overlap at the ends. Fig. 4 shows a typical form of lamination. The tongue of the T-shaped plate fits through the centre of the coil. The U-shaped stamping is then placed partly round the other to form a complete magnetic circuit.

The voltage induced in the secondary winding depends on the number of turns in the coil. This is easily deduced on considering the elementary case of one turn of wire in the primary coil, and one in the secondary. Whatever the applied voltage in the primary, a similar E.M.F. will be induced in the secondary. If we double the number of turns in the secondary coil, we shall get a doubled effect in E.M.F. The ratio of the secondary voltage to the primary voltage in every case is equal to the ratio of the number of turns in the secondary coil to that in the primary coil.

In symbols this may be expressed as :— $\frac{V_s}{V_p}=\frac{T_s}{T_p}$ where V_s and V_p are secondary and primary voltages, and T_s and T_p are secondary and primary turns.

As an example :—What is the secondary E.M.F. of a transformer having 100 turns in the primary, and 2,500 turns in the secondary, if the applied voltage is 50 volts ?

From the expression above, we have—

$$V_s=\frac{V_p \times T_s}{T_p}=\frac{50 \times 2{,}500}{100}$$
$$=1{,}250 \text{ volts.}$$

As the secondary voltage is increased, the secondary current decreases in the same ratio. Assuming that there was no energy wasted in the transformer above, if the primary current was 10 amps., the secondary current would be only 0·4 amp. If there were no losses, the power given out by the secondary would exactly equal the power supplied to the primary. In this case, the power input is 10×50 or 500 watts. The secondary power is therefore $1{,}250 \times 0{\cdot}4=500$ watts also. Actually, the output from the secondary falls a little short of this, as a certain amount of the power supplied is wasted in heat and in the formation of eddy currents. In a well designed transformer, only 1 or 2 per cent. of the applied power is wasted in this fashion, so that we obtain from the secondary about 98 per cent. of the power supplied.

If the primary is connected to a source of alternating current, and the ends of the secondary are not connected to any circuit, the transformer will then behave like a coil having a large inductance. When, however, the secondary is supplying current to an external circuit, the lines of force created by the secondary coil will partially neutralise the magnetic field due to the primary, and thus the *effective* inductance of the whole transformer will be greatly decreased.

The more remote the secondary coil is from the primary the less will be this neutralising effect, and hence the greater will be the effective inductance of the transformer. Thus, it is possible to vary the total inductance of the transformer by varying the distance between the primary and secondary windings.

WIRELESS TELEGRAPHY WATCHERS

Under the Merchant Shipping (Wireless Telegraphy) Rules, 1920, ships of Class II (*i.e.*, ships not engaged in the coasting trade carrying 50, but less than 200 persons, and ships engaged in the coasting trade carrying 50 persons or more) are required to carry, in addition to a certificated operator, one watcher if the voyage exceeds eight hours, but does not exceed 48 hours from port to port, and two watchers if the voyage exceeds 48 hours from port to port.

The Postmaster-General has made arrangements for examining watchers at Glasgow, Newcastle, Liverpool, Cardiff and London. Applicants should address their communications to the Wireless Telegraphy Inspector at :—(1) Post Office, Glasgow. (2) Post Office, South Shields. (3) Room 10, Prudential Buildings, 36, Dale Street, Liverpool. (4) Port Office, Bute Docks, Cardiff. (5) Wireless Section, Secretary's Office, General Post Office, London. Forms of application may be obtained at any of these addresses, and the examination fee (2s. 6d.) should be paid by means of postage stamps affixed thereto.

The candidate will be required to show (1) that he is capable of receiving and understanding the Radiotelegraph Distress Signal and the Safety Signal, and (2) that he has sufficient knowledge of the apparatus on which he will be required to keep watch to know, by means of a buzzer or other simple test, that it is in proper condition to receive signals. If the candidate satisfactorily passes the examination he will be required to make a declaration that he will observe the secrecy of radiotelegrams which come to his knowledge in the course of duty. He will then be granted a Certificate of Proficiency as a Watcher in Radiotelegrephy.

Authority, B.O.T. Notice to Ship Owners, Masters, Officers and Seamen, No. 17, *September*, 1920.

BOOK REVIEWS

THE CONSOLIDATED RADIO CALL BOOK.

New York: The Consolidated Radio Call Book Co. Inc. (Second edition). July, 1920. $1.25 net.

THOSE amateurs who are in possession of a receiving station will recognise in this little book much that is of use and value. In addition to the listing of call letters, there is also included considerable information regarding telegraph, cable and wireless rates, D.F. stations, press programmes, weather reports, time signals and similar data. A wireless map of the world is also given. To those amateurs who are interested in "collecting" signals to the uttermost efficiency of their apparatus, such a book as that under review would prove most useful in much the same way as the Year Book of Wireless Telegraphy, though for obvious reasons not to such a considerable degree of utility as the last-named.

LE VIE, MODE DE MOUVEMENT. ESSAI D'UNE THÉORIÉ ELECTRONIQUE DES PHENOMÈNES VITAUX.

By E. PREAUBERT.

Paris: Librarie Felix Alcan. Pp. 214. Price 5 frs. + 10 per cent.

This book is apparently a revision of an earlier study of the subject by the same author. His first theories were published in 1897 in the *Bulletin of the Société d'Etudes Scientifiques d'Angers*, and these are incorporated in the present work, together with the results of subsequent information and discovery. The problem of the nature and origin of life has long been an absorbing one, particularly as so many of the phenomena seem, at all events at first sight, to be at variance with the recognised laws of physics and chemistry. On account of the difficulties of the subject a large number of the arguments set out in this volume are based almost entirely upon analogies. This procedure, although a risky one from the scientific point of view, nevertheless yields a quantity of interesting reading matter, and whether correct or otherwise, the author's remarks are certainly worth reading. The last portion of the book is devoted to proving, or rather to endeavouring to prove, that the essential elements of life are not to be found in any ordinary chemistry which is concerned solely with atoms and molecules, but in something inside the atom. In support of this view a large number of analogies and arguments derived therefrom are collected together, particularly in Chapter III. In this chapter the author considers the subject under the following headings: Atomic Weight, The Vital Cohesion, Biological Chemistry, Temperature, Electricity, Magnetism, Thermodynamics, Nervous Transmission, Animal Heat, The Electric Organs of Fishes, Psychology, etc. From every one of these he is led to the conclusion that it is the intra-atomic forces that are at the basis of all phenomena of life, and thus he is brought to the influence of the electron on such phenomena.

An interesting table is given—a species of Periodic Table—in which the various elements are classified according to their effect upon living organisms, and this shows that it is always the elements of small atomic weight that are least harmful. The author suggests that the phenomena of life are due to intra-atomic vortices or, as he terms it, "Le Tourbillon Vital," and that it is due to the natural forces between such vortices that the cohesion between the various parts of a living organism is maintained.

In some cases the analogies given, although interesting, do not really seem to explain much. For example, when he likens the action of the various organs of an animal to the inhabitants of a city where each individual is cognisant of his own individual duties. This obviously does not tell us the mechanism of the consciousness of each individual.

However, the book is quite an interesting one and makes excellent reading for anyone at all interested in these phenomena, and who has a few hours to spare with an armchair before a fire. P. R. C.

QUESTIONS AND ANSWERS

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

E.H.S. (Carnarvon) *is badly situated and can only get* MUU, *about 12 miles away, and asks (1) Whether any modification of his existing apparatus would give a longer range. (2) Whether, in view of his position it is worth his while to go to the expense of fitting valves, etc. (3) Whether the close proximity of mountains is a serious item in receiving.*

(1) Set could be improved by connecting as in Fig. 1; otherwise OK.

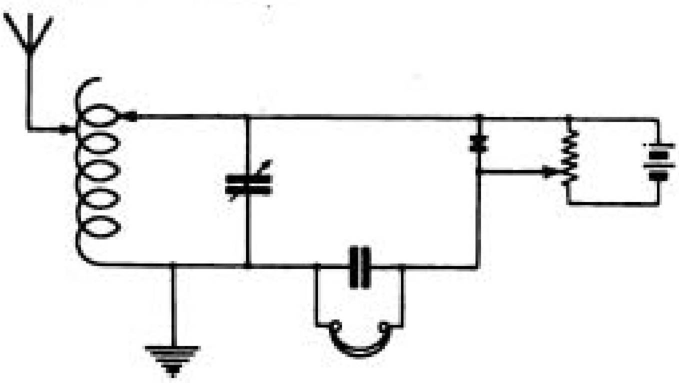


Fig. 1.

(2) This depends largely on how much you can afford to spend. You will, of course, improve results very much by using a multivalve amplifier—but they will never be as good as could be got in any favourable position, and the jamming from MUU will then be a serious complication.

(3) Yes, generally.

P.L.B. (N. en B.) *asks (1) If on page 185 of this volume the figures relative to size of loops, mean the area of loop or length of side. (2) Whether an indoor aerial 9 ms. long, or a frame, would give the better chance of receiving America. (3) How to make* D_1 *and* D_2 *of Fig. 3, page 387, October, 1919. (4) A translation in millimetres of English gauges of copper wire.*

(1) Length of side.

(2) A good frame aerial would probably be the better.

(3) We have no information; consult the authors' original paper.

(4) The numbers are arbitrary and have no simple relation to the size. Most wire tables give the diameter.

LAMBDA (Cardiff) *asks (1) What will be the inductance of the following coils:—(a) 12″ × 6″ wound with No. 21 SWG.; (b) 12″ × 5″ wound with No. 21 SWG.; (c) 8″ × 4″ wound with No. 28 SWG.; (d) 12″×3½″ wound with No. 22 SWG. (2) How can he arrange certain apparatus to form an efficient set. (3) What distance could he hope for under certain conditions. (4) What he would require in addition to what he already has in order that his wavelength range might be 300 to 10,000 metres. (5) Is the capacity (0·002 mfds.) of his condenser too small and would he require another for good tuning. If so, state capacity.*

(1) (*a*) 7,000 mhys.; (*b*) 5,600 mhys.; (*c*) 9,500 mhys.; (*d*) 2,300 mhys.

(2) See reply to **J.W. (Stepney).**

(3) Afraid we cannot say.

(4) Add considerably to loading coil and coupler secondary. Get data from replies to similar queries recently.

(5) Too big. You would get better results by using condenser of about 0·0005 mfds. The 0·002 mfd. condenser could then be used for an A.T.C. if desired. *Four* questions, please.

X.Y.Z. (Scarborough) *sends a circuit which is stated to have given good results and asks for our opinion.*

The circuit is a freak type and though possibly satisfactory for soft valves is unlikely to give good results with hard valves.

A.A.P. (Cahercíveen) *asks if the following statements from Hawkhead and Bangay are correct. (1) Hawkhead on p. 154 states that the ohmic resistance of a conductor varies according to the frequency of A.C. (2) Bangay in par. 138, states that inductance in a circuit, when a circuit in which current is flowing is broken, causes a current to flow in the opposite direction to applied. (3) Bangay in par. 1,189 states that the frequency for a wavelength of 1,000′ is 100,000 oscillations per second. (4) He also asks whether a wave's length is measured along the curvature of the wave or by a straight line from crest to crest.*

(1) This is quite true, but variation from steady current value is small, unless frequency is high.

(2) This is a slip, direction of induced P.D. should be same as steady current.

(3) Should be 1,000,000. This is true to a degree of approximation sufficient for most practical purposes. Strictly, length is measured on a straight line along the path of the wave. The length of a wave obviously cannot be measured in the ordinary sense of the word, *e.g.*, by a foot rule, as one cannot stop it to work with it. It is calculated from the measured velocity and the measured number of waves appearing at any given place in a unit of time.

R.E.W. (Holyhead) *asks (1) For information regarding how to make honeycomb coils. (2) If there is any special formula for the capacity of such coils. (3) What advantage, other than compactness, there* *is in such coils.* (4) *For a diagram showing building method of this type of coil.*

(1) See article in number of June 12th, 1920.

(2) There is no simple way of calculating inductance at all accurately.

(3) The only advantage is small self-capacity in consideration of the compactness. Such coils for example will tune much better than equally compact multi-layer coils. Better tuning than either can be obtained by the use of single-layer coils, if you can afford the space.

(4) Construction is difficult without special machinery, and the methods which have to be adopted would take too much space to describe here.

GRID (Manchester) *asks for the simplest way to make a loud-speaking telephone, to work in conjunction with a wireless set, or if we could recommend any book which deals with the subject.*

A loud-speaking telephone can be made somewhat on the lines of an ordinary telephone by using in place of a permanent magnet, as strong an electromagnet as possible, excited by some steady source of current. In front of one pole of the magnet is placed a coil of wire of suitable dimensions, carrying the signal current. To this coil is fixed a diaphragm, as in the telephone. Variations of current in the second coil cause movements of it in the field of the first coil, thus moving the diaphragm. We are afraid we do not know of any book dealing with these instruments.

SNOWBALL (Huddersfield) *asks* (1) *If certain particulars which he gives of his set are approximately correct.* (2) *Would his secondary coil be improved if wound with finer wire.* (3) *What would be the approximate maximum and minimum wavelengths of his circuit.* (4) *Is a substance enclosed suitable as a crystal for reception.*

(1) Yes, very suitable values.

(2) No. Useless to do this without increasing A.T.I. as well.

(3) Maximum about 3,500 metres, minimum doubtful; probably about 300 metres.

(4) We have tried this with absolutely no results. It seems to be quite useless.

R.G.N. (Norwich)—*With regard to the article on page 64 of this Vol., "Wireless World," he thinks that a range of 600 to 5,000 ms. would be more useful for this receiver, and asks* (1) *If this could be satisfactorily done.* (2) *For the details of alterations necessary for doing this.* (3) *The cost of making the set.*

(1) Yes.

(2) We are sorry we cannot re-design sets to suit individual requirements, but our designs are those which we think most generally useful. However, if you, roughly, double the size of each coil, the maximum wavelength will be about what you want.

(3) Difficult to say exactly, as you may or may not possess already some material. Say, a few pounds.

H.E.A. (Birmingham) *sends sketch of a 3-valve amplifying receiver which is giving poor results. He also asks* (2) *How long a 20 ampere-hour accumulator should last on the set.* (3) *If 4 volts is enough for the valves.*

(1) This type of set should give you very good results. Possibly the coupling between primary and secondary is in wrong sense to give oscillations; try reversing this. Poorness of tuning may be due to too tight coupling, or unsuitability of capacity of condenser — we cannot say from the information you give.

(2) About 8 hours.

(3) Four volts is not enough, but 6 volts will decrease the life of your valves. Use 6 volts with a little series resistance to drop the volts on the valves to about 4½–5½.

A.H.H. (Keighley) *sends a sketch of connections of a single-valve receiver with which he can get no signals, and asks if we can help him.*

Sketch appears O.K., except for grid condenser and leak, which are wrongly connected (*cf.* any diagram showing use of these parts). Your set should work quite well without any grid condenser at all, and you can therefore dispense with it altogether if you like.

C.C.B. (Preston) *has various instruments and asks* (1) *If an efficient receiving station can be made with them.* (2) *For diagram showing how best to use them.* (3) *If a 25-ft. earth lead of bare copper wire, No. 18, soldered to water pipe, is too long.* (4) *Why he can only get Cleethorpes with the* A.T.I. *and without using his loose-coupler, and also why he cannot get* FL.

(1) Yes, but add about 0·01 henries inductance in series with secondary.

(2) See diagram page 65, April 17th issue.

(3) This is rather long, but you should get fair results.

(4) Because you have not enough inductance in your tuned circuit, but you should be able to get FL in the same way as Cleethorpes with gear properly adjusted.

W.J.T. (Norbiton) *asks* (1) *For inductance of coil 37·5 cms. long by 8·75 cms. diameter, with 18 turns per cm., the section being approximately circular.* (2) *How the intervalve resistance described in July 10th issue is connected up to amplifier from rectifier valve.*

(1) 8,600 microhenries.

(2) An intervalve resistance should be used as in diagram on page 290 of the issue referred to.

W.E.L. (Enfield) (1) *Sends sketch of receiver for criticism.* (2) *Asks how to work out sizes of tuning coils of honeycomb type for various wavelengths.*

(1) Sketch is not very intelligible. We do not like the scheme of using separate coils in aerial for each wavelength. This is very wasteful of wire, and arranged as you suggest would give very unsatisfactory tuning. You would do much better to use an ordinary loose-coupler arrangement. There is no necessity for a graphite resistance in the plate-circuit of a valve. Also your sketch shows a crystal in the grid-circuit of the valve, which is useless. Moreover, in your alternative circuit, in which the valve is cut out, you have no detector at all. Otherwise your receiver appears O.K.

(2) We are afraid we cannot give the information required. (Satisfactory honeycomb coils are almost impossible for amateur winding without complicated machine tools).

A.E.I. (Ilfracombe) *encloses a diagram of a receiving set, and asks* (1) *If the instruments shown are most suitably arranged for efficient results.* (2) *If he could detect Wireless Telephony from Chelmsford. Distance about 210 miles.* (3) *Or from Poldhu. Distance about 107 miles.* (4) *For maximum and minimum wavelengths for the set.*

(1) Arrange to tune by sliding tapping on inductance. We should be inclined to use condenser in parallel with inductance. It is too small for a series A.T.C.

(2) With careful adjustment, very likely.

(3) Probably; there is not a great deal of telephony done from MPD., however.

(4) Minimum, perhaps 200-300 ms. Maximum uncertain, as you do not state diameter of loading coil.

N.B.—Aerial is of an inefficient type: avoid an acute angle between two halves if at all possible.

ZETA (Yorks.) *sends a diagram of his detector valve-panel and asks* (1) *If it is correct, and asks how much and what gauge of wire to use for winding two formers to 2,000-8,000 ms., and to 300-1,000 ms.* (2) *If the addition of a second valve would entail the removal of the mineral detector he at present has.*

(1) We regret we are unable to understand your drawing, drawn as it is on both sides of the paper. The switch in particular appears to have 8 contacts on the front and 6 on the back which do not correspond. We suppose you wish to use coil for A.T.I. In this case, for 8,000 ms. former should be wound full with No. 30. Much better results would be obtained by using a larger former and thicker wire. You could find how much to tap off for short-wave coil by experiment.

(2) As we do not understand your circuit we cannot definitely say, but in general the use of a crystal with 2 valves is quite optional.

P.A. (Harwich) *sends description of apparatus he proposes to use on his set. He asks* (1) *If the loose coupler will be suitable and efficient. Primary 9″ × 6″ of No. 28. Secondary 9″ × 5″ of No. 36.* (2) *What is maximum wavelength it will tune, without an A.T.I.* (3) *If it is possible to receive Madrid and Algiers, in Lancashire with a crystal set.*

(1) Secondary is unnecessarily large unless you use a big A.T.I., otherwise O.K.

(2) About 4,000 ms.

(3) Hardly likely, except Madrid, perhaps, at night.

L.F.A. (Bromley) *asks for dimensions of a loose-coupling coil, to be as small as possible, to tune to 5,000 ms., with aerial 95′ long and 18′ high.* (2) *What is capacity of secondary condenser.*

(1) Assuming you do not wish to use any other coils: primary, 16″ × 8″ of No. 26. Secondary, 8″ × 5″ of No. 30.

(2) 0·0005 mfds.

J. de L. (Lisbon) *wishes to use a ¼ K.W., 110 volts set on 220 volts, and sends sketch of a scheme for doing so, using a series resistance reduced in value by the key when sending.*

The suggested scheme is quite satisfactory. We do not recommend the resistances you specify, however. The light load current of a 110 volts rotary of this type is 3·5 to 5·0 amps., and your larger resistance should therefore be 30 to 20 ohms, depending on the actual machine you have.

D.S. (Hornsey) *sends sketch of two aerials, one being a low single wire aerial 85′ long, and the other a low umbrella aerial over a zinc roof, the height of the tip of the mast being 12′ above the roof. He asks* (1) *Which would be the better.* (2) *If he should receive Eiffel, Poldhu, Nauen and Chelmsford telephony with certain advertised medium-wave sets.* (3) *What would be a maximum wavelength.* (4) *If a frame aerial would be preferable.* (5) *If a 30′ lead to earth would be too long.*

(1) Single wire aerial.

(2) You should get all but POZ, which generally uses a much larger wavelength.

(3) About 75 per cent. of maximum guaranteed for full size P.M.G. aerial.

(4) No.

(5) Yes, unless absolutely necessary. Cannot you connect to a water pipe nearer than this. Only *four* questions, please.

R.B.L. (Berlin) *asks* (1) *Why the De Forest Co. claim honeycomb coils, which are essentially multi-layer coils, to be efficient, while we state multi-layer coils are inefficient.* (2) *Seeing that multi-valve* H.F. *amplifiers are not efficient over large ranges of wave-length, what will be the differences between those designed for long and short wavelengths.* (3) *Referring to recent article on telephone transformers for telephones of 120 ohms., what difference should he make in construction for telephones of 100 ohms.* (4) *With two pairs of telephones in action at once, would another transformer be necessary.*

(1) Honeycomb coils are *essentially different* from ordinary multilayer coils for receiving purposes, in that the method of construction gives the former small self-capacity while the latter have high self-capacity. This accounts for the difference in efficiency. Even the honeycomb type is less efficient than a single-layer coil.

(2) This is too lengthy a matter to treat here. Briefly, resistance amplifiers are never good for short waves, and in the aperiodic intervalve transformer type the difference lies chiefly in the design of the transformers.

(3) and (4) No alteration in the transformer will be necessary in either case, particularly in the first. The rule that the resistance of secondaries should be the same as that of the telephones is very approximate only. For strictly accurate design, it would be necessary also to consider other factors besides the resistances, and without elaborate calculations on these lines, any attempt you make to alter the original design is just as likely to make results worse as to improve them.

ENDOLINE (Halifax) *proposes to use a frame aerial with two valves, or crystal and two valves, and asks* (1) *What size and winding of frame aerial we would advise for ordinary "listening in" and general use for wavelengths from 600 to 4,000 ms.* (2) *If an outside aerial consisting of a total length of 140 ft. of wire 40′ high would be much preferable to the above.* (3) *Whether, if a frame aerial were used, the same care would have to be taken in insulating the frame and leads as with an outside aerial.* (4) *If a 25-volt lighting set could be used for H.T. supply for the valves.*

(1) You should refer to the articles on frame aerials in the issues of May 29th and June 20th, 1920.

(2) Yes; from the point of view of signal strength, an outside aerial will give far better results.

(3) Yes; see above articles.

(4) Yes, if you have accumulators and employ suitable valves.

A.L.B. (Manchester) *asks* (1) *To what wavelength can he tune with an arrangement of circuits specified.* (2) *If any use can be made of a trembler coil, (1" spark), for wireless reception.* (3) *What is the most delicate crystal to use (within the scope of amateurs), using a cell across it.* (4) *If the addition of an inductance of a certain specified size would increase the range, and, if so, how much.*

(1) Up to about 2,700 metres.

(2) No.

(3) Difficult to say. Perikon is one of the most sensitive.

(4) Not with your present arrangement of circuits.

C. de la B. (Toulon) *describes a two-valve receiving circuit with capacity reaction and a resistance amplifier, which he says gives satisfactory results from the point of view of intensity but not of selectivity. He states that in receiving Lyons he is constantly jambed by Carnarvon and Nauen, and asks if we can suggest any improvement other than the employment of separate heterodyne.*

It is difficult to say what is causing jambing. You certainly should not be interfered with by Nauen, and even Carnarvon should not trouble you, as it is much farther off than Lyons. We suggest that your capacity reaction may be too strong; this would have the effect of setting up strong oscillations of bad wave-form in the receiving circuit, and it would then be necessary to employ close coupling to hear signals at all. These conditions would combine to give you bad selectivity as you might hear the beats formed by Nauen, with a harmonic of your oscillator.

J.J.F. (Portsmouth) *asks* (1) *What is the wavelength of a coil of certain specified dimensions.* (2) *If the above coil would be capable of receiving from the Eiffel Tower and other large public stations, providing the remaining instruments were all right.* (3) *If the leading-in wires on an ordinary crystal receiving set should be made of high tension wire.* (4) *With reference to a sketch of a twin aerial, if a certain arrangement of leading-in wires would be satisfactory.*

(1) The inductance of the coil is about 3,330 microhenries. The term wavelength as applied to a coil has very little meaning.

(2) In conjunction with your aerial the coil would be of insufficient inductance to tune to Eiffel Tower.

(3) Yes, or any other method may be adopted to ensure good insulation.

(4) It is preferable to have the leading-in wires straight from the top wires.

C.T.A. (Leicester) *is desirous of carrying out experiments with transformer-coupled H.F. amplifiers and says that his present transformers are constructed of ebonite bobbins, the winding being laid in 8 slots about ½" deep and 1/16" wide, 4 slots primary and 4 secondary, wound in alternate slots. He asks* (1) *Is this type of construction suitable for windings of resistance wire to render them more aperiodic. At present they are only efficient over a narrow band of wavelength.* (2) *Or what other type of construction do we suggest. Would plain single-layer coils concentric with air space between be better.* (3) *What gauge of wire (resistance) and how many turns do we suggest. Amplifier to cover as large a range of wavelength as possible.*

(1) Yes, quite.

(2) We do not think the single-layer coils would be satisfactory. Your first suggestion should be difficult to improve upon.

(3) Wire should be as thin as possible, certainly not thicker than No. 46 Eureka, and preferably thinner if you can get it. Amount to put on coil depends on gauge you use. Bring resistance of each half up as near 30,000 ohms as possible.

SPARKS (West Ham) *encloses diagram of circuit and asks* (1) *Why he can get no other stations than Eiffel Tower.* (2) *What suggestions we have to make to bring in other stations.*

(1) Your crystal is in series with your earth lead and shunted by the potentiometer and telephones. We are at a loss to say how you received any signals at all.

(2) Consult any text-book for correct arrangement or see answers to many recent questions.

D.H.T.B. (Woking) *encloses a diagram of his receiver and asks* (1) *If there is anything wrong with it.* (2) *If we can tell him of a good book on the ½ K.W. set, other than Hawkhead.* (3) *Why are leading currents dangerous.*

(1) Yes: you have condenser in series with detector and telephones. See diagrams in any text-book or innumerable answers to correspondents for correct arrangement.

(2) We know of no book dealing with the matter so fully. You may get some further information from Marchant's book on Wireless Telegraphy.

(3) We do not quite know whether you mean leading low-frequency currents or leading discharge positions. In both cases, but for entirely different reasons, excessive voltages are liable to be built up on the condenser.

J.A. (Wellington) *asks* (1) *If a twin aerial, 20' long and 20' high, 5' apart, will give him any results if he employs a larger inductance than necessary with a full-size aerial.* (2) *If it will affect reception if he bring his leading-in wire through an iron roof, through an ebonite tube insulator.* (3) *If a tuning transformer" made as given in the book by "Alfrec," would be of any use in the set he is making.* (4) *Which of the crystals zincite, bornite and chalcopyrites is red, and if they work without a battery.*

(1) You should be able to receive though not so well as with a larger aerial.

(2) No.

(3) This instrument would undoubtedly work, but there are many simpler methods.

(4) Zincite is red. No battery is required.

SPARKS (Gosport) *asks* (1) *What is the best way to connect a valve with batteries, etc., to an ordinary 31A crystal receiver.* (2) *What is the most suitable type to use.* (3) *Must the crystal be removed* *and the valve inserted in its place, or is it possible to use both crystal and valve with this circuit, using one as amplifier.* (4) *If so, is a valve-transformer necessary.*

(1) This question has been dealt with several times in the last two or three months. Consult these replies, which tell you how to connect either as an amplifier with the crystal, or as a rectifier instead of it.

(2) Any hard valve which works on comparatively few plate-volts will do.

(3) See above.

(4) A valve transformer will not be necessary.

N.B.—Do not forget that, under the Standing Orders of the Marconi Company, their operators must not modify their apparatus.

F.O.S. (Manchester) *asks* (1) *What weight and size of wire should be used for the primary and secondary windings of a low-frequency transformer.* (2) *What cross-section of iron should the closed core of a transformer have.* (3) *For criticisms and suggestions of a certain circuit.*

(1) Primary ½-oz., secondary 1½-oz.; both about No. 46 wire.

(2) About ½" square.

(3) Circuit should be quite satisfactory except that filament should be connected to the lower end of the A.T.I.

F.J.B. (Streatham) *has installed a set to receive time signals and can get no results. He suspects his detector, which is galena. He says his aerial is a 3-wire one, 14' long, on the top of a roof 40' above ground level, with single 35' down-lead. He asks for advice.*

The *effective* length of your aerial is considerably under the 100' which you give it, and therefore the most probable reason is insufficient inductance. If you add an inductance wound on a former 10" × 6" with No. 24 wire, you should get FL. See if you can get 600-metre stations; if not, your detector is probably not good. Your circuit should be O.K. If you can either raise or lengthen your aerial you will get better results.

S.C.T. (Forest Hill) *says he has a satisfactory crystal set which he wishes to alter to correspond with set described in April 17th issue. He sends sketches of both arrangements and asks* (1) *For criticism of circuits and advice for getting good results.* (2) *For the inductance of a coil C and of a condenser K for maximum and minimum.* (3) *What is the longest wavelength he can receive, and can he receive C.W. on this set.* (4) *If not a wavelength up to 15,000 ms. what ought he to do to improve set to that capacity.*

(1) We cannot understand how your crystal receiver gives satisfactory results, as the connections of telephone and crystal are fundamentally wrong, and dimensions of coils should not give you more than about 500 ms. at most. Your suggested valve and crystal set is all right, except for crystal telephone arrangement, which is again wrong.

(2) Coil C, of course, depends on wavelength required. You suggest 15,000 ms., but the whole arrangement of the set is unsuitable for this. If we say 5,000 ms., C should be about 50,000 mhys. and B should be increased to 20,000 mhys. K should be 0·0005 mfds. at maximum; minimum as low as possible.

(3) As shown, about 500 ms. Set will receive C.W.

(4) See above.

E.L. (Tooting Junction) *wishes to modify the receiver described in Vol. 8, No. 2, of "Wireless World" and wishes to make it for 6,000 ms. wavelength. He asks* (1) *Would he be in order if he doubled the length of the A.T.I., coupling-coil and secondary units, but still using same diameter of coils and wire.* (2) *If this would not do, for advice.* (3) *If a twin aerial, inverted L type, 22' high, 26' long, with 20' down-leads, would be all right.* (4) *For the gauge of a sample of wire.*

(1) and (2) Refer to reply to **R.G.N. (Norwich)**

(3) Aerial of this size will give very poor results. Moreover, to keep wavelength of set the same, you will require about three times the A.T.I. required with a full-size aerial.

(4) Sample has not come to hand. Any samples sent, should be *securely fastened to the covering letter.*

E.S. (Bognor) *asks* (1) *What would be the effect in a converter circuit without a no-volt release, if the field circuit were to break.* (2) *What amount and gauge of wire is required to load an aerial of 600 metres wavelength, up to a wavelength of 20,000 ms.* (3) *When radiating full power on a Marconi ½ K.W. set, what should be the voltage and amperage in the A.C. circuit.* (4) *What is the best method of making a small quenched-gap.*

(1) Machine would attempt to run away, taking an excessive current meanwhile. If a fuse did not blow in the circuit, the armature would burn out or fly to pieces. Exactly which would happen first would depend on circumstances.

(2) A former 2" × 10" wound with about 3,500 No. 26 will be about right.

(3) About 75 to 80 volts and 7 to 8 amps.

(4) We are afraid it would take too much space to answer this, and, moreover, it is difficult to say without knowing what tools and facilities you have. Consult a drawing of one in a text-book and copy it as near as you can with means available.

W.K. (Colchester) *sends a sketch of a receiving set (crystal), and asks* (1) *Would it work satisfactorily, also for comments thereon.* (2) *What would be the approximate range of wavelength receivable on this set.* (3) *Could a Tikker be put in this set instead of the crystal to receive C.W., would he be able to receive the C.W. signals from FL with it.* (4) *Might he expect to pick up telephone messages from Chelmsford (20 miles).*

(1) No; 30-wire is too fine for a satisfactory A.T.I. Wind it on a former 10" × 6" with No. 24 and re-wind jigger-primary with No. 24 or 26. Otherwise O.K.

(2) With alterations suggested about 3,500 to 4,000 ms.

(3) Yes.

(4) Certainly.

J.F.F. (Blackpool) *refers to suggestion for a H.T. potentiometer given on page 319. He has tried it and found that, contrary to the inventor's claim, generator noises are not cut out by its use. He asks what he has done wrong.*

Contrary to the opinion of the writer referred to, we see no reason why the arrangement should effectively eliminate generator noises, though it *may*, possibly, *somewhat* reduce them. We should suggest a large condenser across the terminals A and B.

E.C. (Bedford) *asks* (1) *If* 100 *feet of wire just under an iron roof of a shed would do as an aerial.* (2) *If he can receive telephony with such an aerial using a tikker instead of valves.* (3) *If a vibrating-reed rectifier of* A.C., *with a choking coil for smoothing out ripples will give a satisfactory* H.T. *supply for a valve.* (4) *He also suggests a type of microphone for magnifying sound in a receiver, and asks if his suggested scheme is possible.*

(1) No. Results would be almost nil.

(2) Failing use of a valve, a tikker is not possible for telephony, as you will realise if you think of its mode of action. You can use a crystal for the purpose, if you like.

(3) No; you will not be able to get rid of a loud hum, at the A.C. frequency, by this means.

(4) We do not understand how your proposed arrangement is intended to work, but do not think it likely to be of much use.

No. 28 (Brighton) *says that he appears to be badly situated as regards earth noises. He sends a sketch of the only crystal circuit which will cut them out. He says he is anxious to use a valve, and has tried all the circuits given in the "Wireless World" without success. He asks if there should not be some valve circuit which will cut out noises, and if we can suggest one.*

The set sketched is of very simple type, and should have no special noise-stopping properties. We are very doubtful of your suffering from earth noises at all, and think the trouble more likely to be from battery noises, due to poorly designed, poorly made, or over-discharged cells. The remedy is obvious. There is no special type of circuit free from noise trouble.

VALVE (South Shields) *wishes to make a Tesla coil to handle* 3 K.W., *using a valve to step-up* 110 *volts to* 20,000 *volts instead of using transformer for the purpose. He asks* (1) *If this is possible.* (2) *Where valve can be obtained.* (3) *For a diagram.* (4) *Where to obtain a book on construction of Tesla coils.*

(1), (2) and (3). We believe this is quite impossible. We know of no valve capable of stepping-up voltage in this way. You are probably thinking of rectifying valves, which are built to rectify currents at voltages up to the order of 20,000. These would be of no use for your purpose.

(4) You will probably find helpful articles in the back numbers of such papers as the *Electrical Experimenter.*

P.H.B. (Rothley) *sends a description of his results with a receiver of the type given by Reed in the December issue. He says that he gets very good results up to about* 900 *metres, but little above this. He thinks he hears* FL *at times but is not sure.* A.T.I. *is about* 4,000 *mhys., jigger primary* 500 *mhys., jigger secondary* 10,000 *mhys., grid-condenser* ·0002 *mfds., special condenser between grid and filament he finds best at* ·00015 *mfds. He says that set will not oscillate, with any capacity between zero and* ·001 *mfds., across jigger-secondary. Also set will not oscillate with less than* ¾ *of jigger-secondary in circuit, which he thinks will account for small wavelengths obtainable. He asks* (1) *For advice.* (2) *Whether Paris press at* 3 *p.m. is in French or English.*

(1) The A.T.I. is too small for FL. Make it about 8″×6″ of No. 24. If, as it appears, you are not using a tuned circuit capacity, this circuit will also be too small for FL, for which you will want about ·004 mfds. in parallel with jigger-secondary. It is unnecessary, and indeed undesirable, to make set oscillate when receiving spark stations such as FL. We do not quite know why your set will only oscillate under the conditions you state, but it is probably due to the unsuitability of the capacity of the special condenser mentioned above. We should try varying this considerably. Are you using a grid-leak?

(2) In French.

H.R.B. (Wandsworth Common) *asks if it is possible to increase wavelength range of a Mark 3 short-wave tuner, and if so, how to do it. He has tried an additional series* A.T.I.

This should be quite possible. Your addition should give an increased wavelength on stand-bi. For instance, on tuned circuit it will be necessary to add inductance in series with jigger-secondary as well.

C.A.J. (Bury St. Edmunds) (1) *Sends diagram of a set for criticism. Set gives good results on the whole, but he finds it difficult to tune in ships distinctly.* (2) *If a reaction coil is advisable for* C.W. *working, how to make it and where to put it.* (3) *If a spare* ·0003 *variable condenser can be inserted anywhere to advantage.* (4) *Method of connecting-in another valve.*

(1) Design of set appears O.K. You might get better tuning on short wavelengths if you put a few tappings in the jigger-secondary, to reduce inductance on short waves.

(2) Yes. Try about ¼ the inductance of jigger secondary. Insert it between plate and telephones, and arrange it to have coupling with jigger secondary.

(3) You might put it in parallel with A.T.I. It will do no harm if it does not do much good.

(4) You will find diagrams of many circuits of this type in recent issues of the *Wireless World.*

J.W. (Leeds) *sends diagram and description of a 7-valve receiver and says* (1) *That there is an excessive crackling which drowns all weak signals.* (2) *That wavelength range appears limited and tuning is not good.* (3) *Can he receive* C.W. *with the set.*

(1) This is probably due to poor valve-filaments or bad batteries.

(2) The type of amplifier shown, is only satisfactory over a fairly small range. It can be improved by winding H.F. transformers with very high resistance wire, or adding tappings. The capacity of closed circuit condenser is somewhat high, which will give rather flat tuning. The set is otherwise O.K.

(3) Yes, but reaction coil should be in plate and not in grid-circuit of first valve.

F.J.S. (Haverstock Hill) *asks* (1) *If set, of which he sends diagram will work, and if so, what will it receive.* (2) *If it will get spark,* C.W. *arc, and telephony* (3) *For formulæ for calculating* *inductance and capacity.* (4) *If an amplifying valve could be introduced.*

(1) No; connections are quite wrong. See article in issue of September, 1919, for typical circuit. You might with advantage study a text-book on the first principles of the subject.

(2) No.

(3) See reply to C.A. (Liverpool) in issue of September 18th, 1920, for formulæ for capacity of two common types of condenser. There is no simple formula for inductances in general, but the inductance of a cylindrical coil whose length is large in comparison to its diameter is roughly given by

$$L = \pi^2 d^2 n^2 l \text{ centimetres.}$$

where d is diameter of coil, l is length of coil, and n No. of turns per centimetre. If the coil has a diameter one quarter of its length, this result is about 10 per cent. too great. For shorter coils it is still more inaccurate.

(4) Not profitably. See article in issue of April 17th for a suitable circuit.

H.V.J. (Grays) *asks for a diagram of connections for a simple receiving set employing amplifying valves and a frame aerial. He asks for values of capacities and inductances but does not state on what wavelength he wishes to receive.*

As we do not know what wavelength you wish to receive or how many valves you are prepared to employ, it is difficult to advise you. The circuit shown in the issue of November, 1919, page 482, Fig. 3, would be suitable if the secondary circuit were replaced by the frame aerial, the reactance R being included in series with it.

W.H.W. (Worsley) *asks* (1) *If it is possible to receive Wireless Telephone messages from a distance, say, of 400 miles, with an indoor aerial, without using valves but using two Brown relays with some other form of sensitive detector.* (2) *For a diagram and description of apparatus required for above.*

(1) and (2) We think this quite impossible except perhaps with the very strongest telephony. With an indoor or frame aerial the oscillations set up are so small that they cannot be efficiently rectified and high-frequency amplification is therefore essential. In any case, a Brown relay is only useful for magnifying comparatively strong signals.

R.W.H. (Canterbury) *asks for some advice on the building of intervalve transformers, as he cannot find much to help him in recent numbers.*

Both L.F. and H.F. transformers have recently been treated in these columns as well as elsewhere in the magazine. L.F. can be wound on iron cores of soft wire (diameter of core about ½"), using about ½ oz. and 1½ ozs. of No. 47 copper wire for the windings. For H.F. of the semi-aperiodic type, use no iron in the core, and make each winding about 30,000 ohms. of the thinnest resistance wire you can get, not thicker than No. 47 and if possible thinner.

H.G. (Darlington) *sends sketch of a proposed receiving circuit and asks* (1) *What would be the dimensions of a tuning inductance to receive 3,000 metres.* (2) *If the angle at which he will have to bring down his aerial lead-in will be inefficient.* (3) *Would a long-distance telephone induction coil do as a substitute for a telephone transformer for 700 ohm. telephones.* (4) *If an alternative aerial system would be better.*

(1) About 10" × 6" former wound with No. 24.

(2) No.

(3) No; resistances are unsuitable. We would suggest trying telephones without any transformer.

(4) There is very little to choose between the two.

N.B.—Set is wrongly connected; crystal and telephone transformer should be across the A.T.I. only, not A.T.I. and condenser.

E.F.V.K. (Forest Hill) *encloses diagram of receiving circuit (Fig. 2) and asks* (1) *If it would work satisfactorily, using valve as note-magnifier, or if we could suggest a better one.* (2) *If certain windings would be correct for making a loose coupled tuner.*

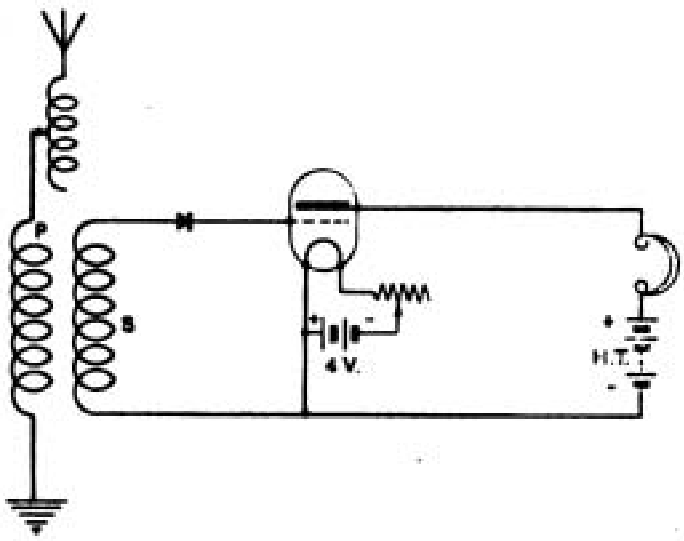


Fig. 2.

(1) Circuit is incorrect because secondary is not tuned; it requires a condenser. Further, there is no advantage to be gained in employing a crystal in the grid circuit as you show. If you wish to rectify at the first stage it is better to use a grid-condenser and leak. It is better perhaps to use the valve as an amplifier and rectify with a crystal. We strongly recommend the crystal receiver with valve magnifier fully described in the issues of April 17th and May 1st, 1920.

(2) You give no particulars of the wavelength you wish to work to. See above quoted articles.

DIELECTRIC (Dublin).—Regret we are not able to help you. Suggest that you apply to the American Consul.

W.L.T. (Liverpool).—These stations are probably amateur stations. Their identity is unknown to us; but an enquiry to the Secretary, G.P.O., may give you satisfaction.

E.G.B. (Peckham).—These stations are not known to us, but it is probable that they belong to any of the following:—R.N., R.A.F., Army of Occupation.

H.T.I. (Birmingham).—Birmingham Experimental Wireless Club, Hon. Secretary, A. T. Headley, 255, Galton Road, Warley, Birmingham;

Birmingham Wireless Association, Hon. Secretary, A. H. Handford, Birmingham and Midland Institute, Paradise Street, Birmingham: Birmingham Experimental Wireless Association, Hon. Secretary, J. B. Tucker, Lynwood, Ashleigh Road, Solihull, Birmingham.

METEOR (Wallasey).—All the information you seek concerning the Eiffel Tower weather reports is to be found in the 1920 Year Book of Wireless Telegraphy and Telephony, or the July 10th issue of the *Wireless World.* Cleethorpes transmits weather reports at 0500 and 1700 G.M.T. on 3,000 metres. Full information concerning the Air Ministry and Aberdeen reports may be seen in the *Wireless World* of September 18th, on pages 447 and 448.

J.R.T. (Derby) *encloses diagram of wireless telephony transmitting circuit (Fig. 3), and asks* (1) *Why when using one control-valve for wireless telephony the anode-current increases when the microphone is spoken into, but decreases when two control-valves are used.* (2) *Referring to his sketch, what resistance should* R_1 *be and what should be the capacities of* C_1 *and* C_2*—(·001 mfds. suggested). He states also that best results seem to be obtained with S closed and anode connections as shown.* (3) *How is the inductance of, say, 5 henries, measured or calculated.* (4) *If we can give the circuit eliminating the dead-space in heterodyning and reception on peak-wave.*

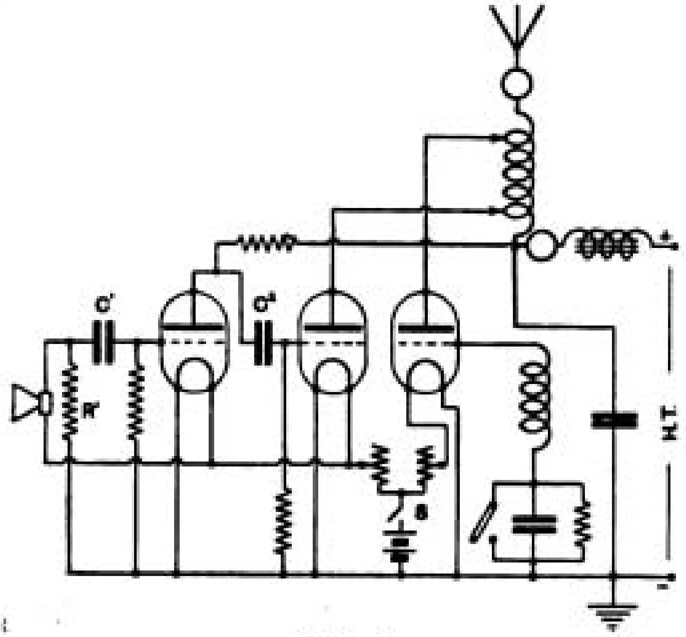


Fig. 3.

(1) In the circuit you show it is difficult to say why such an effect is produced. It appears to be bound up with the characteristic of the valves you employ and the values of the various resistances. It is by no means general to all wireless telephony circuits.

(2) R_1 of same order as microphone resistance. C_1 and C_2 have to react to audio-frequency impulses, so suggested capacity seems to be on small side, if anything. We do not like this form of control (resistance); transformer coupling would seem to be preferable. Your anode connections certainly do not look right, and we should judge that the results you are at present obtaining are somewhat of a freaky nature.

(3) See any text-book.

(4) We do not understand this question. The size of the dead-space in heterodyning depends on the strength of coupling employed; the best way of eliminating it, is by employing separate heterodyne very loosely coupled to the receiver.

A.A.P. (Mill Hill) *asks* (1) *For the capacity of a twin aerial of certain dimensions using single strands of No. 20 SWG wire spaced 3 ft. apart.* (2) *If the capacity would be increased by* (a) *using 3/20 wire and* (b) *increasing the spacing to 6 ft.* (3) *With reference to a diagram of his receiver if the L.S. value in mic-jars in circuits a, b, and c (Fig. 4) should be the same, viz., 2,265 for a 3,000 metre wavelength.* (4) *If so, as he does not wish to increase, the inductances of the loose coupled inductance, where should he put a variable condenser of maximum value 2 jars in circuit b to give this L.S. value.*

(1) About ·00015 mfds.

(2) (*a*) 8 per cent. increase. (*b*) 10 per cent. increase.

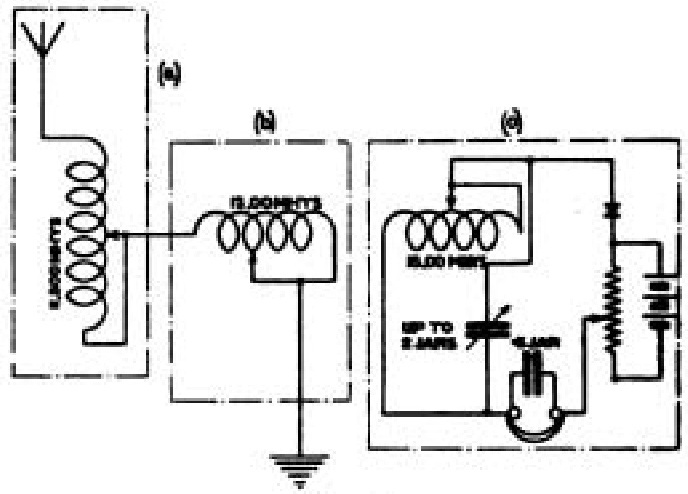


Fig. 4.

(3) The circuits *a* and *b* do not require to tune separately, but as a whole. Your present inductances should be quite large enough. We notice that your sliders are shown connected to one end of the coils always; this is incorrect as you thereby short circuit a large part of each coil.

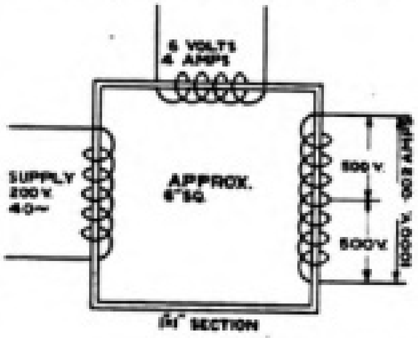
(4) Condenser does not appear to be necessary.

C. de la B. (Toulon) *states that he is intending to build an amplifier similar to that described on page 508, of the issue of December, 1919, and suggests winding the transformers with wire having a resistance of 1 ohm per foot. He wishes to know about what length of wire to employ in the windings of the transformer, in order to receive up to 20,000 metres, and states that he proposes to wind the wire in sections and to provide a switch so as to throw in a varying number of these.*

Your question is very difficult to answer, and the exact conditions can only be determined by experiment. We recommend you to build your transformer, section by section, testing the shorter wavelengths first and adding extra sections as required.

QUESTIONS AND ANSWERS

C.L.D. (Derby) *asks* (1) *For windings for a transformer as in sketch.* (2) *How inductance of a coil on a square former is calculated.* (3) *Inductance of a coil as in Fig. 5.*



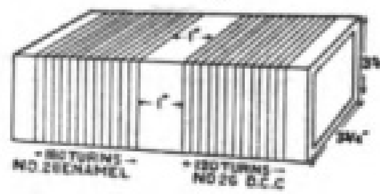


Fig. 5.

(1) Dimensions should be as follows :—200 volts winding, 2,000 turns of No. 22 ; 6 volts winding, 65 turns of No. 16 ; 1,000 volts winding, 10,000 turns of No. 36.

Wind the 1,000 volt coil in separated sections, being very careful of the insulation between sections and between all the windings and the core.

(2) Exact calculation is difficult. A rough approximation can be got by calculating the inductance of a cylindrical coil of a diameter equal to the side of the square and multiplying by 1·23.

(3) A difficult case to calculate exactly. The value 4,700 mhys. will probably be accurate enough for your purpose.

V.O.R. (Uxbridge) *gives particulars of three rectangular frame aerials which he has constructed, and asks* (1) *What wavelength each is capable of receiving, utilising the whole number of turns.* (2) *At which turns we would suggest tappings and what would be the wavelength received by each.* (3) *What is the best size of variable condenser to use with each coil.* (4) *What would the relative wavelength values of these coils be for transmitting purposes.*

(1) Each coil can be tuned to any wavelength required by a suitable condenser so there is no definite limit to the wavelength which any of them is capable of receiving, except their self-capacity, which is small. We should judge that the optimum wavelength for your largest loop is about 2,000 metres, though it would doubtless receive on longer wavelengths. See articles on frame aerials in issues of 29th May and 12th June, 1920, particularly Fig. 13, page 185, of the latter.

(2) Tappings quite unnecessary—shortest wavelengths can probably be obtained on any loop by decreasing capacity sufficiently.

(3) Probably about ·0003 mfds. and a series inductance if required.

(4) Frame aerials are very inefficient for transmission purposes.

SPARKUS (Wolverhampton) *asks* (1) *If a* **V24** *or similar valve were substituted for the valve in the constructional articles, would the value of the circuits require re-adjusting, and would results be satisfactory.* (2) *Gauge of enclosed piece of wire.* (3) *What value of high-resistance telephones are recommended for the set referred to above.*

(1) V24 should be satisfactory ; only alterations would be in size of H.T. battery.

(2) No. 22 SWG.

(3) If H.R. telephones are used they should be not less than 4,000 ohms, preferably more.

Beginner (Essex). In Fig. 1, page 497, Oct. 2nd issue, potentiometer should be connected as shown in Fig. 4, Sept. 18th issue, in reply to **W.A.S. (Kilburn).**

Nota Bene.—Owing to the increasing activity in the world of amateur wireless workers, the number of queries received for these columns has trebled during the past three months, and we have accordingly increased the pages devoted to them. In spite of this, however, we are regretfully compelled to hold over a number of replies each time we go to press.

Now, we welcome this steady influx of Queries, because it is the best proof we could have that we are being of direct assistance to our readers. Nevertheless, in respect of many instances, we are not altogether sure that we are helping them in the best way, because whilst we give them a " lift " over a stile, we ought, perhaps, to encourage them instead to help themselves.

Take, for example, the calculation of Inductance. The necessary formulæ can be found in dozens of books ; they involve simple mathematics only ; they have been printed in the *Wireless World* scores of times, and yet almost every post brings us requests to work out the Inductance values of simple solenoids.

Similar remarks apply to the calculation of capacity, wavelength, or windings, the connections of simple receiving circuits, the use and construction of telephone transformers and the design of aerials.

We shall continue to reply to these questions, because our business is to impart knowledge. No-one need hesitate to bring his difficulties to our notice. Yet we take this opportunity to throw out the hint—that if querists would look through recent issues before writing to us, they would, in all probability, find the required information already in print, and would thus save room in our pages for replies to their co-workers on subjects of more general interest.

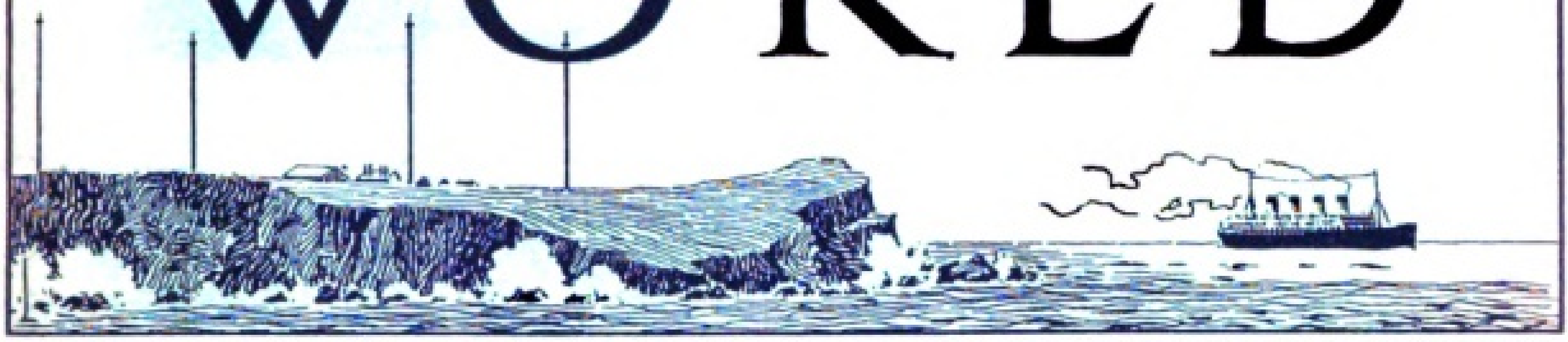
SHARE MARKET REPORT.

Business in all Wireless Stocks is at a low ebb and conditions weak.

Prices as we go to press, October 8th, are :—

Marconi	Ordinary	2¾
,,	Preference	2⅜
,,	Canadian	10/6
,,	Marine	1½

The WIRELESS WORLD



VOL. VIII. No. 16, NEW SERIES] OCTOBER 30th, 1920. [FORTNIGHTLY

CONTENTS

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THE
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VOL. VIII. No. 16. OCTOBER 30TH, 1920 FORTNIGHTLY

MULTI-LAYER WINDINGS FOR RADIO RECEIVING

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

(*Continued from page* 508.)

A SPECIES of combination between the banked windings referred to in the first part of this article and the spaced multi-layer windings which we have just been considering, is effected in the coils often referred to as "Honeycomb-type" inductances, or "Lattice Coils," as they are also called. In these windings the wire does not pass directly round the coil as in the ordinary method of winding, but zig-zags backwards and forwards from one side to the other, and if it is properly arranged the self-capacity may be reduced to quite a small figure. This type of coil originated in the "universal" machine wound coils, often used in commercial work for the construction of magnet windings, etc. In the coils as usually built for high frequency work no cotton is customarily wound in between the layers of the coil, as is often done in ordinary bobbin winding. The additional spacing obtainable by the cotton would often, however, be advantageous in reducing the coil capacity. The leading feature in the construction of one of these coils is that starting from any given point on the circumference of one face of the former, the wire passes around the coil and crosses over to the other face of the coil in about half a revolution round the circumference, and then passes back again to the first face, arriving there a small distance to one side or other of the starting point. Hence, when this process is repeated from this new point, the second turn of wire will trace out a path parallel to the first turn. This process is again repeated until the whole of the first layer has been covered by such spaced turns. If, then, the spacing has been properly arranged, the next turn after the completion of the first layer will arrive *immediately over the turn first put on the coil.* This gives us the first turn of the second layer, and the winding may then be continued indefinitely.

It should be noted that in a coil of this type the wires in successive layers are spaced apart radially by reason of their crossing over the turns in the first layer, and thus an air spacing is introduced between the turns over a considerable portion of their length. Such a coil if properly wound will be found to consist of a number of diamond shaped radial cells between the successive turns of wire, and it is from this that the term "honeycomb coil" was derived. The general features of the construction of such a coil are indicated in Fig. 11 (a).

The rectangle AXYZ in this diagram is intended to represent the appearance presented by a honeycomb coil if its surface were cut through and spread out flat. AX, or YZ, is, therefore, the thickness or width of the coil, and the length AZ or XY is its circumference. Imagine the wire W, as starting at the point A on the front face of the coil. It is then taken across to the point B on the opposite face and about half-way round. From B it passes to D (through C) on the front face again. To reach D it crosses over the first wire AB as shown, the point D being a few degrees *in advance* of A, the length AZ, of course, representing the 360 degrees of the entire circumference. From D the wire goes to E on the back face, the distance BE being equal to AD, so that the wire DE of the second turn remains parallel to the first. The succeeding turns of the wire, GHK, etc., may easily be followed from the diagram.

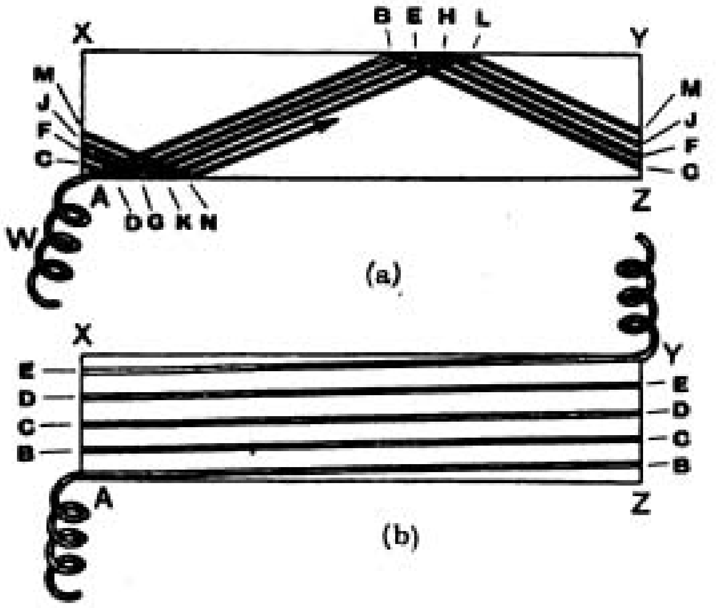


Fig. 11.

Comparison between honeycomb and ordinary windings. (The surface of the coil is supposed cut through and spread out flat.)

In the lower part (b) of Fig. 11, is indicated the appearance that would be presented by an ordinarily wound coil of the same dimensions were its surface layer cut through and spread out in the same way as for Fig. 11 (a). The successive turns of wire, AB, B′C, C′D, etc., may easily be followed, and may serve to emphasise the distinctions between these two types of winding.

It will be seen from this figure and from the description given above that one of the most essential features of this type of coil is that after the completion of one layer the first turn of the second layer should arrive immediately over the first turn on the coil. This will happen if the angular spacing, or *advance*, between the points at which the first and second turns of the first layer are commenced is an integral fraction of 360°, that is, if AD, Fig. 11 (a), is an integral fraction of 360°. Expressed in another way, the **angular advance, AD, multiplied by the number of turns of wire per layer, must give 360° exactly, and there must be an exact number of turns per layer.** For example, convenient values for this angular advance are either six or twelve degrees, giving 60 or 30 turns per layer respectively. Taking the latter figure, it is seen that the first turn, assuming that it starts at a point which we shall designate 0°, will cross to the opposite face coil and arrive there at a point 186° from the starting point; from which point it will cross back again to the first face reaching there 372° from the starting point, that is to say, 12° in advance on the starting point of the first turn. Hence, it will be seen that after winding 30 turns in this manner the first layer will be completed, and the second one will repeat immediately on top of the turns of the first layer.

Although primarily developed for machine winding, it is quite possible to construct these coils by hand, in spite of statements often made to the contrary. For this purpose it is necessary to provide pegs or pins on each face of the coil round which the wire may be passed, so as to secure it in position during the winding. When the coil is completed it may be immersed in paraffin wax to cause the layers to adhere, and the pins then withdrawn.

As an example, we may take the case of the honeycomb coil above referred to, in which the angular advance per turn was 12° and the turns per layer 30. To construct this coil, we require a suitable rigid former to support the pins. This may be of wood, or a stout cardboard tube, through which the pins may be driven. For ease in winding, it is advisable not to make the coil too thin—a convenient thickness (or width) being about equal to the inside diameter, or not much less than three-quarters of that diameter for ease in winding at the first attempt. Thinner coils can easily be built when the method of winding is once grasped. Equally spaced round both faces of this central former pins must be driven in, with 12° between pins—that is, using 30 pins on each face—Fig. 12. The pins on the two faces should be staggered to give the most uniform winding, as shown in the lower part of Fig. 12. Reckoning both front and back pins we there-

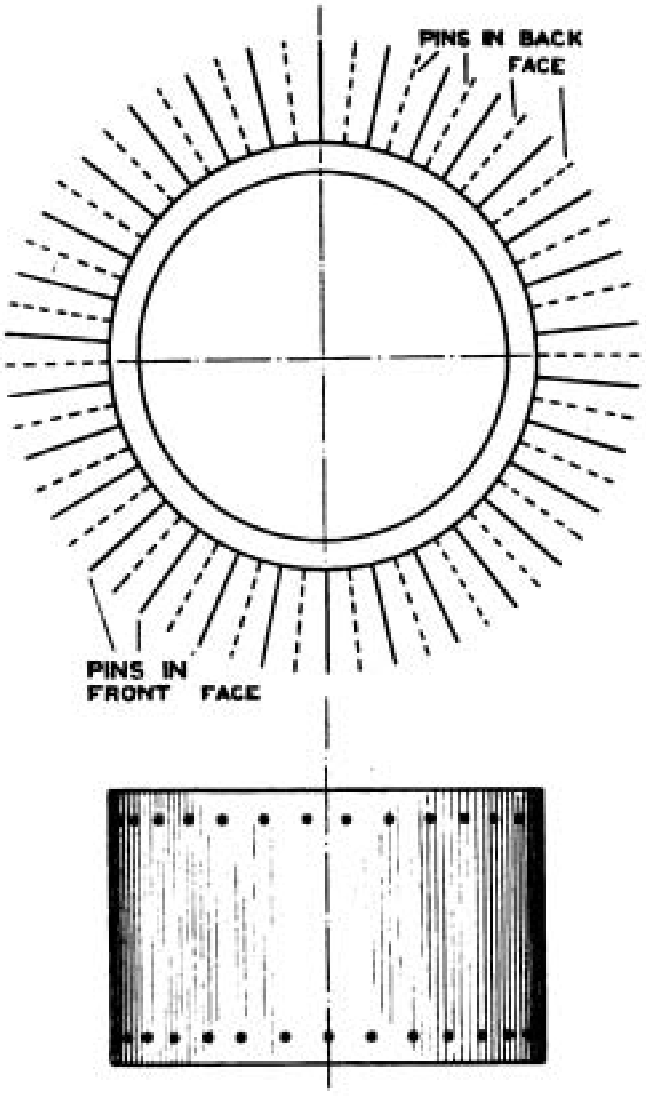


Fig. 12.
Elevation and plan of coil former with pins ready for a honeycomb winding.

fore have a pin every *six* degrees, first on one face and then on the other.

To wind such a coil we may proceed in the manner set out in the following table, remembering that the wire starting at 0, on the front face, passes across to the back face (at 186°), then still continuing round the coil in the same direction (compare Fig. 11a) it returns to the front face at 12°, and so on :—

TABLE I.
WINDING TABLE FOR HONEYCOMB COIL WITH 12° ADVANCE.

FRONT FACE.		BACK FACE.
0°		186°
12°		198°
24°		210°
36°		222°
48°		234°
60°		246°
72°		258°
84°		272°
96°		280°
108°		294°
120°		306°
132°		318°
144°		330°
156°		342°
168°		354°
180°		6°
192°		18°
204°		30°
216°		42°
228°		54°
240°		66°
252°		78°
264°		90°
276°		102°
288°		114°
300°		126°
312°		138°
324°		150°
336°		162°
348°		174°
0°	—Second layer—	186°
&c.		&c.

Many varieties of these patterns of coil have been worked out, and considerable literature has grown up around them, particularly in America, but for the purpose of this article the essential features to grasp are the general principles of the winding such as outlined above. Given these general principles many variations can usually be devised. One such which possesses some advantages over the simple honeycomb coil from the point of view of reduced self-capacity, is that generally termed the "Duolateral Coil" which will be described in a later article in this series together with some other similar modifications of the lattice winding.

NOTES AND NEWS

Dr. O. Sinnatt, M.C., D.Sc., who is at present Lecturer in Mechanical Engineering, London University, King's College, has been appointed to the Professorship of Aeronautical Science at the R.A.F. Cadet College, Cranwell.

Amateur Call-signs.—The following additions should be made to the amateur call-sign list given in the *Wireless World* of October 16th :—**2 G W** : Mr. A. Cash, Lynn, Ches. Hours of working, 7.30 to 9.30 p.m. G.M.T.

Wireless Weather Reports.—The following alterations to call-letters, times and wavelengths should be made in the list of stations transmitting weather reports given in the *Wireless World* of July 10th, 1920 :—Cape Town Radio, **V N C** ; Fuki Kaku, **J F K**. San Francisco should now read **N P G**, 1,600 G.M.T., 600 metres wavelength. **Flamboro' Head D.F. Station** is temporary out of action until further notice.

Einstein's Theory.—According to the *Electrical Review*, it is reported that, in a discussion which recently took place at Badnauheim in connection with Einstein's theory of relativity, Professor Grebe, of Bonn, stated that the third and remaining test of the truth of the theory had been complied with, measurements of the solar spectrum having revealed a shift towards the red which agreed closely with Einstein's predicted value.

Radio Control.—It is reported from Washington that the tests of the Radio-Control installation on the *Iowa*, carried out by the United States Navy Department off the Virginia Capes, have fulfilled the highest expectations of experts. The 12,000-ton battleship was navigated with accuracy solely by means of wireless waves emanated from the control station on the battleship *Iowa*. The control is said to have been thoroughly efficient up to a maximum distance of ten to twelve miles.

To Determine Australian Longitudes by Wireless.—According to the *Scientific American*, wireless signals are to be used in marking out the boundary between South and West Australia, defined by Imperial Act as the 129th degree of longitude east of Greenwich. It is proposed to determine the initial point on the line by utilising longitude signals from a high-power radio station located at some point between Greenwich Observatory, in England, and Sydney Observatory, in Australia, the signals to be received simultaneously at these points. This undertaking will be the first step in a comprehensive scheme involving the re-determination of the whole longitudinal system of Australia. A committee has been appointed to carry out the work in Australia, comprising the Government astronomers of New South Wales, Victoria, West Australia and South Australia, the Commonwealth surveyor-general and the director of the Royal Australian Navy Radio Service. It has been ascertained that, under favourable conditions, signals from Lyons can be successfully received in Australia as well as at Greenwich, and signals from other stations more symmetrically situated are also being tested. The co-operation of the United States, as well as the British Government, has been invited.

The Highways Committee of the L.C.C. are inviting engineers and others to submit new designs for electric tramcars, in the hope of obtaining an improvement on the existing type. A prize of £1,000 is offered to the person whose design is decided by the adjudicators to be the best submitted. Mr. A. L. C. Fell, general manager of the Council's tramways, and an engineer nominated by the President of the Institute of Civil Engineers, are to sit as judges. The designs are to be submitted not earlier than November 1st and not later than 4 p.m. November 30th. All enquiries as to the conditions should be addressed to the General Manager, L.C.C. Tramways, Belvedere Road, London, S.W.

French Wireless Telegraphy and Radio Telephony Stations.—The following wireless telegraphy and radio telephony stations situated on the respective aerodromes, are established :— Le Bourget, **Z M**; C.W., interrupted C.W., radio-telephony, 900 metres wavelength, 0700—1900 G.M.T. **Z M** also transmits meteorological messages relating to the London—Paris Air Service, on 1,400 metres wavelength at 0730, 0930, 1030, 1130, 1330, 1530, 1830. St. Inglevert, **A M** ; C.W., 1,400 metres wavelength, radio-telephony, 900 metres wavelength, 0700—1900 G.M.T. **A M** also transmits meteorological messages to the same effect as **Z M** at 0705, 0905, 1005, 1105, 1305, 1505, 1805. Lyons, **A L** ; C.W., 1,400 metres wavelength, 0700—1900. **A L** also transmits regional meteorological messages at 0850, 1050, 1450, 1620, 1850. Nimes, **A M** : 1,400 metres wavelength, 0700—1900. **A N** also transmits weather reports similar to those emanating from **A L** at 0710, 0910, 1310, 1810. The following D.F. stations have been established in France :— Barre de l'Adour, **F L O**, 450 metres ; Bernieres, **U H N**, 450 metres ; Brest-Capucins, **H U D**, 450 metres ; Brest-Guipavces, **F H A**, 450 metres ; Casablanca - Chetaba, **F C H**, 450 metres ; Chemoulin, **F U H**, 450 metres ; Cherbourg, **F F C**, 450 and 600 metres ; Le Havre, **F F U**, 450 metres ; Lorient, **F F L**, 450 and 600 metres ; Quesant--Pen-Ar-Roch, **F H Y**, 450 and 600 metres ; Point du Raz, **F P U**, 450 metres ; Rochefort-Soubise, **H O B**, 450 metres ; Treguier, **F Q C**, 450 metres. **F H Y** answers **F F F** ; **H U D** answers **F F K** ; **F C H** answers **C N P**.

Wireless Institute for New Zealand.—According to the *Auckland Weekly News*, it is understood that legislation will be passed this session to permit the formation of a New Zealand Wireless Institute for the purpose of encouraging work in wireless telegraphy in the Dominion. This body will have branches in various centres, and it is desired that a licence shall be granted to each local branch to instal wireless apparatus and train persons interested in its use.

H. W. Sullivan, the Electrical and Telegraph Engineering firm, have informed us that owing to the enormous demand for their present list "W," the edition is entirely exhausted. A new and larger catalogue, "W 2," will be available early in October. This list will cover practically everything used in wireless reception and will contain details of a number of novel instruments.

THE PROCEEDINGS OF THE WIRELESS SOCIETY OF LONDON

SOME PERSONAL EXPERIENCES IN CONNECTION WITH THE CONSTRUCTION AND ACTION OF A SIX-VALVE HIGH-FREQUENCY RESISTANCE AMPLIFIER

By M. Child.

THE first meeting of the session was held at the Institution of Civil Engineers on Thursday, September 30th, the President (Mr. A. A. Campbell Swinton) in the chair.

After the minutes of the last meeting had been read by Mr. McMichael, the Hon. Secretary, and confirmed, the President then addressed the meeting as hereunder:—

The President : There are, I understand, about 20 new members up for ballot. Papers have been distributed in the ordinary way and will be collected at the end of the meeting.

The following further Societies have been accepted for affiliation with this Society: The Preston Wireless Society, Hull and District Wireless Society, Bradford Wireless Society, Stockport Wireless Society, and the Sussex Wireless Research Society.

Owing to the resignation of the following gentlemen from the Committee, Mr. E. W. Kitchen, Dr. F. C. Knight and Capt. J. Shaw, the first two, owing to their having ceased to reside in London, have found they are not able to attend, and Capt. Shaw, I am sorry to say, owing to severe illness, the Committee have filled the casual vacancies that have occurred upon the Committee by the election of Mr. G. G. Blake, A.M.I.E.E., Mr. P. R. Coursey, B.Sc., A.M.I.E.E., and Mr. J. Scott-Taggart, A.M.I.E.E. These gentlemen will be members of the Committee until the next Annual General Meeting, in December, when they will have to be re-elected or not, as the members of the Society desire, because the Committee have only the power to fill the vacancies up to that time.

Also, owing to the pressure of work upon the Hon. Secretary, Mr. McMichael, who, I may say, has something like 50 letters a week to attend to, besides arranging these lectures and other things, the Committee have thought it necessary to obtain further Secretarial assistance, and I am pleased to say that Mr. A. Hamblyn has agreed to act as Assistant Hon. Secretary.

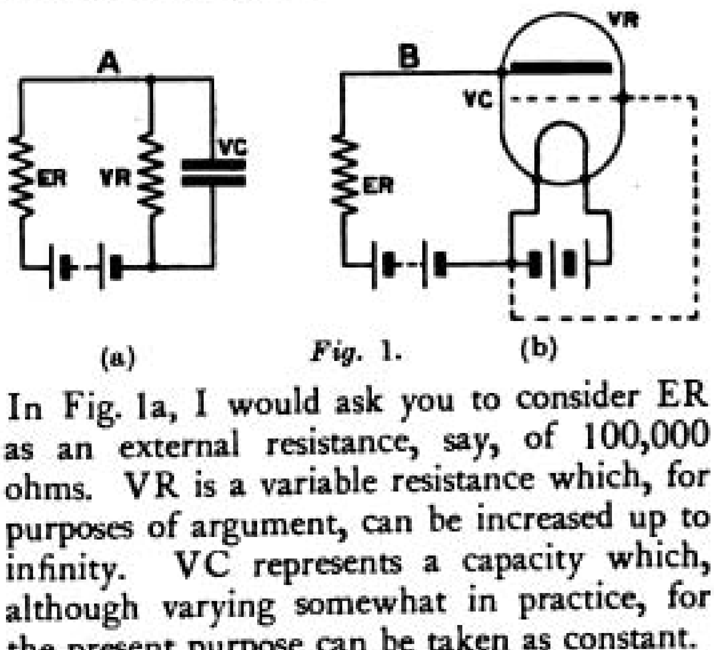
I will now call upon Mr. Child to give his lecture, "Some Personal Experiences in Connection with the Construction and Action of a 6-valve High-Frequency, Resistance Amplifier."

Mr. President, ladies and gentlemen,

It is my intention this evening, with your kind indulgence, to give you some details concerning experiments which I have carried out in connection with the construction of a 6-Valve High-frequency Resistance Amplifier.

Before, however, I deal with the principal subject-matter of this paper, I feel that I should conform to our usual practice of devoting a little time to elementary theory.

Consider for a moment two simple circuits as shown in Fig. 1 :—



(a) *Fig.* 1. (b)

In Fig. 1a, I would ask you to consider ER as an external resistance, say, of 100,000 ohms. VR is a variable resistance which, for purposes of argument, can be increased up to infinity. VC represents a capacity which, although varying somewhat in practice, for the present purpose can be taken as constant.

Fig. 1b shows the equivalent conditions as applied to the 3-electrode valve in resistance amplifiers, relays, etc.

By a simple application of Ohm's Law it is easy to see that if ER=VR, not only is the difference of potential across ER equal to that across VR, but the energy consumed in each resistance is the same.

If now we make the value of VR smaller, then at the same moment that this is done the potential across ER will increase, owing to the rise of current.

On the other hand, of course, the opposite effect will take place if VR is increased.

In practice the variation of VR is accomplished by applied potentials to the grid of the valve. (Fig. 1b).

In examining the characteristic curve, Fig. 2 (actual curve taken with apparatus, not theoretical),you will note that the plate current, and it is this current we have just been considering, can be completely shut off ; or, in other words, VR is made infinitely high, if the grid is normally held or momentarily becomes sufficiently negative.

In cases of low-frequency transformer coupled amplifiers it is desirable from the point of view of battery economy, and also to enable one to work the transformers at the highest efficiency, to keep the grids sufficiently negative.

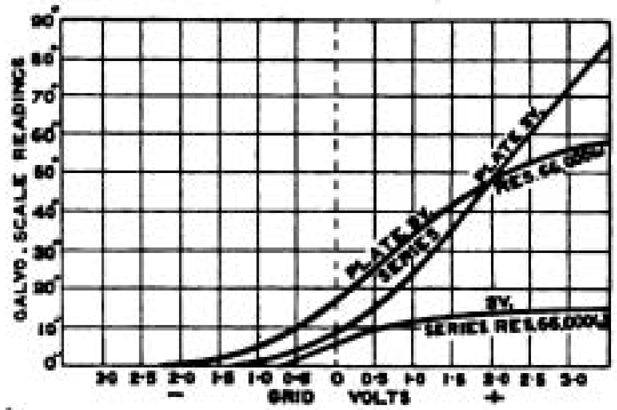


Fig. 2.

This cannot be so successfully accomplished in a resistance-amplifier designed to operate with good sensitiveness on frequencies corresponding to wavelengths to the order of 500 to 1,000 metres. For longer waves, however, we can more nearly, if not entirely, approach the condition of the low-frequency amplifier adjustment.

The reason for this can be seen from a short study of Fig. 3.

Here we have two valves coupled together through the coupling condenser CC. The grid of the left-hand valve is normally held at zero, since it is provided with the leak GL.

Any fluctuation of E.M.F. across CC must be accompanied by a change of current in

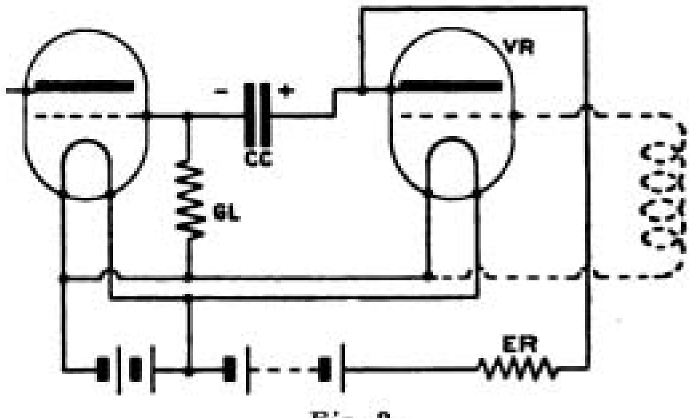


Fig. 3.

ER from the H.T. battery, and it is desirable that the resistance of ER shall be the same as the plate-filament resistance VR of the right-hand valve.

It is obvious that if the grid of this valve is made strongly negative, then VR becomes excessively high (perhaps 10^6 ohms.), and ER therefore will have to be of the same order. In this case, if the frequency of applied E.M.F's. is, say, in the neighbourhood of 5×10^5 per sec., (corresponding to a 600-metre wave), the high value of ER would smooth out the impressed current fluctuations in the plate-circuit with the result that little or no change takes place in CC.

To summarise the position, ER should be high, from the point of view of obtaining maximum potential variation due to change of plate-circuit current, but low from the point of view of *rapid* change.

If ER is chosen to suit this last requirement, it is necessary that VR shall be relatively low, and this is attained by making the grid normally positive.

When I use the terms "positive" and "negative" as applied to the grid, I do so in a comparative sense only. Much, of course, depends on the characteristics of the particular valves employed, the voltage of the H.T. battery and filament temperature.

From the foregoing remarks, you will gather that in the case of a 6-valve amplifier constructed on these lines, the load on the

H.T. battery is considerable. This is, of course, the case, but economies can be made, using only the necessary number of cells to give the desired strength, or by the judicious use of a potentiometer to vary the normal grid potentials, thus getting the desired control in that way.

It may be of interest, if I recount a few of the considerations which led me to decide on constructing this amplifier.

An instrument was required for the purpose of enabling advanced students to obtain practice in reading commercial code and cypher messages, dealt with by certain well-known high-power long-wave stations. As probably most of you are aware, for Morse-practice purposes in London, it is useless to "listen-in" on a wavelength of 600 metres. The results on this wavelength more nearly approximate to a "Jazz band," with an occasional, *very* occasional, respite, which leaves one in some doubt as to whether one's aerial is still intact or telephones burnt out.

The only signal which seems to indicate that the Morse code is used on this wavelength is the QRU, and from the student's standpoint this is rather unsatisfactory.

Since the required long-wave signals had to be of good readable strength, *i.e.*, about strength 5 or 6, and further, to be able to be heard with at least six pairs of telephones connected in parallel, and as the aerial was a very short one, (70 feet at a mean height of 10 feet above earth), I considered that six valves would be required; but, as you will see later, I have made provision for a lesser number to be used by means of a quick adjustment.

Other factors of considerable importance were those of being able to quickly "tune in" and also to determine with accuracy, the wavelength of the station.

For this latter purpose the usual re-action circuit, with a single detecting valve and perhaps a two or three stage audio-frequency magnification, is unsatisfactory. The coupling of the re-action coil, or as our American friends call it, a "tickling coil," to a tuned secondary circuit varies the effective value of the inductance of such a circuit by amounts which, in practical work, it is impossible to make corrections for, and hence accurate calibration of the tuner is impossible.

The resistance high-frequency amplifier, on the other hand, can be connected up to an ordinary two-circuit tuner and with the secondary loosely coupled, direct wavelength measurement is possible from the variable condenser scale-readings with good accuracy.

The last important point was the question of interference from local sources.

In the building where the amplifier is used there are 15 sounder and 16 buzzer-circuits, 6 Siphon Recorder Mousemill motors, 30 telephone Morse practice circuits operated by a central buzzer, local house telephones, a 60-80 volt D.C. generator, and 100 volt A.C. mains. Within 50 yards of the building is the District Railway, with its power sub-station.

The afore-mentioned apparatus in the building is, of course, shunted, but the local currents are still sufficient to render wireless reception almost impossible with any low-frequency magnifier placed in the building itself.

It is known that the aperiodic type of high-frequency amplifier is relatively insensitive to low-frequency impulses, and this is well borne out in practice by the particular instrument described in this paper.

Fig. 4 shows both the front and back views of the instrument.

In the top figure you see the 6-valves; under these a corresponding number of sockets into which a plug with a flexible conductor attached can be placed; under these sockets on the left, is a potentiometer or more strictly speaking, a potential divider, and on the right a variable resistance of 2 ohms. maximum value.

In the bottom figure you see a row of five coupling condensers, and on top of these again, five plate-circuit resistances.

At the bottom right-hand corner is a step-down telephone transformer lying between one pair of the five grid-leak resistances. At the bottom left-hand corner is a condenser

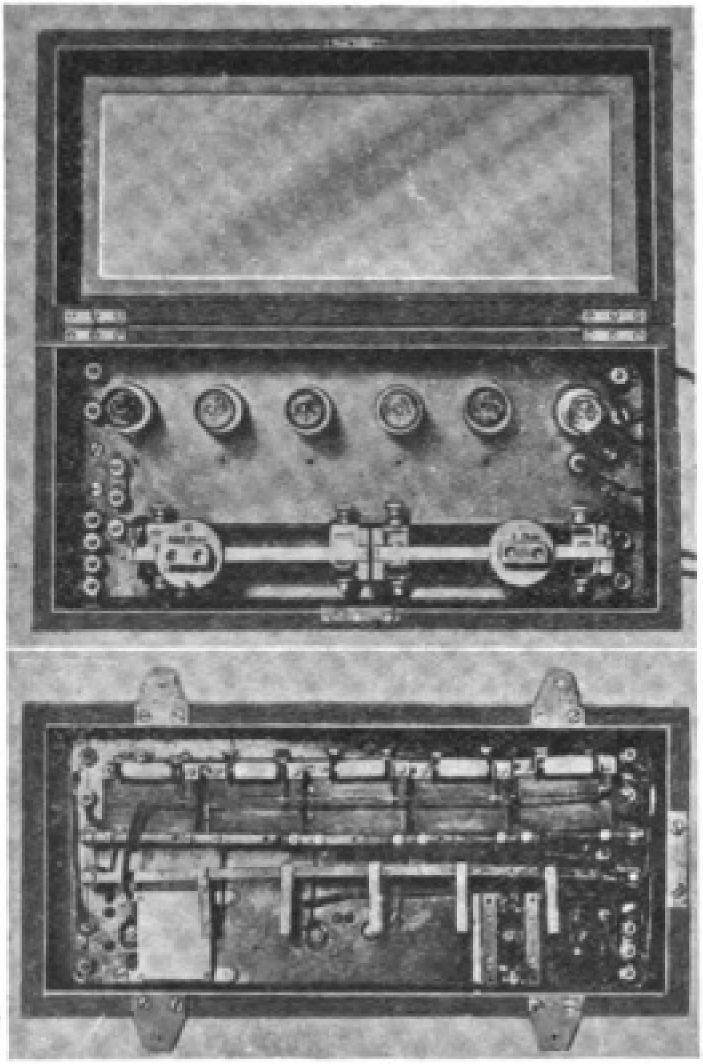


Fig. 4.

for bye-passing the high-frequency impulses around the transformer winding in series with the plate-circuit of the last valve.

Fig. 5 shows the complete diagram of connections which are similar in most respects to those which have been published in text-books. There are, however, one or two points which I would draw your attention to.

Firstly, you will observe that, with the exception of the first valve on the right, the normal grid-potentials can be controlled by the potentiometer. This is not, I believe, very usual, but after several experiments I found that this plan was the most successful.

It is easy to provide a local potential to the first grid, if desired, by means of an external potentiometer. An external leaky condenser can also be used in the lead marked "To tuner" and which terminates on the grid.

I have tried, by making an adaptor for the 4-pin socket valve connections, a Marconi "Q" valve, using the potentiometer to control the first 5 valves as is usually done by the Marconi Company in their 7-valve H.F. semi-aperiodic amplifiers. The results, however, were very poor, and I was unable to get the instrument to oscillate even when the re-action connection was taken from any of the four previous valves.

The "Q" valve is, of course, intended solely as a rectifier, and the fact that the signals were very weak when it was employed, seems to indicate I think, that with this instrument, used as it is with ES4 valves, which have similar characteristics to the well-known "French" valve, the process of rectification is more or less distributed, or can be distributed over the whole six.

It is possible that some other explanation can be given, and that some members may be able to suggest one or two.

Secondly, I would draw your attention to the terminals marked A, B, and C.

A and B are usually strapped together, but for experimental purposes, or in case different types of valves are used, it is possible to connect-in at these points one or more cells to augment the grid-control.

Terminal C is provided for the two following contingencies. Firstly, it is not an unknown thing for the fine wire of the potentiometer to break, usually at the terminals to which it is attached. By strapping B to C, the potentiometer is short-circuited inside the instrument, and can then be removed at leisure, a temporary one being used between A and B if required. Thus the instrument need not be out of commission for more than a few minutes.

Secondly, since the three connections to the potentiometer come right through the base to their respective terminals, it is possible by taking these off to employ it as a separate unit for any additional experimental circuit which one might wish to try out, assuming of course that the amplifier is operating successfully at the time without it, *i.e.*, with B and C shorted.

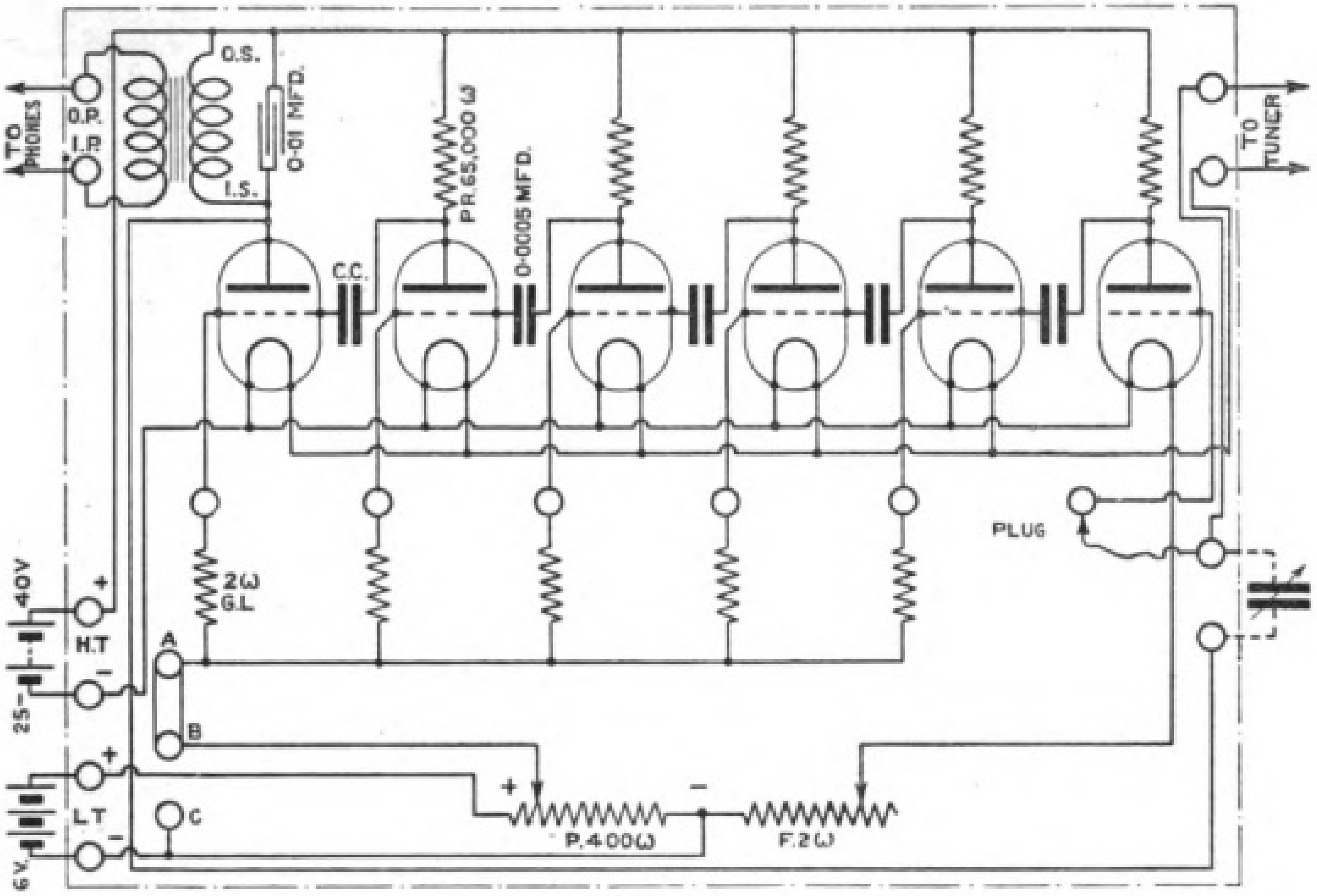


Fig. 5.

You will also note that the plug shown can be placed in any of the sockets opposite each valve.

If less than the six valves are used, it is better to remove any required, completely from their sockets.

I now turn to the more minute details concerning the construction of other parts, and to recount my experiences in their manufacture.

I would like to mention, in passing, that when I commenced this work I had absolutely no previous experience with any instrument of the kind. What knowledge I possessed concerning valves and valve-apparatus was purely theoretical, and there have been times since, when I have almost wished it had remained at that stage.

It was in May, 1919, that I began construction, and it was not until ten months later that I decided to leave it well alone.

The original plan was for high-resistance inductive windings, the plate-circuit coils being magnetically coupled to the grid-coils of the next valve.

No. 46 S.W.G. Eureka wire was used, and great care was taken to equalise the resistance of all the coils.

Numerous tests were made in the way of joining them up but without any success, and persistent "howling" took place even when low plate-voltages were applied.

It was at this stage of affairs that our Society came into activity again, and no doubt many here will remember that at our first meeting there was a display of various pieces of apparatus by members, one of the most interesting exhibits being that of our President, viz., a resistance-amplifier of his own design, I believe. When I viewed the interior of this instrument its comparative simplicity impressed me very much, and I mentally consigned my own inductive coils, over which I had spent so much time, to a place where their resistance might be of more use to them.

The next problem was the supply of non-inductive resistances of the most suitable values.

To this end I made some commercial enquiries as to what could be obtained, and found that I could get high resistances to the order of 2 to 4 megohms at several shillings apiece, but nothing in the neighbourhood of 60,000 ohms except, of course, wire-wound ones. Further, and this was to me important, I wanted accurate values, (not approximations), and inasmuch as I was uncertain as to the best values to employ, there seemed only one way out of the difficulty without involving considerable expense, and that was to make them myself.

Graphite as a high resistance conducting material seemed suitable, both from the point of view of expense and ease to use. The first effort to make resistances of 60,000 ohms from this material was not successful, but as others may be likely to try the same method, I mention it so that they may enjoy any benefit which my experiences may be worth to them.

For each unit I prepared a strip of ebonite 2 inches long and ¼-inch wide. Two small brass plates, drilled for two No. 8 B.A. brass screws, were fixed by nuts at each end of the ebonite. Before finally placing these brass strips in position, the ebonite surface, with the exception of about ¼-inch from the middle, was well rubbed over with a hard pencil, the terminals then being joined in series with a battery and sensitive D'Arsonval pattern galvanometer. The middle space was then rubbed with graphite until the desired deflection was obtained. With a little care it was possible to get several such resistances with a fair degree of accuracy.

I have made 2 megohm resistances the same way—in fact, these are still in use in the instrument. The graphite surface has been varnished, and the terminal connections improved by placing a small strip of tinfoil under the brass, the soft character of the former, bedding well on to the graphite and thus ensuring reliable contact. In connection with the varnishing I used a very rapid drying celluloid varnish, and this was applied in two or three drops from a brush. Being very thin it spread itself over the surface, and in this way the amount of graphite was not disturbed. At the same time that the varnish was applied, galvanometer readings were noted. When the surface was wet, the resistance increased by about 25 per cent., but gradually fell, practically to its original value as it dried. After many trials and failures to get five units having the same value I was successful.

In the case of the 60,000 ohm plate-units, matters were different.

It must be noted that these have to carry an appreciable current, whereas the leak-units have hardly anything measurable passing through them.

Being anxious to see if I was working on the right lines, I assembled the instrument with the plate-resistances constructed as first mentioned, *i.e.*, without tinfoil contacts or varnish, but although I got results, they were poor. There was a very considerable amount of hissing and crackling, suggesting poor contact somewhere, and as this became less when the grids were made negative, I concluded that the trouble had to do with these plate-resistances. On taking them out and testing with the galvanometer I discovered that the values were entirely different from when they were made a few days previously. A curious fact revealed itself here. Out of the five resistances tested, four had all fallen, whilst one remained practically at its original value.

The 2 megohm resistances had not changed. Now, if it had been purely a question of defective terminal contact, one would have expected that out of five tests, two or three perhaps, would have shown increased resistance and the remainder, a decrease. It occurred to me that, considering there was probably a difference of potential of 30 to 40 volts on these resistances, a coherer action might be the explanation, and that if it were so, it would be accounted for by the fact that the adhesion of the graphite to the ebonite was imperfect and that the particles had a tendency to disintegrate and cohere together.

I then thought of what other materials as a basis for the graphite coating could be used, and decided to try a slate-pencil. This has proved much more successful, and I will therefore explain the method I adopted as to the mounting of these.

From an ordinary slate-pencil I broke off a piece 1¼ inches long and squared up the ends with a file. The piece was then placed with about ½-inch protruding from the chuck of a lathe. The former was first smoothed down with sandpaper, and then rotated against the point of an H.B. pencil. By this method quite a quantity of graphite was pressed into the surface, which became relatively hard and bright. The piece was then reversed in the chuck and the same process repeated. I left about ½ inch in the middle uncoated.

Connection was made at the coated ends by wrapping a strip of tinfoil three times round and binding down with No. 30 S.W.G. copper or other suitable wire, the whole being very lightly and quickly soldered to prevent uncoiling. A short length of the binding wire was left extending for the purpose of further connection to the rest of the instrument, or, in the case of the particular specimen I am describing, for threading through holes in the end of the ebonite cylinder, provided with brass screws, on to which thicker conductors can be soldered.

The particular resistances in the amplifier had the graphited rods fixed into small brass cups with Wood's metal, and an outside covering of waxed cloth provided for protection from damp and dust.

I cannot altogether recommend this last method of terminal contact, in that unless great care is exercised there is a danger of fluxite or other soldering flux getting to the graphite, and it is also not very easy to set the rods in straight; however, if done carefully the electrical connection is good.

After the terminal connections have been fixed it is only necessary to join them in series with a good galvanometer and battery, and fill in the intermediate space with graphite, until the desired resistance is obtained. In doing this, I usually rub it in well and bring the resistance about 25 per cent. below the desired value, removing the surplus graphite by means of a clean dry cloth until the exact deflection of the galvanometer is obtained. This last operation is quite easy and remarkable accuracy of resistance value is arrived at.

Probably better connections may be had by copper-blasting the ends, but this is generally a case for the trade manufacturer.

It may be queried as to the necessity of great accuracy in adjusting all the resistances to exactly the same value, inasmuch as it is unlikely that all the valves themselves have the same capacity and resistance, and consequently a slight variation of external resistance cannot materially affect matters.

In answer to this I would point out that small variations in the grid and plate-circuit constants, are sufficient to cause phase differences, and although for damped wave reception these may be unimportant, when a re-action is employed much disturbing hissing in the telephones occurs. Again, for the reception of speech, one may get distortion or the loss of clear articulation.

Apart from this, it must be admitted that the question of "commercial expediency," which has been noticeable in the design of all kinds of wireless apparatus marketed from time to time, should not enter into the calculations of those whose sole interest should be to obtain maximum efficiency from the instrument they construct.

I now turn to the intervalve coupling condensers. At first I made these to ·004 mfds., being guided by the value given on page 172 in Elmer E. Bucher's book entitled *Vacuum Tubes in Wireless Communication.* The actual value shown is ·005 mfd., but reasoning this might be rather large, I decided as a first attempt to try a lower value.

Accordingly condensers were constructed consisting of nine sheets of copper foil 4 cms. square, separated by ebonite dielectric ·01 c.m. in thickness. The sheets were clamped between two aluminium plates and arranged in a row as shown in Fig. 4.

With these condensers and the original resistance high-frequency transformers, I obtained no signals except from a buzzer close at hand. It was by testing with the local buzzer that I found that signals were as good with one valve as with the six. The buzzer was "tuned," and the wavelength approximately 1,000 metres. Since it was a simple matter to alter the capacity of the condensers in question, they were reduced to ·0005 mfds., with the result that "parasitic" noises were greatly intensified. This seemed a good omen, especially as I on one occasion, detected signals superimposed on the somewhat powerful note, due to the amplifier itself.

By experimenting with the instrument connected-up and its interior exposed, I found that the note could be modulated and even stopped at times, by connecting the clamping-plates of the condenser together, either the whole number, or in certain sequence. It was assumed that electrostatic induction, in addition to electromagnetic induction from one transformer and its neighbour, was taking place thus, causing the whole instrument to be set into self-oscillation.

At the time when the transformers were replaced by the graphite resistances, I decided to use ebonite clamping-plates in place of the aluminium ones. By so doing, all unnecessary masses of metal were eliminated and this appears to have satisfactorily assisted in the final successful evolution of the instrument. The present condenser capacities are still ·0005 mfd., or as near that figure as I could get them. The sheets are of the same dimensions as previously stated, viz., 4 by 4 cms., with ebonite dielectric ·01 c.m. thick.

Regarding the other parts of the instrument, there is not very much to be said about them, since their particular design is unimportant to the successful operation of the amplifier, providing they are made mechanically well. I found the introduction of the step-down telephone transformer decidedly useful in eliminating capacity effects due to the body. Without it, the telephones are "alive," and one cannot handle the tuner with any degree of comfort to one's hearing. Apart from this it is undesirable, as probably most of you know, for the plate-current to actually flow through the windings of the telephones, since it may, in time, partially demagnetize the permanent magnets if connections are not correctly made to avoid it.

The transformer in the instrument was purchased. The potentiometer and filament regulating-resistances were modified from commercial articles to suit the space available, and incidentally their appearance is improved. The filament-resistance was reduced from 6 ohms—its original value—to 2 ohms by rewinding with No. 22 S.W.G., enamel insulated copper wire, a less critical adjustment of the sliding contact is therefore necessary, and consequently better control obtained.

Having now given you particulars of the constructional details, I will pass on to general remarks concerning some practical operating points and results.

Firstly, it is desirable to use a variable high-tension battery, so that a minimum of 20 volts changing up to a maximum of 65 volts, in three steps of 15 volts each, are available.

The amplifier can be set into feeble self-oscillation at a frequency determined by the capacity and inductance of the secondary circuit of the tuner, with 4 volts on the filaments and 40 to 45 volts H.T. battery. The critical point can be found by means of the potentiometer. There is no tendency to "howling" until 60 volts are applied, but again the potentiometer comes in useful to keep just off this point. An interesting point in this connection is the effect of coupling by the tuner. If the point of "howling" is obtained with the secondary "loose," then a very slight increase in the coupling will put everything quiet again. Adjusting the aerial circuit to exact resonance produces the same effect.

With 20 to 30 volts, the amplifier will not self-oscillate on any wavelength, but is quite good for "spark" signals. Speech is also extremely clear with this voltage.

Secondly, it should be remembered that an amplifier of this kind is not primarily intended to give excessively loud signals. On the contrary, it functions rather as a "limiter," that is, amplifying weak signals and limiting the strength of strong ones. For this reason strong atmospheric disturbances are not magnified in anything like the same ratio as weak signals, and here again the skilful use of the H.T. battery and potentiometer is brought to bear. For "limiting," the grids require to be made positive even to allowing a flow of current in their circuits, whilst the filament current should be kept down. This may have the effect of reducing signals of a certain strength, but it may be better from the standpoint of operating, than when signals are louder with accentuated atmospheric disturbance.

Thirdly, for C.W. reception with separate heterodyne, quick adjustments are readily obtained before the transmitting station commences work, a point which appears rather to be overlooked in text-books and which is extremely useful if the whole of a transmission is required. Usually, when one is searching for a C.W. station, especially with separate heterodyne, much of the message is lost before everything is adjusted.

The method adopted is as follows :— The secondary inductance of the tuner is very loosely coupled with the aerial, and the condenser is set to the exact wavelength of the station required. The valves of the amplifier are then brightened up until a "beat-note" is heard from the local heterodyne circuit acting directly on to the secondary coil. The local circuit is then transferred to act on the aerial only, and this is tuned until the "beat-note" is again heard at a maximum. The valves are then "dimmed," or the potentiometer adjusted until the "beat" disappears, and signals from the station awaited, during which time, if the best coupling position is not known, the secondary may be varied, when the critical point is quickly found during the first two or three preliminary signals.

I now turn to the use of a condenser reaction for purposes of exciting local oscillations in the amplifier circuits.

This increases the range of wavelengths over which the instrument can be made to oscillate. It is particularly effective in this respect on short waves from 800 to 2,000 metres, and enables less H.T. battery to be employed.

Personally, I do not like using the arrangement. It upsets what I may call the straightforward adjustments.

It is clear from a study of Fig. 5 that it must upset the calibration of the secondary circuit to which the first valve is connected, and I do not see at present how any reliable correction can be made for this, in order that one could obtain a direct wavelength measurement. Further, the capacity of the condenser must be exceedingly small, (·000 mfds. max.), and the adjustment is consequently difficult unless a special handle or other arrangement is provided to prevent the capacity of the body or hand affecting matters. Hence, I avoid the use of such a condenser, for the general work for which the amplifier is designed.

Before I conclude, it may be of some interest if I suggest one or two points regarding the design of an instrument of a similar character.

For very short waves to the order of 300 to 600 metres, a very low efficiency of amplification is usually found, and instruments constructed on the principle of the one described are unlikely to give good results. This is due to the capacity of the valves themselves, which lowers the impedance of the plate-circuit resistances—with consequent losses of potential variation on the coupling condensers.

For the same reason, the intervalve coupling condensers must be made very small, but this has also the effect of reducing the energy applied to the grids to which they are connected. The grid-leaks should not be a very high value, (1 or 2 megohms is sufficient), for there is a great tendency for low-frequency oscillations to be set up, on account of the grid-charges piling too much. Further, for the reason that I have already stated, the plate-circuit resistance should be kept relatively low—say, about 20,000 ohms, or slightly higher, to suit any particular type of valve, and this fact limits the initial energy which can be stored in such a resistance by the use of an extra high tension battery.

For long wavelength designs, the points just enumerated do not apply to the same extent.

The slower the frequency of the incoming oscillations, the greater can be the plate-circuit resistance, provided there is a corresponding increase in H.T. volts. On the other hand, long-wave resistance-amplifiers are apparently very susceptible to the reception of harmonics.

Two other points which I think should be observed are : small over-all dimensions of the coupling condensers, and a symmetrical lay-out of the various parts to ensure short, stiff connections, without an undue amount of cross-wiring.

In conclusion, I trust that the particulars and experiences which I have furnished you with, may perhaps prove of some practical utility to those actually engaged in, or about to become engaged in, the construction of a high-frequency resistance-type amplifier.

I have apparatus arranged, but I do not think it is very much use my attempting to show you any experiments at the present moment, because, as I said in the Paper, the amplifier itself is not intended to give loud signals. This particular instrument is very sensitive to weak signals, but it will not give very strong results, even when considerable amounts of oscillating energy are put close to it. I thought perhaps it might be better if those who cared to do so, were to permit me to show them any results which I may be able to obtain either with an ordinary buzzer-circuit some distance off, or a heterodyne wave-meter circuit acting directly in conjunction with the instrument, and for that purpose I have brought four pairs of telephones so that four people can listen at the same moment.

(The discussion on this paper will be published in our next issue.)

WIRELESS CLUB REPORTS

Manchester Wireless Society.

(Affiliated with the Wireless Society of London.)

On Wednesday, September 10th, under the chairmanship of Mr. J. McKernan, Mr. Woodyer, of the Stockport Wireless Society, read his paper on honeycomb coils. Touching upon the subject of single-layer coils, Mr. Woodyer then gave an outline of the principles and winding of multi-layer coils, together with their advantages over the single-layer coils.

In proposing a hearty vote of thanks to the lecturer, Mr. J. C. A. Reid called attention to the fact that there seemed to be still a great deal to be found out about these coils, and that it would be some time before the loose-coupler could be entirely substituted. Mr. H. A. Blackburn seconded the proposal, and heartily agreed with Mr. Reid's remarks. The Chairman, in supporting Mr. Reid's proposal, said that after listening to the explanation of the lattice-wound coils, and remarking upon the very instructive nature of the subject, his own receiving set seemed very much out-of-date, and that he would certainly try the value of these coils. Furthermore, he hoped that the members would endeavour to construct similar coils and try them on their sets with a view to the future development of this class of instrument. He then moved, that the meeting show its appreciation of Mr. Woodyer's work in the usual way, which request was heartily responded to.

Mr. Woodyer then returned thanks for the appreciation shown, and remarked that it had been a great pleasure to visit the Manchester Wireless Society and put before the members his own experience of lattice-wound coils. He also expressed a wish that we would give a return lecture at Stockport in the near future, and extended a hearty welcome to all members at any time, with a view to mutual benefit from the interchange of ideas. (Applause.)

All communications should be addressed to the Hon. Secretary, Mr. Y. W. P. Evans, 7, Clitheroe Road, Longsight, Manchester.

Stockport and Cheshire Wireless and Scientific Society.

(*Affiliated with the Wireless Society of London.*)

A meeting of the above Society was held on Friday, October 1st, Mr. H. C. Woodhall being in the chair. The minutes of the last general meeting were read for confirmation, and adopted.

The Secretary, addressing the assembly: "Gentlemen, I have much to say, but our time being limited I will be brief. The question of affiliation with the Wireless Society of London has been definitely settled, and you will heartily agree that the advantages afforded by such affiliation are many. It is pleasant to see so many members present, and although the Society was formed so recently as June last, the results up to date are beyond our expectations. In view of the fact that so many members reside outside the town, it has been agreed to adopt the above title, and I now wish to place before you our present position. First of all, our officers have been completed as follows: President, Le Général Ferrié; Vice-Presidents, Captain H. J. Round and A. Roberts, Esq.; Secretary and Treasurer, Mr. Z. A. Faure; Chairman, Mr. H. C. Woodhall; Committee, Messrs. Woodhall, Ewart, Banks and Faure. Secondly, our membership is now thirty-seven and is steadily increasing. Our financial position is good, and I think we have now made for ourselves a place amongst the wireless societies of Great Britain. (Applause.) As time is passing quickly I must, before I conclude, introduce Mr. Roberts, Postmaster of Stockport and District, one of our Vice-Presidents, and I hope you will all join with me in extending our most hearty welcome to him." (Loud applause.)

Mr. Roberts: "Mr. Chairman, Secretary and members, I must thank you for your hearty welcome, and may say that I felt highly honoured when I received your invitation to become a Vice-President of your Society. It is with the greatest pleasure I accept your kind offer."

Mr. Woodhall then took both sections, advanced and elementary, delivering a lecture on modern receivers. Commencing with a valve receiver of simple type and finishing with a five-valve amplifier, he showed the most efficient way in which the circuits should be connected, using numerous diagrams and sketches to illustrate his meaning.

Particulars of membership can be obtained from the Secretary and Treasurer, Mr. Z. A. Faure, 3, Banks Lane, Stockport.

Three Towns' Wireless Club.

(*Affiliated with the Wireless Society of London.*)

A special meeting was called on Wednesday, September 29th, at the temporary club-room, 16, Bedford Park. The Secretary stated that it was time the members woke up to their responsibilities. He proposed to re-organize the club on a much more ambitious basis, suggesting at the same time that a suitable club-room be obtained where members could meet every evening of the week with a view to holding discussions, lectures etc. He hoped that some of the more advanced members would give lectures in elementary wireless for the benefit of the younger section. In conclusion, he dwelt on the necessity of revising the present rates of subscription.

In the discussion which followed, Mr. Jerrit proposed that a committee be formed. Thereupon the following were elected: Messrs. Jerrit (Chairman), Lock (Secretary), Rose, Arbery, Graves and Currah.

Mr. Rose then proposed that the subscription should be 4s. per quarter, payable in advance, and this was carried unanimously.

Mr. Jerrit then asked if ladies could be admitted to membership, and the Secretary replied that anyone, of either sex, interested in electrical science was eligible for membership.

On October 2nd a very successful field-day was held at Hartley. Some excellent C.W. and spark signals were obtained; Clifden was quite good and another spark station of about 9,000 metres wavelength was easily readable.

A meeting of the Club took place on Wednesday, October 6th. No special business had been arranged, so the meeting took the form of an informal discussion of various matters of interest.

On Saturday, October 9th, advantage was again taken of the surprisingly good weather to have another field-day. Hartley was visited, and with the Secretary's two-valve portable set signals were received from Vienna (C.W.), Paris (C.W.), Poldhu (spark and C.W.). Poldhu came in so loudly that the 'phones were laid on the ground and everybody could hear. These excursions are so much enjoyed that it is hoped the weather will permit another outing.

All particulars of the Club can be obtained from the Hon. Secretary, Mr. G. H. Lock, 9, Ryder Road, Devonport

Derby Wireless Club.

(*Affiliated with the Wireless Society of London.*)

A preliminary meeting was held on Wednesday, September 29th, at the Court, Alvaston, to discuss various matters for the coming season. The Committee have drawn up a programme of fortnightly meetings as far as the end of the year. They will be pleased to hear from any member who is willing to read a paper before the Club.

The Secretary will be pleased to hear from old or new members.—Hon. Secretary, Captain W. Bemrose, Littleover Hill, Derby.

The Gloucester Wireless and Scientific Society.

(*Affiliated with the Wireless Society of London.*)

A general meeting of the above Society was held on October 1st at Sir Thomas Rich's School, Gloucester, the President being in the chair. After a general discussion of the policy of the Club, nominations were asked for the post of Honorary Secretary, and Mr. J. J. Pittman was unanimously elected. The President reported the erection and testing of the Club's aerial, and various members present promised apparatus necessary for a good valve receiver.

It was decided to start the winter session with fortnightly meetings on the first and third Thursdays of each month.

Messrs. Mawer and Sandoe kindly consented to act as buzzer instructors to the Society, so intending members who are not familiar with the Morse code need have no hesitation in joining.

Any information with regard to the Club can be obtained from the Hon. Secretary, J. J. Pittman, 1, Jersey Road, Gloucester.

Newcastle and District Amateur Wireless Association.

(Affiliated with the Wireless Society of London.)

The series of lectures by Mr. Dixon are well in hand, the last introducing elementary principles of receiving and transmitting circuits. On October 11th Mr. Dixon followed his lecture with very thorough descriptions of the R.N.A.S. Amplifier, type T.B. A type Mark 4 three-valve L.F. Amplifier on view also gave satisfactory results, and was much admired for its smart appearance. Meetings are held every Monday evening, 7.30 p.m., at the Wireless School, Eldon Square, Newcastle. Intending members please communicate with Hon. Secretary, Mr. Colin Bain, 51, Grainger Street, Newcastle-on-Tyne.

Plymouth Wireless Society.

(Affiliated with the Wireless Society of London.)

A detailed and exhaustive paper on "Wireless Direction-Finding," submitted by F. E. Nancarrow, Esq., A.R.C.Sc., the London representative of the above society, was read by Mr. J. C. Andrewartha. The principles underlying directional wireless were simply described, whilst the various apparatus necessary for the practical working of a direction-finding system were also dealt with, together with diagrams of circuits which have been used at various times. The lecture concluded with some interesting references to the part played by direction-finding during the war.

The kindly supply, at the instance of the author, by the Marconi Company of a number of their pamphlets on Wireless D.F. work, was much appreciated by the members.

The Society is indebted to Mr. Nancarrow, and would welcome any such papers from other of its members whose absence on service prevents them from attending our meetings. Hon. Secretary, Mr. H. P. Mitchell, Municipal Technical College, Plymouth.

Wireless Society of Hull and District.

(Affiliated with the Wireless Society of London.)

At a meeting of the above Society, held on October 7th, Mr. G. H. Strong opened the meeting with an interesting description of a crystal detector which he had made at home. This had many features uncommon to these instruments. He was joined by Mr. Hy. Strong, and together they interested and instructed the members with a lecture on the De Forrest Honeycomb-coil showing various patterns, both bought and constructed They also produced a "former," wound with string, to show members the method of winding, and gave their experience when using these coils.

Messrs. De Fraine and Webster related some of their experiences during the war, which the other members greatly appreciated. Membership now numbers 21. All information can be obtained from Hon. Secretary (pro. tem.), Mr. J. Jephcott, 79, Freehold Street, Hull.

North Middlesex Wireless Club.

(Affiliated with the Wireless Society of London.)

The usual fortnightly meeting of the Club was held at Shaftesbury Hall, Bowes Park, on Wednesday, October 6th. After the new receiving set had been connected to the aerial, and various experiments made, the Chairman called upon Mr. Frank Hilton to entertain the members by relating a few of his sea-going experiences. For the next half-hour, Mr. Hilton kept his audience amused by a number of short yarns, which were very welcome as a comic relief to the more serious part of the Club's work.

It is hoped that at the meeting to be held on November 3rd, Mr. Wm. Le Queux will be able to pay his promised visit to the Club, and members may look forward to an interesting evening on that date. As this will be a special occasion, the meeting will commence at 8 p.m. instead of at 8.30 p.m. Will members please note.

Full particulars of the Club may be obtained from the Hon. Secretary, Mr. E. M. Savage, Nithsdale, Eversley Park Road, Winchmore Hill, N.21.

Luton Wireless Society.

At the inaugural meeting held on Wednesday, September 22nd, 1920, it was decided that the society shall consist of full members and junior members. In order to further scientific interests it was also decided that boys attending any Luton school shall be eligible as junior members on recommendation by their headmaster.

Some time ago the Borough of Luton Education Authority erected aerial-masts on the Hitchin Road Boys' School, for the licensed receiving apparatus used by the scholars, and on application by the headmaster, the Authority readily granted the use of the school to the society free of charge, a material help duly appreciated.

Meetings are held fortnightly. The society has made a promising start with a good number of enthusiastic members.

Particulars and application forms may be had from the Hon. Secretary, Mr. W. F. Neal, Hitchin Road Boys' School, Luton.

Aberdeen Amateur Wireless Society.

The first meeting of the Aberdeen Amateur Wireless Society was held on Tuesday, October 5th, at 41½, Union Street. Mr. W. W. Inder occupied the chair, and there was a gratifying attendance of about 40 prospective members.

The Chairman, in his opening remarks, pointed out that there were a considerable number of amateur wireless societies in the British Isles, the members of which met periodically for the purpose of lectures, demonstrations and discussions on wireless topics. Most of these societies were equipped with workshops for the use of those members who desired to construct their own apparatus under the instruction and guidance of senior members, whose apparatus had shown a high degree of efficiency in the reception of wireless signals and wireless speech over considerable distances. It was proposed that the Aberdeen society should be similarly equipped, and that a permit for the erection of an aerial should be sought from the Postmaster-General, so that members might test their constructed apparatus.

Mr. G. Benzie, Culter, moved that an amateur society be formed, and this was carried unanimously. A committee, consisting of Mr. F. H. Cartwright, Mr. G. Benzie, Mr. J. Miller, Mr. J. Mitchell, and Mr. W. Jolly was elected, whilst Mr. W. W. Inder consented to take on for a time the duties of secretary and treasurer.

At the next meeting a lecture is to be given on "An Outline of the Principles of the Transmission and Reception of Wireless Signals." Hon. Secretary, Mr. W. W. Inder, 22, Gray Street, Aberdeen.

The Birmingham Experimental Wireless Club.

On Saturday, September 25th, equipped with the necessary permit and apparatus, certain club-members visited Streetly, near Birmingham, to hold a field day.

The Club has recently been granted a transmitting permit and has been allotted the call-sign 2GD.

The present membership is 24, and it is hoped to increase this figure during the winter months Hon. Secretary, Mr. A. F. Headley, 255, Galton Road, Warley, Birmingham.

Stoke-on-Trent Wireless Club.

At a meeting on October 5th, held at the Club's headquarters, a demonstration with a one-valve receiver and frame aerial was successfully carried out. Meetings are held every Tuesday at 7.30 p.m., when Morse practice, reception of signals and experimental work is indulged in. Owing to pressure of work Mr. Wilkinson has unfortunately relinquished his office of Hon. Secretary, Mr. E. H. Adams, of 23, Park Terrace, Tunstall, Stoke-on-Trent, being elected in his stead.

Lancaster and District.

The proposal has been put forward to form an amateur wireless club for Lancaster and District on similar lines to other local amateur clubs. The arrangements are in the hands of Mr. George E. Hebden, who will be glad to hear from any readers of the *Wireless World* residing in that area. Mr. Hebden's address is 124, Scotforth Road, Lancaster.

Walthamstow Amateur Radio Club.

The opening of the Walthamstow Amateur Radio Club was held recently, when the members assembled at the general meeting to elect officers, and to discuss the most efficient lines on which the Club should be run. The officers elected were :—B. Purnell, (Chairman), C. Fewings, (Treasurer), and K. Hardie, (Secretary). Intending members should communicate with the Hon. Secretary, Mr K. Hardie, at 58, Ulverston Road, Upper Walthamstow.

South African Radio Society.

A largely attended meeting was held on September 3rd in the Chamber of Commerce, Capetown, for the purpose of forming a South African Radio Society. Colonel Standford presided, and was supported by Professor A. Ogg, Mr. H. E. Penrose, Mr. Lewis Simons, Mr. A. H. E. Royen, and Mr. J. E. Williams, of the General Post Office.

The Chairman, in a brief speech, referred to the early days of telephony in South Africa, sketching its progress and developments up to its present state of efficiency.

Mr. Penrose, in moving that a society be formed, and that it be called "The Radio Society of South Africa," said it was felt to be necessary, now that the Postmaster-General was granting licences for private stations, to have some sort of society, not only for the advancement of the science itself, but to see that the rules and regulations governing those licences were not abused. Such a society would also be able to make representations regarding legislation on wireless telegraphy and telephony —a matter that is becoming of national importance. Further, it should be not only their pleasure to instal instruments and listen for signals, but it would be their duty to undertake the collection of facts and data for the benefit of members and the science generally. South Africa had taken a foremost place in war, and it was for the country not to find itself lacking in the more peaceful and scientific pursuits of the wireless world. It was not suggested to make Cape Town the headquarters, but to have executive committees in various centres.

Professor Ogg seconded the motion, which was carried unanimously.

Members were then enrolled, after which the meeting proceeded to adopt the constitution of the Wireless Society of London.

The proceedings concluded with a vote of thanks to the Chairman.—Communications to Mr. G. L. R. Lowe, 51, Kitchener Avenue, Bezuidenhout Valley, Johannesburg.

Blackburn.

An amateur wireless club for Blackburn is being formed under the auspices of the Y.M.C.A., Limbrick, Blackburn. Prospective members should communicate with the Secretary, Mr. J. Whittaker, Y.M.C.A., Wireless Club, Limbrick, Blackburn.

Loughborough.

It is proposed to form a wireless society in the Technical College, Loughborough. Those associated with the college or interested in wireless should communicate with Captain F. Pamment, the organiser of the Society, addressing him at the college.

Amateur Club for Blackheath.

Mr. Arthur F. Bortle, of Flat No. 3, 27, Kidbrook Park Road, Blackheath, S.E., is anxious to form an amateur wireless club with a view to exchanging ideas and discoveries, as well as following the usual studies of wireless telegraphy. This gentleman proposes to embrace Greenwich, Lewisham, Blackheath and District ; interested amateurs residing in or about these areas should therefore communicate with him.

Oxford Amateur Wireless Society.

Meetings of the Oxford Amateur Wireless Society are now being held fortnightly. The receiving station is installed at 7, Bartlemas Road, and the Society is now awaiting a licence for the use of a valve. Any communications should be addressed to Mr. S. Barter, Hon. Secretary, Oxford Amateur Wireless Society, 29, Divinity Road, Oxford.

A CAMP WIRELESS RECEIVING SET.

By P. W. Cunliffe.

THERE was the usual struggle to fit tents, poles, accumulators and gear of divers sorts in the van, but the seemingly impossible was ultimately accomplished and in the course of time we were unloading in a delightful nook on the verge of Ingleton Woods in Yorkshire.

This being written for the champions of the aether, 'twould be bathos indeed to describe such terrestrial accomplishments as cooking, cleaning and the art of bed-making, so to business.

The immediate environment of the camp was chiefly open country, but within one or two miles were several 1,000-foot hills.

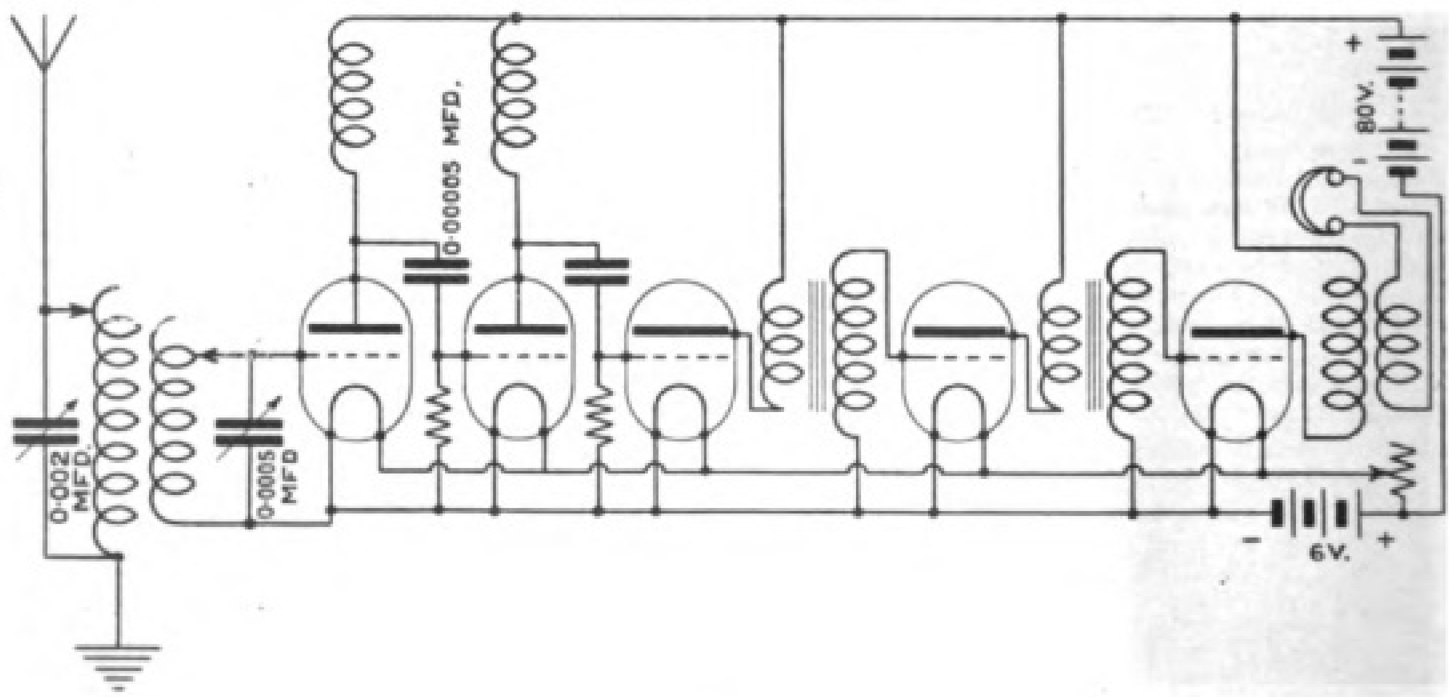
The aerial used was a Marconi Military Light Portable Type No. 3, which proved very efficient, the earth was a mat of copper gauze about 12 feet by 2 feet 6 inches, stretched on the ground beneath the aerial, the remainder of the apparatus being of the usual amateur type.

Two sets were used, a 5-valve set and a 2-valve set, the former being the more popular. In the former set the first two valves were for high-frequency magnification, employing impedance-capacity couplings ; one was for rectification, and two for low-frequency magnification. Iron core transformers were used, made up originally, as given in the Wireless World, Vol. 7, No. 80, but later the amount of wire on the primary was increased with advantage.

Fig. 1 is a diagram of connections of the circuits employed. The usual long-distance stations came in loudly, and no trouble was experienced until an inquisitive cow became entangled in the aerial-guys causing disaster to the aerial. While executing repairs, a few experiments were carried out with aerials of different types. A single bare wire about 100 feet long and an average height of 20 feet, was stretched between trees. The directive properties of this aerial were marked as it pointed east, Clifden (to the west) was particularly loud.

Good signals were also heard using a wire 9 feet long and 6 feet high, parallel to the ground.

A few experiments were carried out with a kite-aerial, a wire 100 feet long, at an angle of about 45 degrees to the ground being used, but only a slight increase in the intensity of signals was noticed.



THERMIONIC MAGNIFIERS

By H. Monteagle Barlow.

(*Continued from page* 523.)

The Telephone Transformer. Electro-Magnetic and Electro-Static.

THE use of a transformer in the telephone circuit of a valve receiver (Fig. 11) is *not essential, nor is it considered of any practical value by some radio engineers.* It has been argued that whilst certain advantages are gained by its employment, the resulting reduction in efficiency makes it *a detriment rather than an improvement to the receiver.* This, however, is not the case with a well-designed transformer specially adapted to the telephone with which it is to be used. Under such conditions the insertion of a transformer will make no perceptible difference to the strength of signal, and the life of the telephones will be greatly prolonged.

Obviously the continuous anode current will pass through the primary circuit, and only the magnified current variations will be transmitted to the secondary and telephones. When designing an electro-magnetic telephone transformer, it should be borne in mind that the impedance of the anode winding should be approximately equal to that of the inter-valve transformer primary, and generally the same conditions should be observed. Here again electro-magnetic coupling may be substituted by electro-static. Fig. 12 shows a suitable circuit provided the resistance of the telephones is not abnormally low. By varying the relative capacities of S_1 and S_2 any desired potential not greater than the volts across the resistance R may be obtained. *This arrangement forms an excellent substitute for the transformer, and there is no reason why it should not be made equally sensitive.*

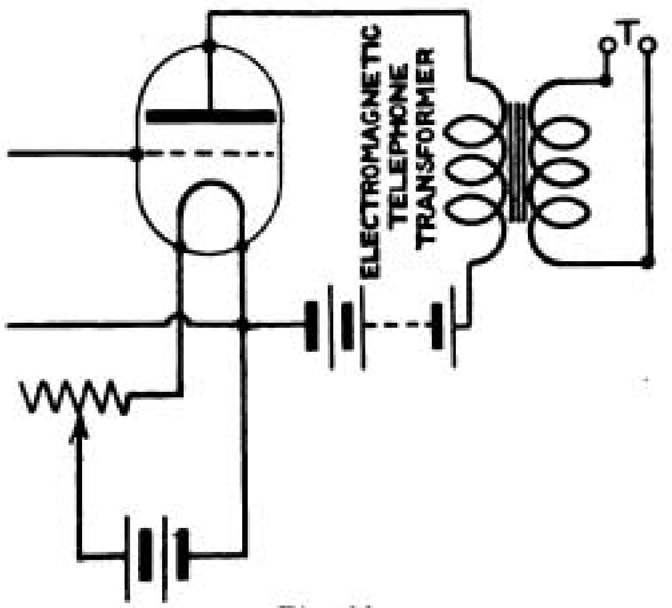


Fig. 11.

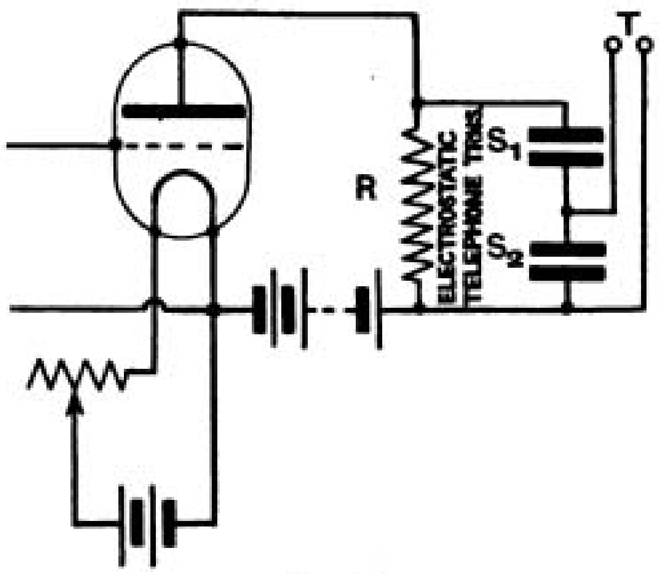


Fig. 12.

If the condenser S_1 is of the order of 1/20 mfd. and the resistance R about 100,000 ohms, then the impedance of the telephone circuit will be comparatively small, and the unidirectional impulses of current resulting from the incoming signal will pass almost exclusively through it.

The shunt condenser S_2 must also be sufficiently small to form a high impedance at low frequency and yet in combination with the series capacity S_1 provide an easy path for any high frequency current changes which may find their way through.

The Electro-Static Cascade Magnifier.

The inter-valve transformer can also be substituted by capacity and resistance. A. Hoyt Taylor has described an arrangement in which two audions were coupled together in this way, and more recently Scott-Taggart has written some interesting articles[22] on

[22] *Wireless World*, 1919, Vol. 6, p. 628.

the subject in the *Wireless World*, but in neither case does the apparatus appear to have been confined entirely to low frequency currents.

Radio-frequency electro-static coupling [23] has been universally adopted as a working proposition, but as a means of transferring energy between audio-circuits it is generally considered of little practical value. It is certainly more difficult to obtain the same *degree of linkage*, and under any circumstances the secondary potential is unfortunately limited to that of the primary. From this point of view electro-static coupling is in no way adapted to the thermionic magnifier, but on the other hand it has that inherent ability for remaining immune from external disturbances which are so detrimental to the overall efficiency of the receiver. The transformer may be carefully screened, but with it all the currents concerned are so small that they are audibly affected by any stray fields within a wide range.

Taking every feature into consideration, the author *is of opinion that the capacity magnifier is equally useful if not more so than the transformer type, and has been quite unwarrantably neglected.* There is no doubt that it offers by far the greater field for development since the little disturbances which reach the telephones are mostly due to variations in the valve characteristics.

Fig. 13 shows a suitable circuit for an electro-static cascade magnifier. The inter-valve capacities S_1, S_2, S_3 should be of the order of 1/20 mfd., so as to form low impedance at audio-frequency, whilst the anode resistance R_1, R_2, R_3 and R_4, should be non-inductive and correspond as nearly as possible with the primary winding of the transformer. The grid leaks, Z_1, Z_2, Z_3, prevent the respective electrodes from becoming unduly charged, and, as in the case of the anode resistance, should be non-inductive preferably of the carbon filament or deposited platinum type. Such an arrangement has been found an excellent substitute for that shewn in Fig. 7, and in spite of the additional valve required to obtain similar magnification, the total space occupied is much less.

It is very necessary, however, to arrange the wiring so as to avoid any autodyne action,[24] that is to say, any appreciable stray capacity between anode and grid which may tend to maintain internal oscillations. Unfortunately, this effect becomes curiously prevalent when a large number of valves are used, and in fact will sometimes wipe out the signal altogether. The oscillations are apparently of a radio-frequency, so that if it were possible to control them they might be very useful when receiving continuous waves. An electro-static cascade magnifier can be worked

[23] E. Orland Lytle, "Proc. Inst. Rad. Eng.," Vol. 7, 1919, p. 427; and E. Bellini, *La Lumiere Electrique*, Vol. 32, 1916, p. 241.

[24] E. H. Armstrong, "Proc. Inst. Rad. Eng.," Vol. 5, 1917, p. 145; J. L. Hogan, Jnr., "Proc. Inst. Rad. Eng.," Vol. 3, 1915, p. 249, and Vol. 1, 1913, p. 75.

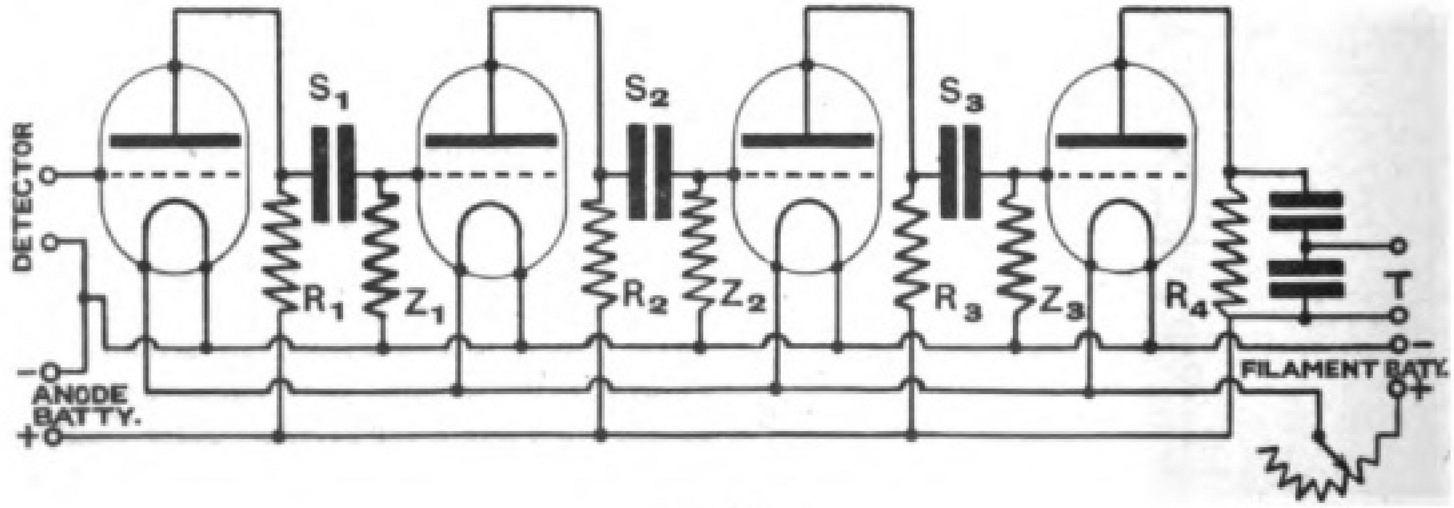


Fig. 13.

efficiently with 7 or even 8 valves if the most stringent precautions are taken.

The anode-grid capacity of the valves themselves must be reduced to a minimum, and the potentials of these electrodes carefully regulated so as to operate the limiting action of the valve. The investigator meets with some strange phenomena when experimenting with high power amplifiers, and there are still many problems attached to the capacity coupled cascade magnifier which await explanation.

The fact that only some of the valves of a series appear actually instrumental in magnifying the impressed signal and that those valves do not necessarily immediately follow one another is rather perplexing. *The autodyne action probably accounts for this to a certain extent since some stray capacities tend to maintain the oscillations*, whilst others tend to overcome them, according to the phase concerned.

Magnification Co-efficient and its Measurement.

It has been said that the *Thermionic Magnifier is only of service in increasing the intensity of a signal which is originally sufficiently strong to produce an audible sound in a telephone receiver*. Whether that is literally true or not remains in doubt, but it is agreed that the magnifier works *much more efficiently when the initial current variations are not too small.* The magnification co-efficient [25] therefore is not a constant when derived experimentally. There is no standard method of measuring this quantity, but comparisons are often made by shunting the receiving telephones of the apparatus under test until the strength of signal corresponds with that of the standard. Dr. Eccles has explained [26] this arrangement, and given some approximate values of the co-efficient under various conditions. The definition of the measure of this co-efficient [27] is apt to create misunderstanding. The term "magnification," as applied here, means magnification of the energy contained in the impressed current variations, *and it is the energy independently supplied to the valves by way of the anode and filament batteries which effects that "magnification."*

L. W. Austin has also contributed a paper [28] on the determination of signal strength by the shunted telephone. The method, however, is generally considered unreliable, and many prefer to compare the linkage between the receiving circuit and the magnifier, but undoubtedly the best way of all is to control the signal at its source.

Conclusion.

In conclusion, I have to thank Dr. Eccles for his kindness in lending me certain apparatus, and also to express my appreciation of the generosity of the Marconi Company in supplying other apparatus and slides.

[25] S. Ballatine, "Proc. Inst. Rad. Eng.," Vol. 7, 1919, p. 129; Miller, "Proc. Inst. Rad. Eng.," Vol. 6, 1918, p. 141.

[26] W. H. Eccles, "Proc. Inst. Rad. Eng., 1919," Vol. 7, p. 267.

[27] W. H. Eccles, "Year Book of Wireless Telegraphy and Telephony, 1917," p. 674.

[28] L. W. Austin, "Proc. Inst. Rad. Eng., 1917," Vol. 5, p. 239.

REPORTS OF WIRELESS CLUB MEETINGS.

With the re-opening of Amateur Wireless Clubs for the winter sessions, Hon. Secretaries will do well to forward their reports of meetings at an early date in order to avoid, as far as possible, any delay in their publication.

PAGES FOR BEGINNERS

Under this heading we publish COMPLETE *instructional articles, forming a series specially designed and written for beginners in wireless work. Hardly any mathematics will be introduced, and we hope to present the fundamental facts of wireless in such a manner as will prove attractive to a much wider range of students than that for which this series is primarily intended.*

THERMIONIC VALVES—I.

CHEMISTRY teaches us that all liquids, solids and gases are made up of a number of minute particles, termed *atoms.* The atom was said to be the smallest particle of matter which could exist in a free state, and that it could not be sub-divided. The researches of various scientists such as Crookes, J. J. Thomson and Curie, however, have since proved to us that the atom is really composed of still smaller particles. These particles, first known as *corpuscles* and later as *electrons*, are in reality small charges of negative electricity. It is convenient to consider them as small particles negatively charged, but at the same time it is important to remember that the charge cannot be separated from the particle—in fact, it *is* the electron.

All elements, then, are composed of a number of atoms, which in their turn may be sub-divided into numerous small charges of electricity. The number and arrangement of these charges in the atom determines the nature of the substance. Thus, hydrogen is a gaseous element, and lead a solid. It is supposed, therefore, that the number and arrangement of electrons in the atom of hydrogen differs from the number and arrangement in the atom of lead.

It is also believed that the electrons in the atom are in a state of continual movement amongst themselves.

Under certain influences, such as heat, or electrical disturbances, this activity of the electrons becomes greatly increased, in fact, one or more electrons may become detached from the atom altogether, and be propelled into the surrounding medium. If, by this means the atom is robbed of one or more of its electrons, it is no longer in a normal condition. As soon as it loses any of its normal complement of electrons it becomes *positively* charged. In the same manner, if one or more surplus electrons become attached to any body, that body becomes *negatively* charged.

If one body having a deficit of electrons (*i.e.* positively charged), is brought near another having a surplus quantity, there will be a state of strain between them. Each will try to resume its normal condition. In consequence of this, there will be an attraction exerted between the two bodies until the electrons have resumed their normal position.

If we arrange a circuit in which, at one point there is a continual disturbance of electrons, and provide a path by which more electrons can flow in to take the place of those detached, we shall have a steady flow of current in the circuit. This flow of electrons can be provided by chemical means, as in the case of a simple cell, or by heat, as in the case of a thermo-junction. In the case of two metals immersed in acid, and having their ends joined, we have the following:—The action of the acid on the metals will cause a surplus of electrons on one metal. We can imagine that these extra electrons will flow hither and thither seeking to return to their normal state. A path is provided for them through the connecting wire. But as fast as the liberated electrons flow back along the wire, more are discharged through the acid. Thus we have a steady flow of electricity from one metal to the other, or in other words an electric current. In some cases, the surplus electrons in one part of the circuit return abruptly and quickly. This corresponds to the electric spark, such as is obtained when a condenser is discharged.

As before stated, the emission of electrons from a body can be considerably increased by heating. Suppose we take a length of fine wire, and pass a current through it. It will get red hot, and hundreds of electrons will be propelled from it into the surrounding air. They will not travel very far, however, because they will collide with the molecules of air, and become attached to them. We can avoid this, however, by placing the wire in a glass bulb, and exhausting the latter of as much air as possible. In this case the electrons will fill the space around the filament, forming a negatively charged field, and, in time, will prevent the further emission of electrons. (Fig. 1).

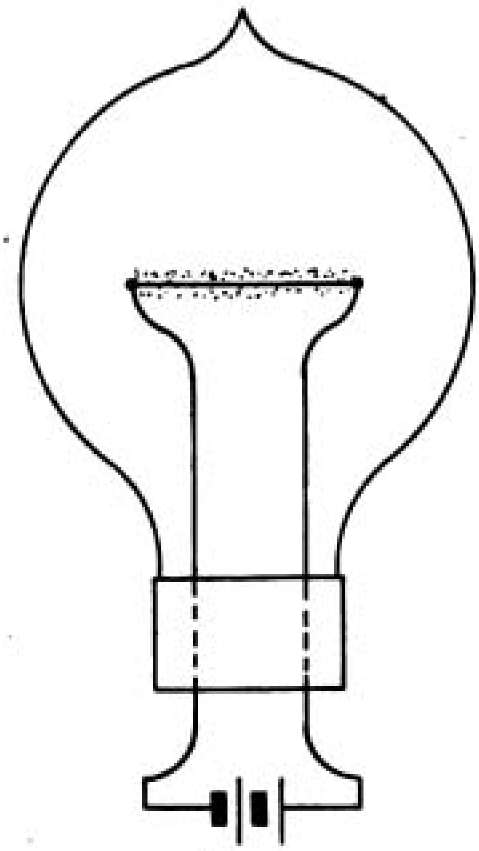


Fig. 1.

Now, if we introduce into the glass bulb a metal plate, and charge it with a positive potential from an external battery, we shall attract all the electrons from the filament to the plate, whence they will return through the battery to the hot filament. (Fig. 2.) Thus there will be a continuous stream of electrons flowing from the filament to the plate, which flow, as we have seen, constitutes an electric current.

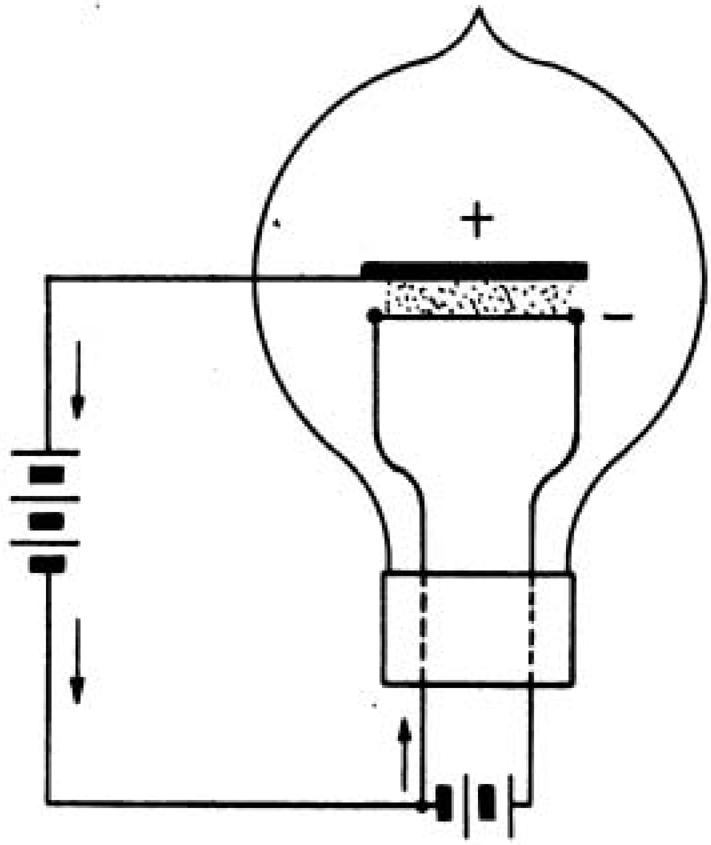


Fig. 2.

It should be noted here, that the current is really a flow of negative electricity from the filament to the plate. We usually consider current as flowing from the positively charged point to the one negatively charged. Actually, however, an electric current, considered as a flow of electrons, is from negative to positive.

Should the potential of the positively charged plate fall below that of the filament, it is clear that the electron flow will cease, and the current will be interrupted. So, if we were to apply an alternating or oscillating current to the plate, the flow of electrons would only occur when the plate was positively charged, that is, during one half-cycle. The bulb will therefore act as a rectifier of oscillatory current, permitting current to flow in one direction only. It is for this reason that the apparatus has been named a *valve.*

The modern type of rectifying valve consists of a filament of tungsten mounted between two wires sealed into a glass support.

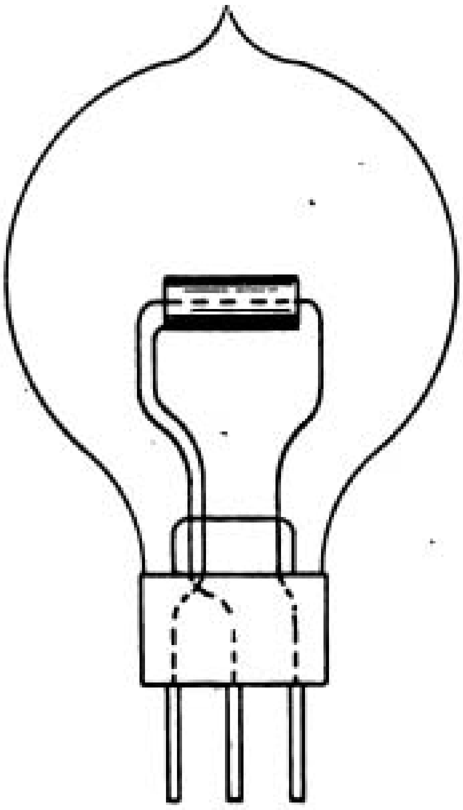


Fig. 3.

To another stiff wire is attached a tube of thin nickel sheet, which completely surrounds the filament. This is usually termed the *plate* or *anode*. The whole mounting is enclosed in a glass bulb, from which the air is exhausted by special pumps. (Fig. 3.)

The valve is connected in circuit in the same manner as a crystal detector. (Fig. 4).

The flow of electrons, and consequently the current through the telephones, can be controlled by two methods. The temperature of the filament can be varied, thus varying the number of electrons emitted, or the potential of the plate can be altered.

To both these methods of variation there is a limit. The potential of the plate can be raised to such a value that the whole of the electrons emitted from the filament are attracted to it. After this point has been reached, it is obviously of no advantage to increase the plate potential, for the difference in the flow of electrons will be inappreciable.

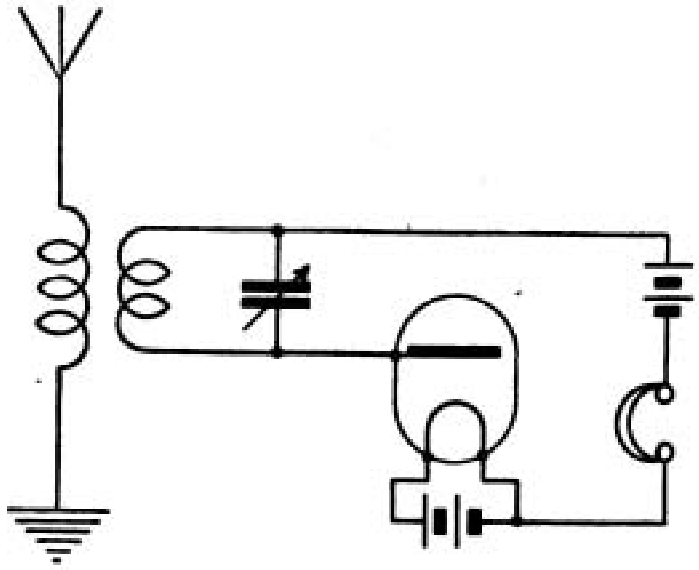


Fig 4.

When this potential has been reached, *i.e.*, when a further increase makes no alteration in the electron stream, assuming that the filament temperature is constant, the plate is said to be *saturated*.

RACE RESULTS BY WIRELESS

It may interest our readers to know that during the recent International Yacht Races at New York, the Radio Corporation of America reported the results of such races direct to the editorial offices of the *New York Evening Post*, by wireless.

Receiving apparatus was installed in the newspaper offices and reports were sent thereto from a "blimp," equipped with wireless, a similarly fitted seaplane, and from the U.S. Destroyer *Goldsborough*.

The arrangement, in brief, was that a transmitting station at 47th West Street, New York City, operated and controlled at the editorial offices, transmitted when required to the three mobile stations, whilst they, in turn, transmitted to the editorial offices of the *Evening Post*. Duplex receiving sets were installed at the last named, special rejection circuits being used to eliminate local interference.

The CONSTRUCTION *of* AMATEUR WIRELESS APPARATUS

A FRAME AERIAL RECEIVING SET

IN the present and succeeding articles it is intended to describe a frame aerial receiving set which may be used either for indoor work, or in the field. The set will consist of a frame aerial with tuning condenser and loading inductance, together with a three-valve amplifier and local oscillation generator. It is intended that the set be used for the reception of the long-wave high-power stations working on C.W., such as Carnarvon, Clifden, Nauen, Hanover, Stavanger, Lyons, Eiffel Tower, Nantes and Clifden. These stations all work on wavelengths between 5,000 and 15,000 metres. The frame and amplifier will not be suitable for the reception of short-wave ship stations.

For the tuning condenser we will use the ·0015 mfd. variable air condenser, recently described in these columns, together with a fixed condenser of approximately ·0015 mfd. capacity, which will be connected in parallel with the variable condenser.

The Frame.

For general convenience in indoor work, and for portability for outdoor use, we will use a 4-foot square frame.

A frame of four sides, nailed together with two diagonals for support, is easily made, but better results will be obtained if the wire is wound in a square form on the diagonals only—the sides not being used—to avoid possible dielectric losses as a result of damp wood.

To make a frame, obtain two pieces of hard, dry wood, 6 feet 6 inches long, 2 inches wide, and 1 inch thick ; cut through each piece and make a hinged joint, as shown in Fig. 1. On the side of the wood opposite the hinge, mount a 3-inch brass hook and eye so that the hinged portion may be fixed while the frame is being used. Groove the centre of each piece to half the width of the wood, so that the two pieces may be fitted into one another, thus forming the diagonals of a square, as shown in Fig. 2. Arrange for two brass links to be fitted to lock the two sections together, as shown in Fig. 2.

Fig. 1

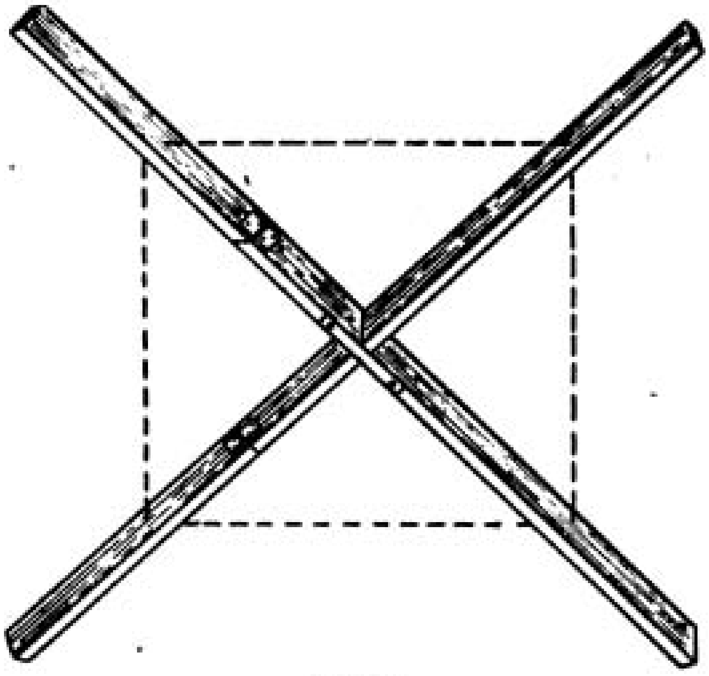


Fig. 2.

The dotted lines in Fig. 2 represent blind-cord guys, which may be used if desired to strengthen the frame.

The next thing is to make a stand which should be so arranged that the frame may be rotated through 360°. Obtain a universal ball-and-socket joint from a gas-fitter's, and fix it to the frame, as shown in Fig. 3. To the upper part of the joint fix two pieces of brass, 6 inches long and ½ inch wide, to which the frame may be secured by means of two screws with wing-nuts. The lower portion of the joint should be fitted into a brass tube about 6 inches long and approximately 1 inch in diameter, which should drop over the round pole of the stand. This pole should be about 3 feet long. When not in use, such a frame can be dismantled and will pack up into a small space.

It is possible to wind the wire over the ends of the diagonals, but if this is done, a space of 1 inch must be left in the centre so that the wire will be clear of the stand pole.

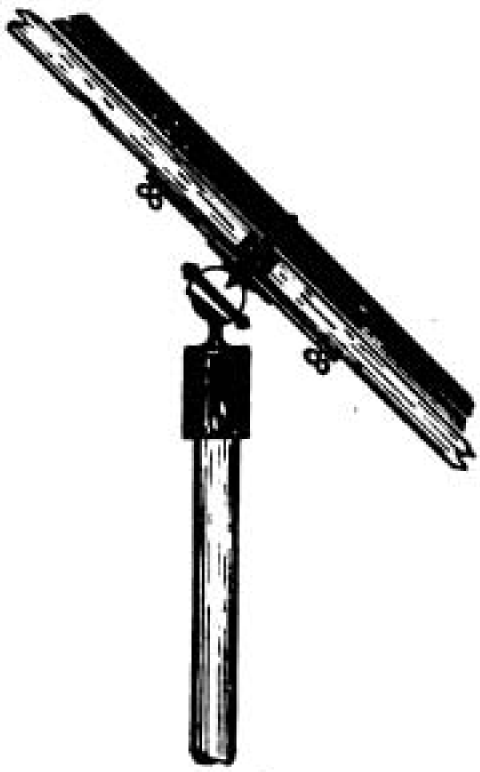


Fig. 3.

A better method is to mount four pegs, one at each end of the cross-pieces, (on the side opposite to the universal joint), as shown in Fig. 1: The wire may then be wound without fouling the pole. The pegs should be square-sectioned, with the sharp edges rubbed off.

Now a word about the electrical side of the frame. It is necessary to decide on an efficient winding.

The capacity of the variable condenser, plus the fixed condenser, is ·003 mfd. The inductance required with this capacity to tune to 15,000 metres is approximately 21,000 mhys., which has to be provided in the frame and loading inductance. To get the best results most of the inductance should be provided in the frame. Again, to obtain an efficient frame, its winding should be spaced to keep down the self-capacity of the coil and reduce dielectric losses.

With a small frame it is difficult to obtain a big inductance with a spaced winding and yet keep the winding within reasonable dimensions, as will be seen from the following figures, taken from experimental frames.

A frame, 4 feet square, wound closely with 60 turns of No. 20 D.W.S. in a single layer, had an inductance value of 14,000 mhys. and a natural wavelength—due to its self-capacity—of 2,500 metres, leaving 7,000 mhys. to be provided in the loading coil. Another frame, with 30 turns of No. 20 D.W.S., closely wound, gave an inductance of 4,000 mhys. and had a natural wavelength of 1,500 metres. A third frame was wound with 20 turns of No. 20 D.W.S., spaced ⅛-inch apart and gave an inductance of 1,500 mhys. and a natural wavelength of 550 metres.

C.W. signals were received on each of the frames, and were approximately of equal strength on the 60 and 30-turn frames, but were weaker on the 20-turn spaced winding.

Spark signals were strongest on the frame with the least loading inductance.

More figures will be given in the next issue, and the loading inductance and blocking condenser described.

BOOK REVIEWS

HOW TO MAKE WIRELESS INSTRUMENTS.

Edited and revised by C. A. LE QUESNE, JR. New York: The Modern Publishing Company, pp. 93, illustrations 80 (net 25 cents).

The average modern day amateur, whether he be a club member or not, would seem to derive much of his interest in wireless telegraphy from the construction of his own apparatus. Apart from developing what mechanical genius the experimenter may possess, such a course also permits of a better understanding of the principles and apparatus of the science of wireless telegraphy as a whole. There are, however, many amateurs to whom the matter of construction with its required initiative presents many difficulties; yet given the ideas, shown the apparatus in rough diagram, its manufacture becomes but a mechanical accomplishment within easy reach of the average amateur's capabilities.

Though perhaps not of recent date, the book under review contains many ideas for the experimenter to materialise. The suggestion for making a complete wireless station, of two miles range, on page 71, is one that will interest many amateurs whose pockets will not permit of a very great expenditure. A number of the ideas given in this little book come well within the scope of the various clubs, with a view to aiding instruction to their junior members. Many forms of aerial insulators are described, together with a mast design for amateur stations, and though the book is somewhat out of date in its subject, *i.e.*, apparatus, the small cost of its purchase justifies its recommendation to constructors.

THE TELEGRAPHIST'S GUIDE.

By JAMES BELL and S. WILSON.

London: S. Rentell & Co., Ltd., pp. 258 illus., pp. 156, 5*s.* net. (8th Edition).

This book is intended to serve as a guide to the Government Departmental and City and Guilds Examinations in telegraphy, and, those engaged in acquiring the necessary knowledge for their ultimate success, may use it to good advantage. It is essentially a text-book for the land-line telegraphist and none other; notwithstanding this fact, however, there is much to be found within its pages which will interest our readers.

It is often the case that too little attention is given by wireless amateurs to the earlier stages of electricity, and the use of such instruments as the Megger.

To such amateur clubs embracing buzzer practice in their programmes, this book would give that familiarity with land-line circuits which would permit them to combine experimental land-line telegraphy with Morse practice.

INDUCTION COIL DESIGN.

By M. A. CODD.

London: E. & F. N. Spon, New York: Spon Chamberlain. Pp. 239 illustrations 169 (21s. net).

In writing this book the author has endeavoured to give more exacting information on points relating both to the theory and practice of induction coils, than is found in most of the existing text books. As a general rule, such books either treat the matter from a purely mathematical standpoint or else in giving practical details, omit such points as to render their contents of little use to those readers desirous of constructing their own apparatus. Within the pages of this book the author gives standards of measurement, which, based upon practical experience, must necessarily be of interest to amateurs, both from constructional and theoretical viewpoints. On page 106 a "Wire Table" is given, permitting one to arrive at the approximate dimensions of any required coil.

The many uses of the induction coil, and its popularity in experimental work, justify the amateurs in seeking a thorough understanding of its working. The book under review, exclusively devoted to this type of apparatus, offers to its readers much that is missing from most of the handbooks at present on the market, and would make a worthy addition to any library.

QUESTIONS AND ANSWERS

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

D.H. (Nottingham) *asks* (1) *For diagram of a crystal receiver using a tapped inductance and a variometer.* (2) *For windings of inductance and variometer to tune to 3,600 metres with a two wire aerial 65 ft. long.* (3) *If a pancake coil could be used for the inductance.* (4) *What is the capacity of a "jar."*

(1) Diagram given (Fig. 1).

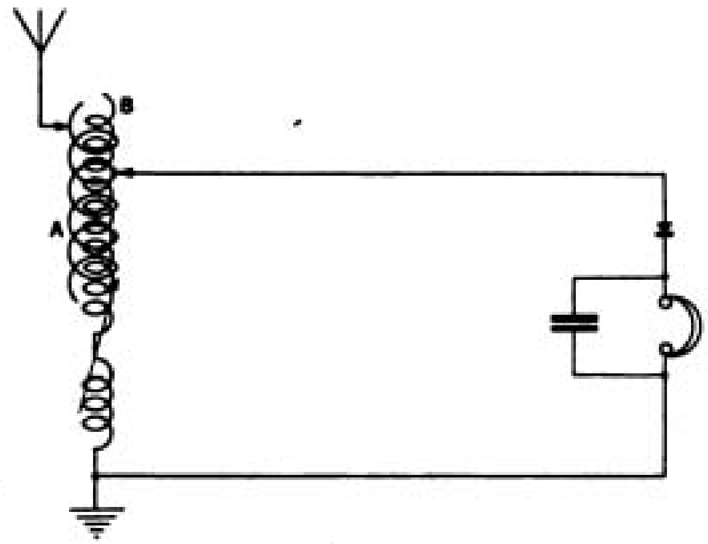


Fig. 1.

(2) Coil A 6" diameter, 14" long, wound with No. 22 S.W.G. Coil B may be wound on a spherical bobbin fitting closely inside former of A. Exact windings immaterial, No. 22 S.W.G. would be suitable.

(3) Yes.

(4) 1,000 centimetres (electrostatic units).

S.S.D. (Dewsbury) *asks* (1) *Could we give diagram of wiring for making a loud speaker.* (2) *Is Gamages "Polaris" receiving apparatus patented, and, if so, what is the patent number.*

(1) See reply to **GRID (Manchester)**, recently.

(2) We believe the patent is still pending.

W.R.T.S. (Hampstead) *asks* (1) *Who is* GGB. (2) *Whether* GFA *employs tonic-train, as although he is described as* C.W. *our correspondent gets him on crystal.* (3) *Who are telephone stations* 2AA *and* 2AF. (4) *For instructions for converting a crystal receiver to a single-valve receiver. He is prepared to use a crystal as well as valve if necessary.*

(1), (2) and (3) GGB is unknown to us. GFA is a C.W. station; tonic-train not being used. We have no information regarding 2AA and 2AF. They are probably experimental wireless telephony stations.

(4) Set described in issue of April 17th should meet your requirements.

L.S.B. (Alton, Hants) *asks* (1) *For data for the construction of a pancake frame to receive 2,500 ms.* (2) *Will this be allowed under the P.M.G. regulations.* (3) *In a certain catalogue the following is suggested for frame aerial for 2,600 ms.: "Size of frame 200 cms. square, number of turns 14." This appears inconsistent with article in "Wireless World," Vol. 8, No. 6. He asks if the above figures will be correct.*

(1) If no tuning inductance is to be used make it a pancake 6' square, 40 turns ¼" apart.

(2) Believe so.

(3) Frame would be rather small for use without tuning inductance, but will probably give satisfactory results with a suitable loading coil.

H.C. (Bolton) *asks* (1) *If sheet aluminium (gauge about 18 or 20 SWG) would be suitable for a variable air-condenser.* (2) *Would it be advisable to place a sheet of insulating material between each plate to prevent shorting.* (3) *Will the valve-set recently described, make an efficient crystal receiver with the valve parts removed, and using the same values of inductance and capacity.* (4) *If a circuit in April 3rd issue under reply to* **CARBORUNDUM (Chapel-en-le-Firth),** *would work well with a valve-magnifier added.*

(1) Yes.

(2) Not necessary with proper workmanship.

(3) Yes, except that somewhat tighter coupling between the circuits may be desirable.

(4) We presume you mean as a L.F. amplifier. If so, yes.

SPARKS (Galloway) *says, that the no-volt release of a ½. K.W., combined starter and field regulator, which had been in use for over three years, commenced to burn while on load. A temporary magnet was wound and this also has commenced to burn. The connections of the gear appear all right. He asks if we can explain this.*

Without detailed information we cannot give reason for this effect. Field-coils may have been accidentally shorted at some time, causing excessive current to flow through the release-coil. Or the insulation of the release may have deteriorated gradually. Or again, the internal connections of starter may have become defective, allowing an excessive current to pass through the coil.

J.T. (Birmingham) *asks, with reference to the receiving set shown in Fig. 4, page 319, July 24th, 1920,* (1) *Whether this set could be used for receiving spark as well as telephony signals, and if an* RV30 *valve would be suitable.* (2) *Whether it would be possible by altering the inductance and capacity to receive up to 5,000 metres.* (3) *If so, could we give the number of extra turns of wire and capacity* *needed.* (4) *If hank-wound coils are suitable for long wavelengths.*

(1) Yes—spark and telephony signals are receivable on circuits of essentially the same type, as pointed out several times recently.

(2) Yes, the A.T.I. should be considerably increased, and the A.T.C. increased by a smaller amount if desired. None of the other condensers should be increased. Set would probably not be very efficient.

(3) Try A.T.I. about 400 turns, increasing diameter to 4". Make condenser about double the size given.

(4) No, there is too much self-capacity.

TUNER (Manchester) *wishes to convert a Mark 3 short-wave tuner to the maximum efficient wavelength by means of a series of pancake coils arranged to form a loose-coupler. He asks* (1) *For criticism of design.* (2) *For particulars of gauge of wire, number of turns, and number of coils.* (3) *For particulars of necessary re-winding of coupler on Mark* 3.

(1) Coupler shown is much too tightly coupled, and no provision is made for varying the coupling.

(2) The number of sections is largely optional. You might use a mean diameter of about 3", the total number of turns on primary being about 300 of No. 24 wire, and the total number of turns on secondary about 200 of No. 28 wire. This should give you somewhat over 3,000 metres, but exact calculation for such a design is not possible.

(3) If you arrange suitable coupling between primary and secondary pancakes there will be no necessity to alter the coupler of the tuner.

G.T.S. (Newark) *sends sketch of receiver and asks* (1) *Our opinion of a loose-coupler, primary* 5½" × 4" *of No.* 24, *secondary* 5½" × 3½" *of No.* 28, *both with tappings.* (2) *Our opinion of sketch sent.* (3) *If addition of* 4 *volts to crystal detector terminals would be of any assistance.* (4) *If coupler would tune to* 2,500 *metres.*

(1) Quite satisfactory for your set.

(2) The circuit shown is fairly satisfactory, but would be greatly improved by a variable condenser of maximum capacity about ·0005 mfds. across the secondary of the loose-coupler.

(3) No; but the application of up to 4 volts to the crystal by means of a suitable potentiometer, for which see most crystal receiver diagrams in these columns, will probably be useful.

(4) Yes, with the primary loading-coil you propose to use, and the condenser suggested above.

N.B.—Down-lead should be taken from an end of the horizontal wires.

A.E.P. (Chatham) *asks* (1) *What are the maximum and minimum wavelengths that can be received with his apparatus, of which he gives diagrams and particulars.* (2) *If, when using a* 6-*volt French-type valve, a grid-leak is necessary and if the capacity of grid-condenser* (·8 *jars*) *is suitable.* (3) *What is the capacity of a circular-vane condenser, air dielectric, of certain specified dimensions.*

(1) Maximum wavelength, 6,600 metres, approximate minimum wavelength uncertain.

(2) No, you can rectify on either the top or bottom bends of the characteristic. If you wish to use the cumulative method of rectification, a grid-leak is necessary, but your condenser is much too big. Try ·005 jar and one 1 megohm leak.

(3) You do not give enough information from which the area of overlap of the plates can be calculated. The capacity is about ·008 mfds.

FORMALIN (Norfolk) *gives a sketch of a suggested aerial which consists of two portions* AB *and* BC *at right angles to each other in a horizontal-plane, and asks* (1) *Where is the best position to tap off the leading-in wire.* (2) *If a double-aerial be fixed to* A *and* B *or from* B *and* C, *where should he tap off for leads-in.* (3) *Which gives the better results,* 100 *ft. single-aerial or* 140 *ft. double-aerial, other considerations being equal.* (4) *If any advantage is gained in fixing aerial so that it runs in any particular direction.*

(1) It is best to tap either in the middle or at one end, preferably the latter, though this may not be possible in your case. Other points are less efficient and in any case your right-angle arrangement may lead to trouble. Have you considered a single-aerial from A to C, the mast at B being dispensed with?

(2) At either end, in either position. This arrangement would also be preferable to yours.

(3) It is difficult to say. Would you personally prefer the single wire if straight?

(4) No, unless you wish to receive from any particular direction, in which case your aerial should point away from it.

A.R. (Brighton) *asks* (1) *For the capacity of a variable condenser with semicircular plates, eight fixed plates,* 3½" *diameter, seven moveable plates,* 2⅞" *diameter, spaced* ⅛" *apart.* (2) *If the above condenser will be suitable for a grid variable-condenser in a valve-circuit, if not how many more plates will have to be added.* (3) *What is the cause of a whining noise in the 'phones on a valve-receiver when the switch-arm of the A.T.I. is off the contact studs.* (4) *If a loose-coupler with primary* 7" *long,* 5" *diameter of No.* 23 *wire, and secondary* 7½" *long, wound with No.* 26 *wire, would be suitable in a valve-circuit and what wavelength it would receive.*

(1) ·00018 mfds.

(2) The capacity is too high for this purpose; use about three fixed and two moving plates.

(3) We are afraid we cannot explain this without detailed examination of set. Effect is probably due to local oscillations of some sort in receiver.

(4) The coupler should be satisfactory, and will give about 1,600 ms. under the conditions stated.

W.H.B. (Castleford) *asks* (*re sketch on* 3-*valve ship amplifier on page* 930 *of* 1920 *Year Book*) *How it is that second valve alone rectifies, seeing that grid and plate potentials are fixed and the same for all valves, and that therefore they should all function the same way.*

This would be true if all the valves were of the same type, but in this type of receiver the first and third valves are V24's and the second a Q. By choosing valves in this way it is possible to arrange that the particular potentials which put No. 2 at the rectifying point also put No.'s 1 and 3 on the amplifying part of their curves.

M.B.K. (Taunton) *asks* (1) *Why is no detector required when a tikker is used for receiving C.W.* (2) *He has two crystals and finds that when both are* *in their best adjustment for a certain type of signal each will give better results than the other with different signals. He asks the reason for this.*

(1) Tikker should be used with blocking condensers to the 'phones; when tikker contact closes, the blocking condenser picks up energy from tuned-circuit. When contact opens, the charge on the blocking condenser at instant of opening, discharges through the telephones, giving an impulse to the diaphragm.

(2) This is due to the fact that the form of the wave trains are different from different types of sets, and in general the strength of signals will be different. The best adjustment of crystals varies with strength of signal, and does not usually vary in the same way with different crystals.

NOVICE (Ashford) *wishes to make a crystal receiving set and asks the following questions:—(1) Would a given circuit with an A.T.I., 8" × 3½", to be wound with a suitable wire, be satisfactory. (2) What advantage would be gained by use of loose-coupler, 8" × 3½" and 6" × 2", in place of A.T.I. in question (1). (3) If his circuit is workable and what approximate range should it give. If not suitable for advice as to how to pick up, say, Paris and Dutch stations. (4) If a tikker would be suitable to receive C.W. on his circuit.*

(1) The circuit is fairly good; if possible, use former of somewhat larger diameter and wind coil with about No. 24 wire. You do not need more than about 4 volts in the potentiometer.

(2) Loose-coupler of dimensions shown would not improve results.

(3) To receive up to 3,000 metres you should make primary 8" × 6" of No. 24 and secondary 7" × 5" of No. 26, with a variable condenser of maximum capacity ·0005 mfds across it.

(4) C.W. reception with such a circuit could be carried out with a tikker instead of crystal, as you suggest. It is possible to make a successful tikker out of a buzzer.

E.B. (Sheffield) *sends diagram and particulars of a valve circuit and also of his aerial, and asks (1) For criticism of circuit and coils, and for his maximum wavelength. (2) If reaction coils are all right. His secondary is fitted with a hinge and works like a flap on to the primary. (3) If a 4,000 ohm single telephone would do. (4) Is his aerial correct. (5) If he would get C.W. and telephony.*

(1) The general arrangement of set is quite O.K., but a Q valve will not give satisfactory results for grid-condenser rectification with only 50 volts on the plate. At least 200 volts would be necessary for this method and preferably more should be used. If you can only use 50 volts, use a V24 valve. You do not give enough information for accurate determination of your maximum wavelength; for instance, we cannot determine capacity of A.T.C. from the mere statement that it has eleven plates. However, maximum wavelength is almost certainly above 4,000 ms., and may be much higher.

(2) Yes.

(3) Yes.

(4) Aerial is bad, having small acute angle at down leads. Take lead from other end.

(5) Yes.

(*Four* questions, please.)

J.H.W. (Birmingham) *asks (1) Where it is possible to purchase rotary condenser plates. (2) If and where it is possible to get valve filaments repaired.*

(1) Enquire of any of the advertisers of parts of wireless apparatus in our columns. We doubt if you will find many sizes stocked, but the plates can be easily cut from thin sheet metal.

(2) This cannot be done at present. Among other things, the difficulty of adequately re-exhausting the valve makes it not worth while.

S.H.H. (Bexley) *gives particulars of a one-valve receiver and asks (1) If it is suitably wound for telephony, as he gets spark and C.W. quite O.K., whereas telephony is faint and impossible to tune on account of howling, which, on the other hand, does not occur with spark and C.W. (2) For size of wire, number of turns and tappings for wavelengths from 3,000 to 10,000 ms., for primary and secondary wound in the form of a hank. (3) Where to obtain book of wireless station call-signals.*

(1) Circuit should be all right for telephony. Poorness of speech and presence of howling are due to too tight reaction coupling. Reaction should be weakened till set ceases to oscillate—*i.e.*, till howl ceases.

(2) Primary might be 800 turns, mean diameter 4", No. 26 wire. Secondary might be 600 turns, mean diameter 4", No. 26 wire. Hank coils will not give good results on such a job.

(3) The "Year-Book of Wireless Telegraphy," from The Wireless Press, Ltd., 12-13, Henrietta Street, London, W.C.

F.Z. (Paris) *asks how to connect up a set with following items: Double slide-coil, variable condenser, grid-leak, 2 valves, filament battery and resistance, H.T. battery and H.R. telephones. (2) Is an inductance really necessary for C.W.*

(1) We are afraid items listed would not give satisfactory results without additions, one of the simplest being the introduction of an intervalve transformer as shown in Fig. 2. We should dispense with grid-leak.

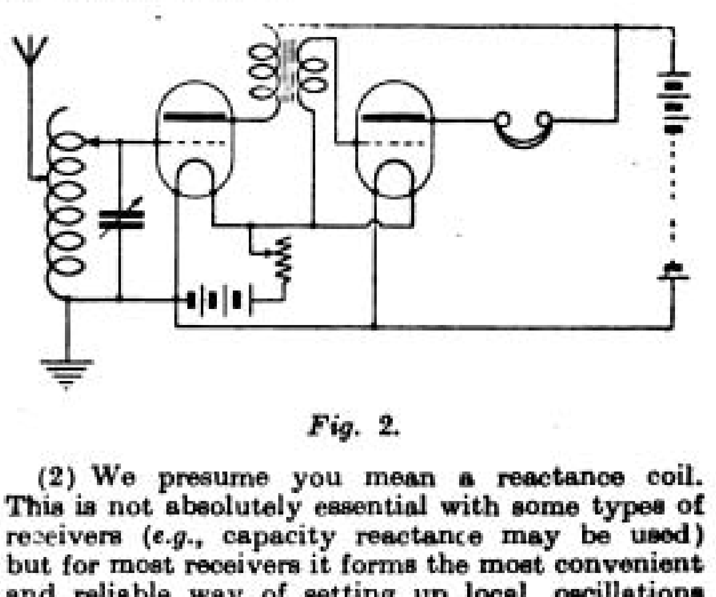


Fig. 2.

(2) We presume you mean a reactance coil. This is not absolutely essential with some types of receivers (*e.g.*, capacity reactance may be used) but for most receivers it forms the most convenient and reliable way of setting up local oscillations necessary for heterodyne reception.

JIGGERED (Tonbridge) *sends a large number of questions, under four headings, some of which would require much space for adequate treatment. We give replies to four of these questions.* (1) *Seeing that the inductance-capacity ratio of a receiver circuit with potentially operated detector, should be large, why is a condenser introduced and the self-capacity of the coil used alone.* (2) *What ratio of microfarads to microhenries is reckoned the maximum limit in good practice, in such a circuit.* (3) *Of what order is the self-capacity of an inductance.* (4) *Can it be calculated and treated as a localised capacity to give the natural frequency of a coil without additional capacity, by formula* $\lambda = 1885 \sqrt{LC}$.

(1) As you suggest, a condenser is added for convenience of tuning and to limit size of the coil, chiefly the former.

(2) No fixed ratio can be given. In practice it is more usual to limit the capacity of the condenser to a maximum of approximately ·0005 mfds. in any case.

(3) This depends on the type of coil. For single layer of ordinary dimensions, capacity is generally only a few centimetres. On the other hand for a multilayer coil of considerable size, capacity may be of the order of ·001 mfds.

(4) The self-inductance cannot be easily calculated at all accurately, and the results obtained would not give satisfactory results in the wavelength formula quoted.

E.J. (Sutton) *states that he wishes to introduce a second valve amplifier into the circuit shown on page 65 of the issue of 17th April, 1920. He employs V24 valves and wishes to use resistance-capacity coupling between the circuits. He asks for a diagram of the connections showing values of the resistances, etc., introduced. See Fig. 3.*

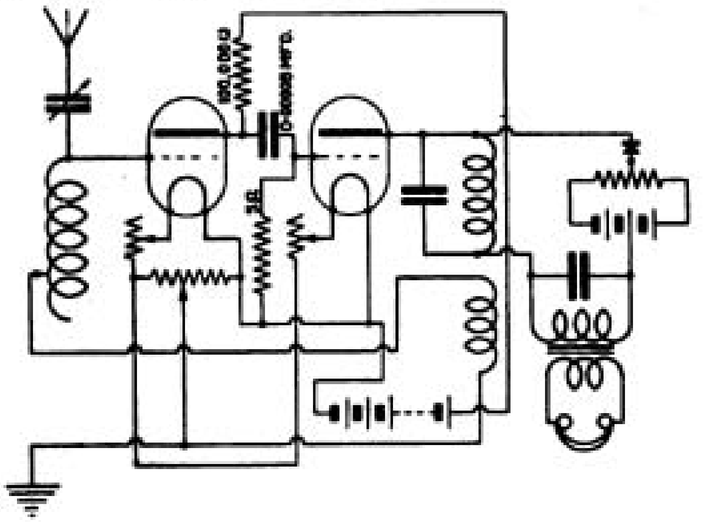


Fig. 3.

L.B. (Bath) *asks* (1) *What would be the approximate wavelength reached by a loose-coupler of certain dimensions.* (2) *If galena can be used with fine copper-wire contact.* (3) *If there are any advantages in using a battery and potentiometer with any crystal besides carborundum.*

(1) You do not give any particulars as to the circuits in which the primary and secondary are included; for instance, you do not state capacity used with the secondary. The inductances of the coils are, primary 815 mhys; secondary, 4,020 mhys.

(2) Yes, this is one of the standard forms of galena detector.

(3) Most crystals require a potentiometer or, at any rate, can be improved by its use. Zincite-chalcopyrite, molybdenite and galena for instance, all work better with potentiometer.

C. de la B. (Boulogne) *asks* (1) *What is a compound-condenser and what is its use.* (2) *Whether we can inform him of tables giving the diameters in mms. of SWG sizes of wire, and, further, what do the following abbreviations mean,* DWS, SWG, SSC, DSC, SCC, DCC.

(1) We cannot say without further particulars. The term "compound condenser" might be applied to many different condensers made for many different purposes.

(2) Tables are given in W. H. Eccles Handbook, B. Hoyles standard tables, Munro and Jamieson's Pocket-Book, and elsewhere. Abbreviations mean: double-wound silk, standard wire-gauge, single-silk covered, double-silk covered, single-cotton covered, double-cotton covered, respectively.

L.A.W. (Yorks) *asks* (1) *What is the longest wavelength used at the present time for spark stations.* (2) *What is tonic-train telegraphy.* (3) *Describing a case in which a set would only give signals for a weak value of coupling—no results whatever being obtained with tight coupling—he asks if we can explain this.* (4) *For the natural wavelength of a twin-aerial, 98′ high, at one end, and 106′ at the other, 215′ long, with down-lead of 60′.*

(1) Probably Glace Bay, 9,000 metres.

(2) C.W. interrupted by a buzzer. A typical form is for the grid-potential in a valve-transmitter to be varied by means of a buzzer.

(3) The result is unusual, and we cannot offer an explanation without more detailed examination of the set.

(4) About 230 metres.

WATCHMAKER (Liverpool) *has a set, somewhat similar to that described in the April 17th issue, constructional article, which gives good results, but he finds that if he reverses connections to the loose-coupler secondary, in one direction he gets results with normal couplings, and in the other, only when the coupling is dead weak. He asks* (1) *What is the correct direction to use. He also has a pair of basket coils of 150 turns each, which give him YN and MUU. He asks* (2) *If he could get Annapolis by using a loading coil with the above pair of coils.*

(1) This is due to the reaction being in the wrong sense when connections are in the direction in which coupling has to be dead weak. Use the other connection.

(2) If you can get YN you will probably need to make a similar coil of about 200 turns, and add this to the others in order to get Annapolis.

A.D.M. (Roehampton) *encloses diagram of his set and states that he has trouble with howling. He asks* (1) *Is the set wound up in the best way for using one H.T. and one 4-volt accumulator.* (2) *How he can stop the howling without using two H.T.'s and two accumulators. Particulars are given regarding the howling.* (3) *If amplifier C Mark 3 (which is* *embodied in his set), was designed for use with power buzzers, and if so whether the primary of the first transformer would be correctly wound for use with a wireless set.* (4) *If he should be able to get* PCGG *on a fair aerial.*

(1) Your set seems all right as far as can be judged from a diagram.

(2) Try inserting the reactance on the earth side of condenser B. If this does no good, try reversing the connections of some of the transformers. Keep amplifier well away from the valve V and the lead, joining the anode of this valve to M, clear of the "output" end of the amplifier.

(3) The amplifier was designed for both purposes, no alterations required.

(4) Yes.

J.S.R. (Spalding) *gives a diagram and some particulars of a valve-circuit which he has tried to make oscillate, without any success. He asks* (1) *If we could suggest why the set does not oscillate.* (2) *What is the general arrangement. (Presumably for an oscillating valve).* (3) *What is the name of a station having the call* LAF *and sending on arc,* 20,000 *metres or more wavelength.*

(1) The grid-condenser and leak is not necessary to make the set oscillate, and may possibly prevent it from doing so. Try removing it and putting negative potential on the grid, (*i.e.*, slightly negative to the negative end of the filament).

(2) There are a very large number of equally good arrangements. Yours is about the most usual for C.W. reception.

(3) This is the new French station at Croix d'Hins, near Bordeaux, known as the "Lafayette" station.

A.H.R. (Bow) *asks* (1) *For particulars whereby he can construct a transmitting set for a three-mile radius, using a frame aerial.* (2) *For particulars of a receiving set of* 30,000 *metres; he has a three-valve amplifier and a frame aerial* (100 *ft.*).

(1) We are afraid both your questions are somewhat out of our scope. The ban on amateur transmission in this country has been removed such a little time that we do not know of any articles that have appeared on such a set recently. A frame aerial will be very inefficient for transmission.

(2) The efficiency of a set at such long wavelengths makes it doubtful if the results obtained would repay the trouble and expense of construction, particularly as we know of no stations working on a 30,000 ms. wavelength. If you decide to make it, however, tuned-circuit condenser should be about ·001 mfds., tuned-circuit inductance 300,000 mhys. We cannot give data for aerial circuit without more information about your frame.

A.G.S.R. (Chorley Wood) *asks for our opinion on* (1) *A crystal circuit.* (2) *An aerial.*

(1) The circuit should be O.K. if coils are of suitable dimensions.

(2) Aerial is all right, if down-leads are taken from mid-point of horizontal span. It would be better, however, to take leads from the end of the span nearer to the house, if this can in any way be managed.

E.J.B. (West Norwood) *referring to the set described in the constructional articles recently, asks* (1) *If we can suggest the best earth system, taking into account the position of his aerial and the fact that the nearest water pipe is* 30′ *from his instruments. He wishes to have adequate protection from lightning.* (2) *If he constructs a telephone transformer as on page* 699, *March issue, what resistance each ear-piece of the telephones should be.* (3) *If an* R *type valve is suitable as a magnifier for this set.*

(1) Connection with water pipe appears to be your best earth. Keep aerial earthed when not in use, and there will be little risk from lightning. Only other alternative seems to be lowering aerial in thunderstorms, but this is not necessary. Avoid sharp bends in your aerial and earth leads.

(2) About 60 ohms per ear-piece.

(3) Yes.

M.G.S. (Cambridge) *asks* (1) *What kind of tuner for use with a* H.F. *resistance-amplifier satisfies the following conditions—(a) Wavelength range* 3,000 *to* 17,000 *metres, on spark and* C.W. *on* P.M.G. *aerial. (b) Good efficiency and selectivity. (c) Minimum tuning adjustment. (d) Ease and cheapness of construction. (e) Adaptability to various types of receivers.* (2) *What would be rough dimensions of above tuner.* (3) *Apparatus is to be installed in the top of a house. Would inefficiency result from earthing to the earthed middle wire of a three-wire house lighting supply in the room.* (4) *Whether a potentiometer method of using the lighting supply for* H.T. *supply would be satisfactory. He complains of induction in trying this.*

(1) Your requirements are somewhat comprehensive. We do not know of any specially suitable circuit, but should recommend a simple two-circuit receiver with a loose-coupler, A.T.C. in parallel with A.T.I. and a capacity reactance. Condition (*e*) not quite understood.

(2) We should not advise boxing up a receiver of this type. The coupler will be the largest item, and of single layer coils, should be about 30″ × 8″ in plan. The whole receiver might be put on a board about 3′ by 2′. If honeycomb or pile-wound coils are used size will be considerably less, but set will be less efficient.

(3) You would probably have serious trouble from generator noises.

(4) Scheme should be all right if it is possible to eliminate the induction, by using a condenser across the H.T. terminals of your amplifier.

SHARE MARKET REPORT.

Marconi's are hardening somewhat and some good quiet investing is proceeding. The present situation as we go to press (October 22nd) is:—

Marconi	Ordinary	2 11/16
,,	Preference	2 3/8
,,	International Marine ..	1 7/16
,,	Canadian	10s.