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Some Modern Developments in Duplex Telephony

By CAPTAIN P. P. ECKERSLEY of 2 MT.

INTRODUCTION.—DEFINITION.

DUPLEX Telephony is in this article taken to mean any system of wireless telephony in which the usual send-receive switch is done away with.

There are thus two types of Duplex telephony, one which may be termed true Duplex, and the other partial Duplex.

In the true Duplex system, the apparatus approximates in performance to the ordinary wired telephone of daily and blasphemous use. In the partial Duplex system, the participants in the conversation cannot break in one upon the other, in fact simultaneous reception and transmission is impossible.

THE USES OF DUPLEX TELEPHONY.

I think all who have been much associated with wireless telephony will agree that the send-receive switch is a nuisance, and may lead to confusion in the hands of neophytes, but that once mastered, the rapid exchange of messages becomes quite a simple matter.

Duplex therefore scores in the matter of foolproofness in operation, but this is counterbalanced by the extra technical complication sometimes involved.

Personally I think the real use of duplex telephony is for installation either as an adjunct or as replacement to the ordinary wired telephone.

Thus there are many places where it is costly or impracticable to lay telephone cables, or again, a stretch of sea or impassable country may form a barrier between two ordinary telephone networks, and here the wireless link may often replace a trunk line.

THE INHERENT PROBLEM.

The reason why it is so much more difficult to do duplex by wireless than by ordinary wired telephone, is the fact that the ratio of the power of the transmitter to the sensitivity of the receiver is in the former case so much greater than in the latter. In the wireless case the ratio of transmitted power to receiver sensitivity may be of the order of 10,000 times greater than in the ordinary wired telephone case, and it is extremely difficult therefore to eliminate or balance out the effect of the relatively powerful transmitter.

PRINCIPLES OF SOLUTION.

In the past inventors have been at pains to solve the problem along two main lines :—

(*a*) Only to radiate power from the transmitting aerial while speaking ; or

(*b*) To make the receiver so selective that it is not interfered with by the presence of the local transmitter ; or

(*a*) and (*b*) Combined partially.

In (*a*) the problem is concerned practically entirely with the transmitter.

In (*b*) the transmitter is standard and only the receiver circuits present any novelty.

The former system of duplex where aerial current is produced only when speaking, involves the use of so-called "quiescent

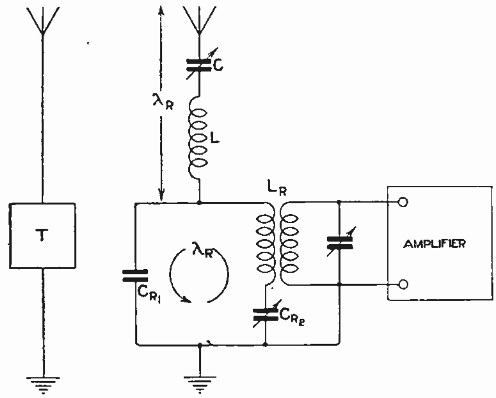


Fig. 1.

aerial transmitters," the latter system involves the use of "protected receiver systems."

The quiescent aerial transmitter gives the inventor the opportunity of doing duplex on one wavelength (a great advantage for group communication as will be seen later), but it usually nullifies the possibility of doing true duplex, unless most elaborate arrangements are resorted to.

THE AERIAL SYSTEM.

It must be obvious that the protected receiver system becomes more simple if there are two separate aerials, one for receiving and one for transmitting, and becomes more and more easy of solution for a given power of transmitter, the further the aerials are separated one from the other.

There is thus the further distinction in duplex systems of two aerial systems or single aerial systems.

Having now defined the various possible principles of solution, it may be interesting to go into more detail under headings as defined above.

QUIESCENT AERIAL SYSTEMS.

The conclusion I have come to as regards quiescent aerial systems is that "the game is not worth the candle." The achievement of a simple quiescent aerial system that gives good speech is very difficult, and if one is so clever or lucky as to hit upon such a system, the problem of the receiver still remains if true duplex is wanted, and partial duplex scores very little over the ordinary simplex system.

The whole problem lies in arranging a system where the aerial oscillations are only present when speaking, and in getting good intelligible speech out of such a system.

It is hardly within the scope of this article to go into great detail as regards quiescent aerial systems, because the modern methods of solution do not involve such arrangements.

Captain Round has pointed out however, that in many quiescent systems only one half of the voice disturbance is used, and this results in the oscillations in the aerial being constantly stopped and started again. Now there is no insurance that the high frequency phases in one burst of voice controlled oscillations will be the same as in the next burst, and the resulting disturbance is so "phase jumbled" as to produce bad speech in the receiving system.

The solution of the problem is to supply independent drive or master oscillator, but even then there is the trouble of "threshold

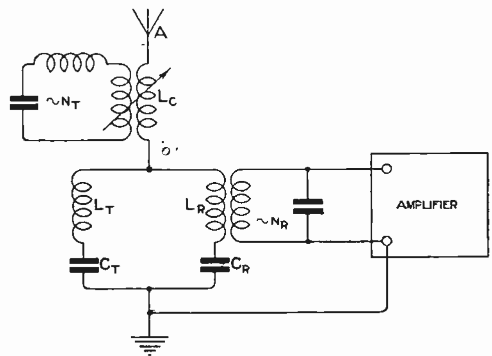


Fig. 2.

voltage," *i.e.*, the feebler electrical disturbances failing to produce any oscillations at all.

For a full discussion of quiescent aerial systems the reader is referred to a paper by the author, read before the Institution of Electrical Engineers, Vol. 58, No. 292, dated July, 1920.

PROTECTED RECEIVER SYSTEMS. TWO WAVELENGTHS, TWO AERIALS.

It has been pointed out that with protected receiver systems true duplex is possible. But this involves the use of two wavelengths, one for receiving and one for transmitting, because the protection to the receiver is nearly always wholly bound up in its being tuned

Duplex Telephony Apparatus, comprising Transmitting and Receiving Units, Generator, Switchboard and Telephone Instrument.

The latter is installed at some distance from the other components, as may be convenient, and the removal of the receivers from the switch hook starts up the motor generator and effects other necessary connections. This outfit permits of simultaneous transmission and reception with power sufficient for reliable communication up to 30 miles.

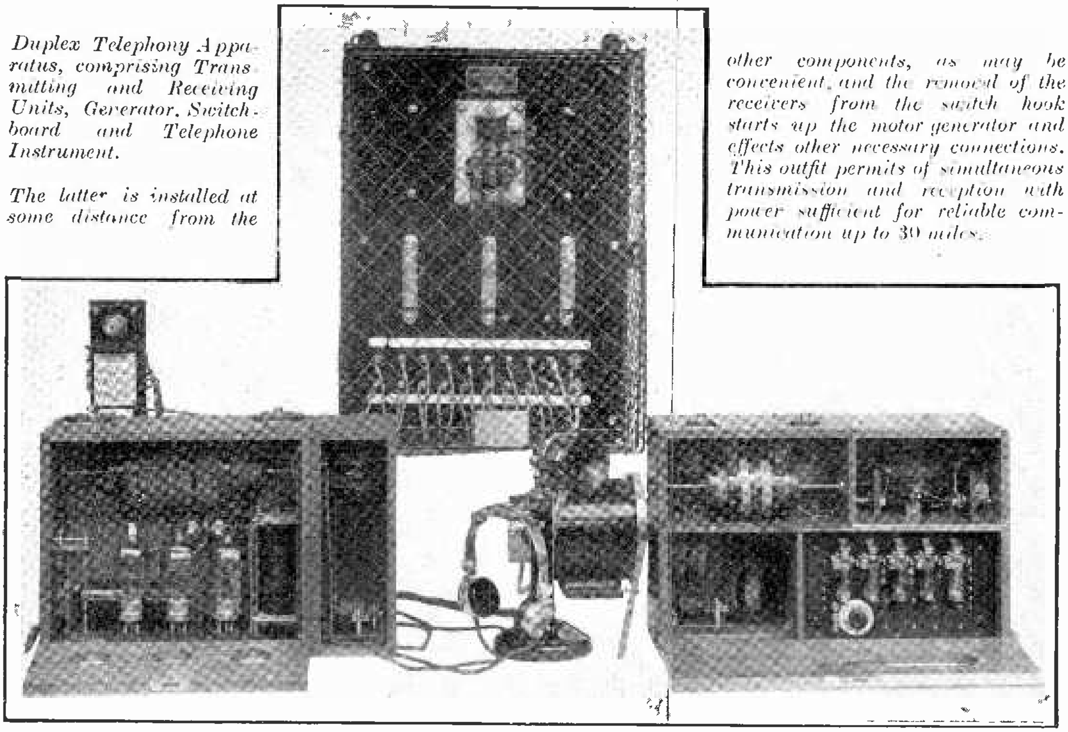


Photo: Courtesy Marconi's Wireless Telegraph Company, Ltd.

to a wavelength different from that of the near-by powerful transmitter.

Let us first take the case where two wavelengths are being used, and also two aerials.

The whole problem now lies in making the receiver ultra-selective to one particular wave only, and thus some simple form of loose coupling arrangement is necessary.

One form of protected receiver system is shown in Fig. 1. This involves the use of a rejector system.

Thus T represents any form of telephone

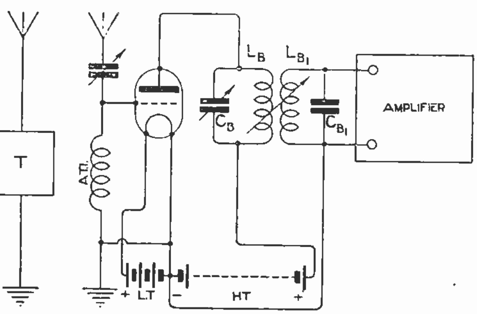


Fig 3.

transmitter oscillating in any normal manner, connected to its own aerial A_T and producing a disturbance of wavelength λ_T. Now the receiving aerial is connected through an inductance L and tuning condenser C, and this part of the aerial system is tuned to a wavelength λ_R. This tuned circuit "stands" on another tuned circuit C_{R_1} C_{R_2} and L_R. C_{R_1} is a large condenser and the circuit C_{R_1} C_{R_2} L_R is tuned to a wavelength λ_R also. If disturbances of λ_R fall on the aerial, the circuit C_{R_1} C_{R_2} L_R is set into oscillation, being in fact electrostatically coupled to the aerial system A_R C_L, the degree of coupling being determined by the value of the condenser C_{R_1}. By making C_{R_1} large, the looseness of coupling is greater. But the effect of the local transmitter is to produce oscillations in the aerial A_R of frequency N_T, these oscillations being less and less in magnitude the more λ_R differs from λ_T. These forced oscillations have two paths to earth, one through the condenser C_{R_1}, the other through the inductance and condenser C_{R_2} and L_{R_2}, and it is obvious that the impedance of the pure condenser path is much less than the inductance capacity path. Thus nearly all the forced oscillations are diverted from the inductance L_R which can therefore be connected to some form of amplifier as shown, which will still be sensitive in spite of the relatively near-by and powerful transmitter.

I have worked this system with about ½ amp. in the transmitting aerial, and a separation of wavelengths of about 15 per cent. with success. The two aerials ran parallel about 5 feet apart, and were run on each side of a 5-ft. spreader on a 30-ft. mast. The amplifier consisted of an audion and two note magnifiers; no high frequency amplification could be used. The value of the condenser C_{R_1} might be of the order of 0·003.

This system has a very limited application, because the direct effect of the local oscillations has to be carefully screened, and because the rejector system is apt to reduce the sensitivity of the receiver.

I have given this as a typical example of a protected receiver system for small powers for two aerials and two wavelengths.

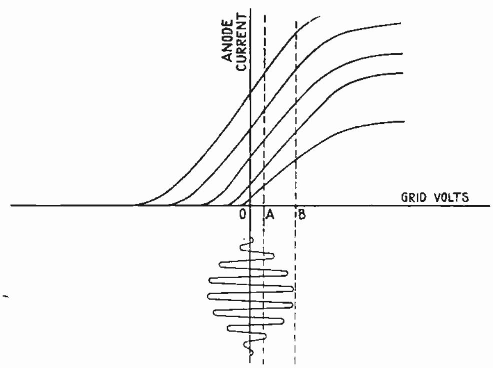


Fig. 4.

TWO WAVELENGTHS AND SINGLE AERIAL.

It is very often important to use a single aerial, as for instance on aeroplanes, or where space is very limited.

In Fig. 2 is given a two-wavelength single aerial system. Here the path to earth is branched, and the aerial is in fact given two natural periods.

Let L_C be the common inductance, and L_T C_T be inductance and capacity in one branch and L_R C_R be the inductance and capacity of the other branch.

Suppose a closed circuit to be oscillating at a frequency N_T, and to be coupled to the common aerial inductance L_C as shown. Now let L_C be adjusted so that if connected between aerial and earth the system has a natural frequency N_T. Also let the product of L_T and C_T be so arranged that they too have together a natural frequency N_T. Then if the aerial be connected through L_C L_T and C_T to earth, the whole system will have a natural frequency N_T and will be in resonance with the closed circuit. Thus currents will be set up in the aerial which will flow through L_C L_T and C_T and will be almost entirely confined to the path L_T C_T provided L_R C_R does not equal L_T C_T, since the point O is a node of potential to currents of frequency N_T.

Thus the closed circuit may be made to oscillate powerfully, and the aerial A L_C L_T C_T will form an ordinary transmitting system. But again the aerial with L_T L_R C_R will form a receiving system of another natural period N_R, and will be sensitive to disturbances of wavelength λ_R, and what is more, nearly all the received currents will pass down L_R C_R, this path being of relatively low impedance to the received currents to the path L_T C_T.

Thus we have the condition of nearly all the transmitted currents passing down the leg L_T C_T and nearly all the received currents passing down the leg C_R L_R, provided the correct adjustments are made.

This obviously gives a duplex system, and this can be used with success for small powers up to perhaps 0·5 amps. in the common aerial, using an audion and two note magnifying amplifier. Again, however, the disadvantage of the system is that the *direct effect* of the local transmitter may prejudice the performance of the amplifier, especially if the latter embodies high frequency magnification.

It is essential to cut down the *resistance* of the inductance L_T, because the higher this resistance the more current will be forced into the leg L_R C_R, but if the resistance is cut down by cutting down the inductance, the sensitivity of the receiving system will be prejudiced, since O is *not* a node of potential to the receiving system. One is thus between the devil and the deep sea, and the problem lies in making a given inductance of low resistance, not always an easy matter.

THE BEAT WAVELENGTH METHOD.

The above systems, and many permutations and combinations of them, had a very limited application up to a certain point, but they have been entirely superseded by using the beat wavelength system, which is the outcome of the beat method of reception, and was first applied by Franklin in his experiments on duplex telephony.

Everyone is probably aware of the usual method of receiving continuous wave by heterodyne. Briefly, of course, the continuous wave is received normally, and another disturbance of slightly different wavelength is superimposed upon it to produce audible beats.

The frequency of the beat is determined by the difference in frequency of the two disturbances producing the beat frequency or

$$N_b = \pm n_1 \pm n_2$$

Where N_b is the beat frequency.

n_1 is the received frequency.

n_2 is the superposed frequency.

It will be realised then that N_b can be made to have a value much greater than audibility, in fact if we have two wavelengths, one of 400 metres and the other of 300 metres beating, the beat *wavelength* will be 1,200 metres, which is, of course, an inaudible frequency.

This principle has been used for the solution of duplex telephony.

Consider Fig. 3 where T is a transmitter close to a receiving system. Suppose the transmitter is radiating a wavelength of 300 metres, and the receiver is receiving a wavelength of 350 metres.

Now the receiver has two frequencies superimposed in the aerial system, one of 10^6 per sec. (300 metres) and the other of $0{\cdot}8575 \times 10^6$ sec. (350 metres). There will thus be beats set up in the aerial circuit of frequency $(10^6 - 0{\cdot}8575 \times 10^6) = 0{\cdot}1425 \times 10^6$ or of a wavelength 2,100 metres. These beats, to be detected, must of course first be rectified, and to this end the receiver must be arranged as shown, with a rectifying valve V_R connected across the A.T.I. of the receiver, and a circuit L_B C_B in the anode of the rectifier, tuned to a frequency $0{\cdot}1425 \times 10^6$ or a wavelength of 2,100 metres. Now the amplifier can be made sensitive to 2,100 metres and *not* to 300 metres, and so will experience no "wipe out" from the local powerful transmitter; or at least the wipe out will be very small compared to what it would have been had the amplifier had to have been sensitive to 350 metres, and not to 300. Thus if a circuit L_{B_1} C_{B_1} is connected across the amplifier terminals, and is coupled to L_B C_B, a duplex system of considerable sensitivity and robustness is achieved, for if the received signal is modulated telephonically, obviously the intensity of the beat will be modulated in the same way.

In fact, summing up, provided the forced oscillations from the transmitter are not strong enough to prejudice the performance of the valve V_R as a rectifier, and provided the amplifier is given a measure of selectivity so that it is sensitive to long waves of the order of 2,000 metres, and not to short waves of the order of 300 metres, then true duplex working is achieved.

It will be realised also that the amount of the forced oscillation can be a good deal greater than would be the case were V_R the first valve of an ordinary amplifier. To get good rectification, the amplitude of one half of this oscillation can have any value between OA and OB in Fig. 4, which represents an ordinary valve characteristic. Anywhere between A and B the peak of the oscillation lies on the straight part of the curve, and the little extra received oscillation rides on the peak of the forced oscillation or later falls into the trough, producing, always provided the peak of the big oscillation lies between A and B, perfect rectification.

SIDE TONE.

While on this point, the question of side tone may be profitably discussed. By side tone is meant the sounds produced in the receiving 'phones by the effect of the voice modulation of the near-by transmitter.

It might at first be imagined that the voice modulation of the powerful near-by transmitter would produce heavy side tone, but this is not actually the case.

For consider again Fig. 4. The effect of the modulation might be to cause the forced oscillation peaks to be increased and decreased in intensity between values OA and OB, that is along the straight part of the curve. Now in this case the rectified component will be unchanged, since the amount of the oscillations in the beat wavelength circuits depends (always provided the main oscillations do not change any more than from A to B) simply and solely upon the magnitude of the received oscillations, riding on the crests of the forced oscillations. This amount is unchanged therefore by the modulation of the near-by transmitter, provided this does not exceed a certain amount.

But if the modulation of the transmitter exceeds a certain amount, and the peaks travel up beyond saturation or down to the bottom bend of the characteristic, heavy side tones are produced because the effective steepness of the characteristic curve is changed.

Thus by proper adjustments the amount of side tone may be given any value.

DESCRIPTION OF A TYPICAL INSTALLATION.

In a certain typical duplex installation of this sort the transmitter is arranged to transmit on any wave between 400 and 300 metres, and its power is 50 watts input. The circuits of the transmitter are absolutely standard, and any well-known form of speech control circuits may be employed.

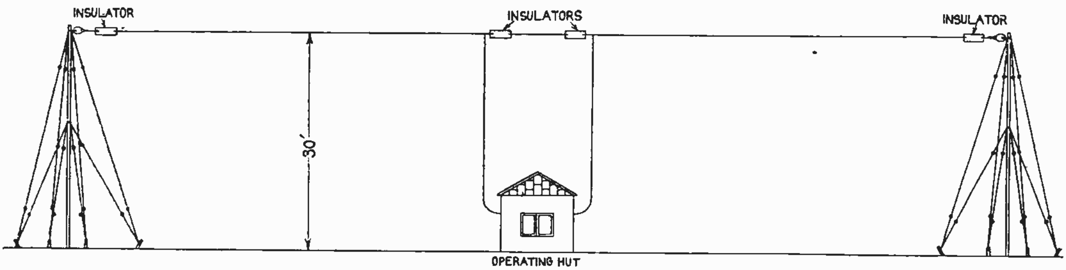


Fig. 5.

The receiver is in principle exactly as outlined above. Thus the aerial circuit embodies a coupled circuit receiving system similar to that illustrated in Fig. 3.

The beat wavelength rectifier has a grid leak, the function of which is automatically to adjust the intensity of the forced oscillations from the local transmitter to a value consonant with good rectification.

The beat wavelengths circuits are arranged so that the primary (in circuit with the anode of the rectifier) has a fairly large condenser and relatively small inductance (this to shunt any forced oscillations), while the secondary has a large inductance and small condenser to give voltage step-up.

The amplifier is sensitive to long wavelengths only, and has two H.F. magnifications, a detector and one note magnifier. The transmitter and receiver are arranged in separate boxes, and are installed about six feet apart to get over direct wipe out and induction effects.

There is a remote control attachment consisting of a pedestal microphone and head telephones, and this may be installed up to 50 feet away from the instrument boxes. Lifting the head telephones from the hook on the pedestal microphone lights all valves, starts up the transmitter generator, and all is ready for communication.

Thus all the user is confronted with is the microphone and telephone apparatus, which can of course be installed in the house, while the other apparatus can be installed anywhere conveniently, in an outhouse or garage for instance.

The aerials are 30 feet high, and are hung on two masts as shown in Fig. 5, and are simply really two L aerials.

The guaranteed range of the installation under good conditions to give R9+ speech is about 30 miles.

GROUP COMMUNICATION.

It will be realised that for group communication the use of a two wavelength system involves a definite difficulty. If there are only two stations, of course, the wavelengths need never be changed. If, however, there are three stations, obviously one pair of stations cannot inter-communicate.

This has been overcome by arranging relays which, when energised, invert the transmitted and received wave of any installation. (Obviously the beat wavelength remains constant.)

Thus *all* stations stand-bi on the same wave. On wishing to call up, however, any given station energises his relays and transmits on the stand-bi wavelength and receives on the other wavelength. This overcomes all difficulty. Thus on each microphone and telephone unit there is a switch marked "close for call," and all this does is to energise relays which change over the wavelengths as indicated, when it is desired to initiate a call.

The whole apparatus therefore approximates in performance to an ordinary party line telephone without calling bell. Anyone listening-in, however, to another conversation will only hear half what is said, unless he is clever enough with his "call" switch and constantly changes waves as one or the other side of the conversation is desired to be heard. Such malicious listening-in, however, involves expenditure of battery power, and might deter certain people.

A calling bell can be added to the apparatus, and standing-bi would involve the use of a separate heterodyne to reproduce the effect of the near-by transmitter, which obviously cannot be allowed to oscillate continuously.

A photograph of the installation is given on page 457.

SINGLE AERIAL SYSTEM WITH THE BEAT METHOD

Consider again the circuit of Fig. 2. Obviously the beat method helps enormously in this case. The receiving leg L_R C_R has in it two frequencies N_T and N_R, which beat to produce the long wavelength which can be amplified without being wiped out by the frequency N_T. Furthermore, and herein lies the whole ingenuity of the arrangement, thanks to the fact that O is nodal to the transmitted oscillations, and forced oscillations in L_R C_R will be commensurate with the received oscillations, and so the method is successful.

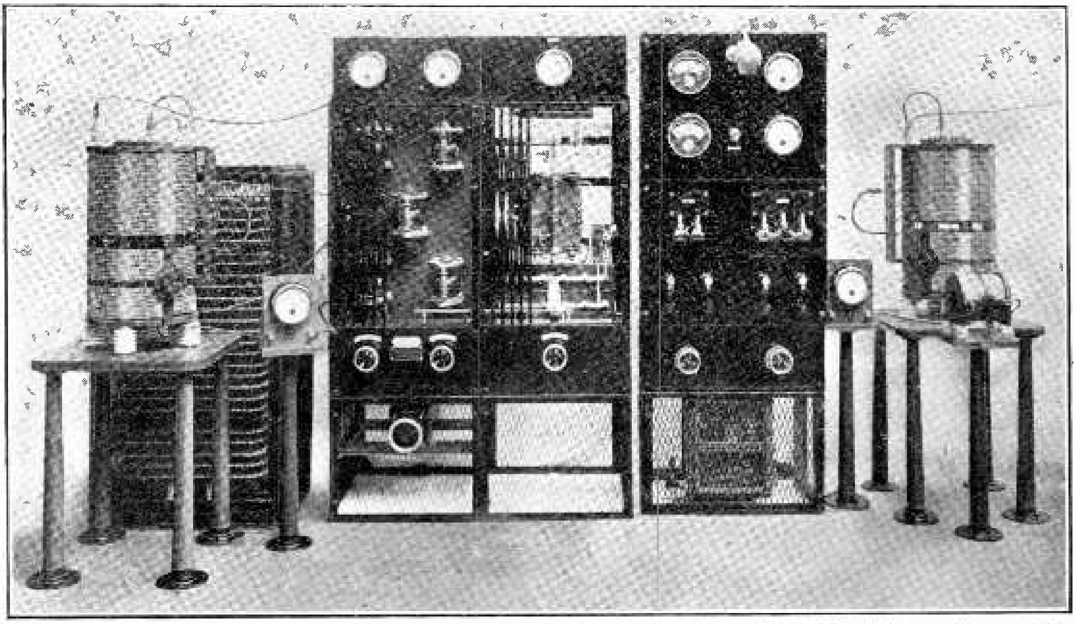
I have actually used this circuit and have obtained good duplex working with as much as 5 *amperes in the same aerial*, that is receiving the desired signal.

This circuit is obviously very useful for aeroplane working.

TWO AERIALS AND TWO WAVELENGTHS FOR LARGER POWERS.

The same duplex system can be used with greater or less separation of aerials and wavelengths, depending upon the power. Obviously also in certain cases it will be possible to use a separate heterodyne and not the heterodyne effect of the near-by transmitter.

COMMERCIAL 3 kW. C.W. TELEGRAPH TRANSMITTER.



Marconi type valve transmitter. The power panel is on the right, and the rectifier and oscillator valve panel in the centre. The air dielectric condenser is enclosed in a cage on the left. Tuning inductances are on either side.

ELEMENTARY INSTRUCTIONAL LECTURE.

An experimental Lecture dealing with the Principles of Radiotelephony, and primarily intended for Associates of the Radio Society of Great Britain, will be given by Mr. G. G. Blake, M.I.E.E., A.Inst.P., at the Institution of Electrical Engineers on January 12th, at 6.30 p.m. Tickets will be sent to Associates. All interested are invited, and tickets can be obtained by sending a stamped and addressed envelope to Mr. Leslie McMichael, Hon. Secretary, The Radio Society of Great Britain, 32, Quex Road, West Hampstead, N.W.6.

A Five-Valve Experimental Receiver

By RALPH W. H. BLOXAM.

PERUSAL of the Questions and Answers columns of *The Wireless World and Radio Review* each week indicates that there are many who are desirous of practical constructional details and designs for experimental receivers, so that the writer begs to offer a description of his set, in the hope that it may suggest lines on which to work, to some, at any rate, of the many seeking information.

No very special features are claimed for this instrument, but it incorporates one or two novel "gadgets"—if I may be permitted to use a term beloved of the ardent wireless enthusiast—which may be of help and interest alike to the dyed-in-the-wool "ham" (an apt American term for the radio "old stager"), or the beginner.

Although an experimenter, and constantly trying out various new ideas and arrangements, the writer has a passion for neatness and order in the matter of instruments, their disposal on the operating table, connecting wires, etc., a fad, perhaps, but one that possibly has saved many burnt-out valves, shorted H.T. batteries, etc., so that throughout, the aim has been to preserve a neat appearance and yet be able easily to carry out experimental alterations in the coupling of valves, circuit arrangements, values of various components, etc. Partly for appearance, but mainly for economy of space and accessibility, the sloping front cabinet type of instrument has been adopted.

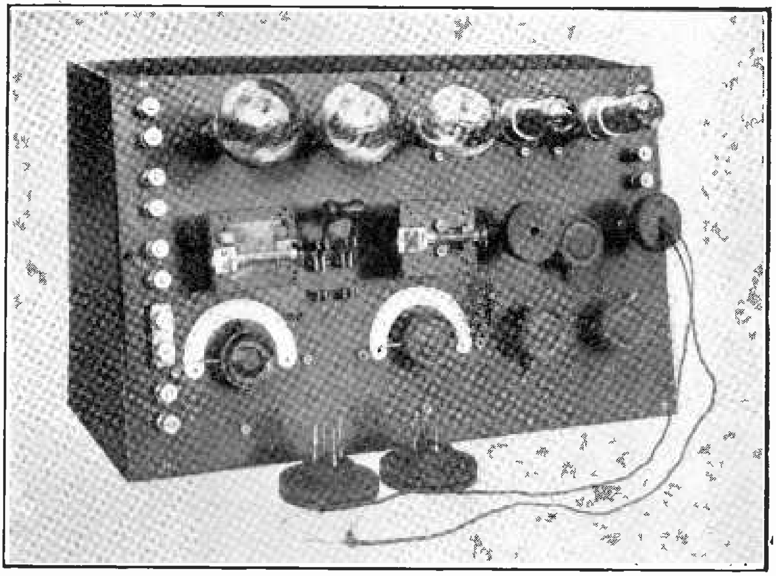


Fig. 1. Front view showing interchangeable H.F. intervalve coupling and arrangement of controls, valves, and terminals.

CABINET.

The cabinet is of French polished mahogany ½ in. thickness throughout. Dovetailing is employed in the construction. The following are the dimensions: 16 ins. long by 10 ins. high by 4 ins. deep at the top, 6 ins. deep at the bottom. It is provided with a removable back, sliding vertically upwards in guides, so that it is an easy matter to get at the internal connections without having to remove the ebonite panel from the front, with the attendant unscrewing that this would entail.

PANEL.

The panel is of ¼-in. ebonite 16⅛ ins. by 10 ins., which was procured cut to rough size. The edges were filed to size, bevelled and polished, while held in the vice, after the centres for all holes had been marked off. Here a word of warning to the unwary. The writer once traced an obscure case of "no signals" to the fact that the gentleman in question had marked off centres with heavy pencil lines, thus providing high resistance leaks all over the panel. A scriber should be used, the lines being scratched lightly, on the reverse side of the panel of course. The edges, and finally the face side of the panel, were polished with bathbrick and oil, a little oil being rubbed on to a piece of flannel smeared lightly with the powdered bathbrick and then applied to the ebonite with plenty of "elbow grease" until all scratches are removed. The final polish is applied with a perfectly dry and clean flannel. No more bathbrick and oil should be used than is absolutely necessary.

VALVE COUPLINGS.

Having heard and read the praises of other experimenters on their particular fancies for the four well-known methods of intervalve coupling, namely, "high frequency transformer," "tuned anode," "resistance capacity" and "low frequency transformer"—and combinations of these, the set was designed so that any of these couplings could be readily used at will, and quickly changed, in order to allow of comparison on a given signal reception. Many amateurs do not appear to realise how easily these changes can be accomplished.

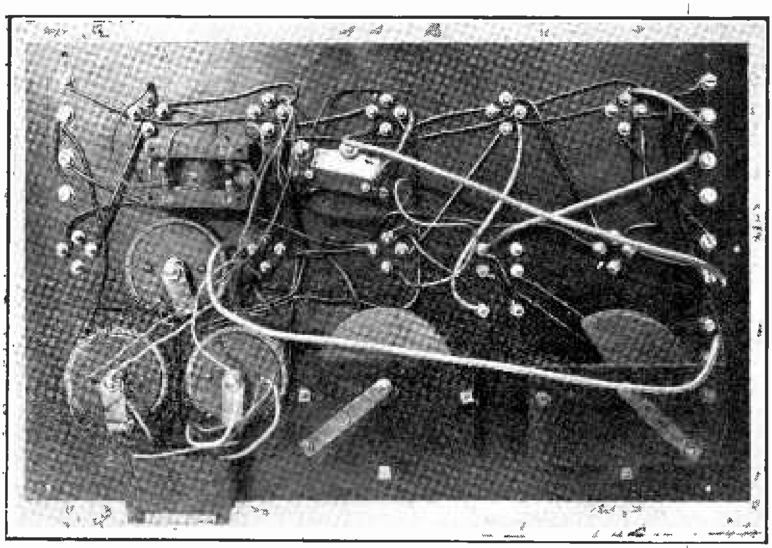


Fig. 2. The interior.

The diagram of connections (Fig 4) shows at W and X the "R" valve sockets providing the means for coupling between the first and second, and the second and third valves, while Fig. 3 shows at A, B, C and D, the four usual methods of coupling between valves—respectively, "resistance capacity," "tuned anode," "H.F. transformer" and "L.F. transformer." Immediately below, at A_1, B_1, C_1, D_1, are shown the connections required on the plugs to couple the valves in that particular manner, the plugs being of course provided with "R" valve pins to fit the sockets W and X. A short study of Fig. 3 will show that it is simply a matter of bringing four leads—from "plate" and "+H.T.," and "grid" and "negative filament" of the two valves to be coupled—to a suitable socket. Receivers fitted with "R" valve holders to take H.F. "plug-in" transformers provide all that is necessary. It is essential however to ascertain the exact order of internal connections of the four legs or sockets. It should be pointed out here that in the receiver described, the coupling between the first and second, and the second and third valves only, can be altered in this way, the last two valves being permanently low frequency transformer coupled. The extra two valves are added for loud speaker working. If desired, however, all intervalve couplings could be arranged for interchanging, as will be readily seen, the only requisites being additional plugs, sockets and tuning condensers. Normally, however, two high frequency valves will be found sufficient for the average experimenter to work with. In the case of resistance capacity and tuned anode plugs, these are made of $\frac{3}{16}$-in. sheet ebonite $2\frac{1}{2}$ ins. square. Four valve pins (these can be purchased from dealers) are tapped into the ebonite at corresponding positions to the usual pins at the base of the "R" type valve. Connections are taken through small holes drilled close to the corresponding pin, and the wires soldered, or if desired, may be held under a nut.

The coupling condensers are made as follows:—Four plates 1 in. square with "tabs" $\frac{3}{4}$ in. by $\frac{1}{4}$ in. are laid with alternate "tabs" to each side in the usual manner. The dielectric consists of mica (the writer has also used thin paraffin waxed paper) 0·002 in. thick, the whole being bound with strips of waxed paper, and covered with a strip of empire cloth for neatness. The plates are made of thin sheet brass, 0·007 in. thickness. The tabs are bent double with connecting wires between, and soldered It has been found that the value of these condensers is not critical. The resistances used are of the "pencil" form mounted between clips, so that they may be readily interchanged. Resistances of 50,000 ohms are used for short wavelengths (up to 2,000 metres). Above 2,000 metres 80,000 ohms has been found most satisfactory. It is not advisable to attempt to make these resistances, as the commercial article of well-known make will be found most satisfactory, being constant in value and free from parasitic noises. For the "tuned anode" circuit plugs, condensers were made as described for resistance-capacity coupling. The coils were made in the form of a "hank" wound on a 2-ins. diameter former, the coil being wound up with cotton when complete. Sixty-four turns of No. 33 S.W.G. D.S.C. wire was found satisfactory for 300 to 500 metres range. Honeycomb coils were also used, ten layers on the former to be described, being found correct for the above wavelengths.

With similar plugs, "reactance-capacity" coupling may be employed. Coils for these should be wound with silk-covered resistance wire of about 36 S.W.G. The resonance peak is thereby flattened as compared with that obtained with the "tuned anode" coil. While somewhat getting over the difficulty of tuning the circuit, this arrangement reduces the amplification slightly.

High frequency transformers were purchased. Some were also made, 60 turns of 40 S.W.G. D.S.C. wire being found correct for 300 to 700 metres, the former being $2\frac{1}{16}$ in. diameter, and having a slot $\frac{1}{8}$ in. wide by $\frac{1}{4}$ in. deep, primary separated from secondary by a layer of silk ribbon.

For L.F. transformer coupling the "primary" and "secondary" of an intervalve transformer are connected to a four-pin plug for insertion in "W" or "X" (Fig. 4).

VALVE SWITCHING.

Reference to the diagram of connections (Fig. 4) will show the method adopted in order to use as required, three only, or the whole five valves. Connection from the 'phone transformer (external to the instrument) is made to a two-pin plug. It is only necessary to insert this plug across the two "filament" legs of the socket "Y" in order to connect the 'phone transformer between the plate of the third valve and positive H.T. A "fixed" 'phone condenser will be seen connected across these legs. It will be seen that the primary of the intervalve transformer is connected across the "grid" and the "plate" legs of this socket.

In order to operate five valves, a special plug is inserted in the socket "Z," the "grid" and the "plate" pins being each connected to a filament pin as shown dotted at "Y." Thus the transformer "primary" is now connected between the plate of the third valve and positive H.T. in the place of the 'phone transformer. The two-pin 'phone transformer plug is now inserted in the socket "Z" connecting the primary between the plate of the fifth valve and +H.T. The filament rheostat for the fourth and fifth valves is now switched "on." Dewar switches could be used for this switching operation if required, although of course slightly more costly.

The whole of the construction of the set was carried out with a few simple tools—a

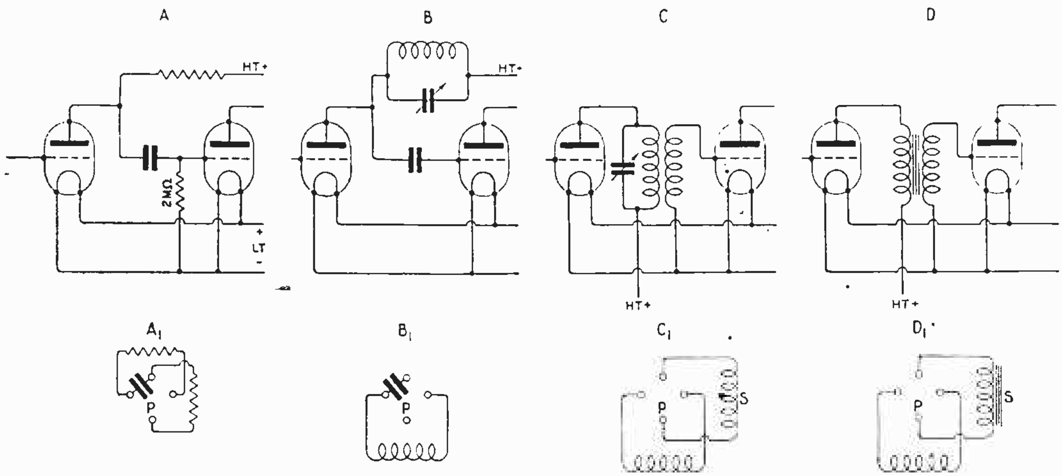


Fig. 3. The four usual systems of intervalve coupling and the method of connecting up valve sockets to effect either arrangement.

breast drill being perhaps chief amongst them, and with the exception of filing the ebonite panel, was all done on a kitchen table.

Fig. 1 shows the photograph of the front of the instrument, while Fig. 2 shows the rear of the panel.

The two H.F. condensers have each seven fixed and six moving vanes—capacity approximately 0·00025 mfds.

" Series-parallel " switch for A.T.C. (connected externally to the instrument) is seen in Fig. 1 between the coupling sockets.

Filament rheostats are provided for first two, the third, and the fourth and fifth valves.

At the top left-hand side of the panel (Fig. 1) will be seen five pairs of terminals. These are respectively, from the top downwards: aerial and earth, A.T. inductance, reaction to plate of first valve, reaction to plate of third valve, variable condenser (A.T.C.), The four terminals at the right of the panel are for connection of H.T. and accumulator. Reference to Fig. 2 will show that the plate circuit connections are brought out well clear of the connections to the grid circuits, in order to minimise capacity effects.

Tuning coils are of " honeycomb " pattern, hand wound, the former used being 2 ins. diameter and having 21 pins on each side. The width of the coils is 1 in. Three are used at a time in the coil stand, one being A.T.I., one the C.C.I., and the third the reaction. For inductance 6½ ins. or seven layers will be found suitable for 350 to 800 metres range with " series " A.T.C., the reaction having about eighteen layers. This information is given for the guidance of those who wish to make similar coils, and the writer assures them it is *well* worth while. These coils are of extremely low self capacity, provided no more shellac is used than is necessary to hold them firmly together.

In conclusion, a few words as to experience in working this set on the 400 metres wavelength particularly.

H.F. transformer coupling gives very fair results, but requires careful and somewhat critical adjustment of the H.F. tuning condensers. Two makes of transformers, and also home-made ones were tried. Tuned anode coupling requires extremely critical tuning when using the honeycomb coils, but is somewhat more flexible when using the small hank coils. Signal strength is much greater than with H.F. transformer coupling. Resistance capacity has been found by far the most satisfactory, being more stable, and no adjustment being required.

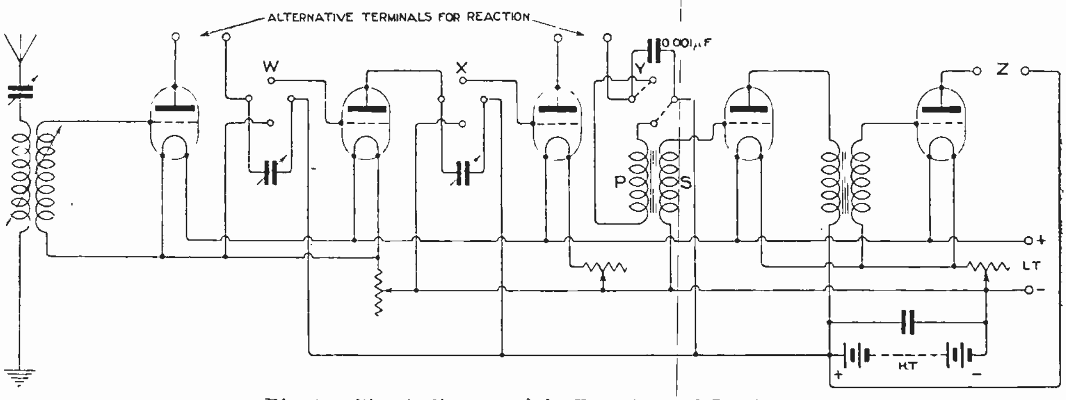


Fig. 4. Circuit diagram of the Experimental Receiver.

As regards signal strength, it is far superior to H.F. transformer, and is hardly perceptibly weaker than with the tuned anode circuit coupling. Also clearest results are obtained with this coupling on telephony, the only disadvantage being the higher H.T. voltage necessary, 70 to 100 volts being used. Owing to the difficulty of tuning when using the transformer or tuned anode coupling, it is almost impossible to follow a conversation between two stations on slightly different wavelengths, and is therefore only useful on a prolonged transmission. The writer has not personally tried it, but a friend of his reports successful working with resistance coupling on 200 metres, having heard **2 JZ** (Aberdeen) here—24 miles east of London. The writer is well aware of the revolutionary statement which he has made, as theoretically, resistance coupling on short wavelengths (below 1,000 metres) is not efficient.

Electrons, Electric Waves and Wireless Telephony—XIV.

By Dr. J. A. FLEMING, F.R.S.

VI.—TELEPHONY AND SPEECH TRANSMISSION.

1. Nature of Articulate Sounds.

BEFORE we can discuss the application of the scientific facts and principles previously described in the development of practical wireless telephony it will be desirable to preface it by a little further consideration of the physical nature of articulate sounds and some description of the instruments employed in the transformation of the energy of aerial vibrations involved into or from correspondingly varying electric current energy.

It has been explained that aerial waves consist in a state of compression at some point in the air, associated with an accompanying state of rarefaction, which states are not stationary at one place, but are propagated through the air with a velocity of about 1,100 ft. per second at ordinary temperatures. The production of these compressional and rarefactional regions is the result of oscillatory movements of the air particles moving to and fro along the line of propagation of the wave. If the motion of the air molecule resembles that of the bob of a long pendulum it is called a simple harmonic or simple periodic motion. The corresponding aerial waves are called simple harmonic waves, and the sensation they produce when acting on the human ear is that of a pure or simple tone such as that given out by a tuning fork or open organ pipe gently blown.

We have also explained that the oscillatory motion of the air particle may be of a more complicated nature, such that the displacement of the particle or the air pressure at any point and at various times, can only be represented by the ordinates or heights of a complex curve called the wave-form curve, the horizontal distances representing the flow of *time*. The wave form of a pure musical tone, or simple harmonic wave, is a curve called a *sine curve* (see Fig. 74).

It has been mentioned that, however complicated or irregular a wave form curve may be, it can always be imitated by adding together the ordinates of suitably placed simple harmonic curves of various amplitudes and of wave-length in the ratio of 1, $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$, etc., or some selection of such waves.

These last are called the harmonic constituents of the complex curve.

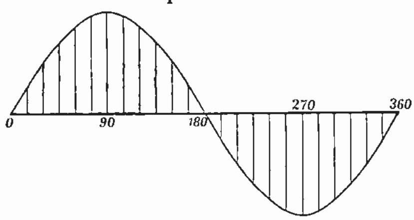


Fig. 74. A Simple Sine Curve, or Simple Harmonic Curve, being the wave form of a pure musical tone.

The equivalent statement in terms of sensations of sound is that any continuous sound having any *quality* corresponding to a certain wave form can be reproduced by simultaneous pure sounds or tones of suitable amplitude and phase difference. If, then, we consider the nature of the sounds made in articulate speech we find that very broadly they may be divided into two classes, viz., (i) Continuous sounds, which are uttered by placing the mouth cavity, lips and tongue, in certain positions, and then forcing air out from the lungs. These sounds can be emitted as long as the breath lasts.

If we except certain sibilant hissing or rolling sounds, such as those indicated by the letters *s*, *sh*, *th* and *r*, we may call the remaining continuous sounds *vowel sounds*. In every language there are a large number of such sounds of different *quality*, and therefore, physically speaking, different wave forms. In English there are about 19 or 20 sounds which are expressed by different modes of sounding the so-called vowel letters *a*, *e*, *i*, *o*, *u*, or combinations of them, such as *au*, *ou*, *ei*, *æ*, *œ*, etc.

Then we have also (ii) discontinuous or consonantal sounds, which for the most part are various abrupt modes of beginning or ending the utterance of a vowel sound. All spoken languages are made up of certain vocal elements called *syllables*, which, combined together or alone, make *words*. A syllable comprises generally a vowel sound, which may be begun or ended with a consonantal sound or some other continuous sound of short duration. Physically speaking, and outside of ourselves, such syllabic sounds consist in short trains of damped aerial waves of complex wave form and of a certain amplitude and wave-length, determining the loudness and pitch of the sound, the said trains being begun or ended, perhaps, in an abrupt or irregular manner corresponding to the consonant. The acquirement of a language consists in learning to associate particular vocal sounds, or groups of them, with certain objects, actions, or ideas.

The art of speech consists in being able to so control the vocal organs, larynx, lips, tongue, mouth cavity, breath, as to create the types of air wave trains which are by custom associated with certain ideas, things, actions, or wants. The human ear, by education, acquires an extraordinary power of distinguishing between the wave forms of aerial waves which strike the tympanum, and noting the manner in which this wave train begins and ends. If, for instance, we pronounce the monosyllabic words *day*, *die*, *do*, *dough*, or *tea*, *tie*, *too*, *toe*, we are, in fact, creating short rapidly damped wave trains of aerial waves differing somewhat in wave form and in the manner in which the wave train begins. Each of these words is associated in our minds with a thing or idea, and a *word* is therefore a more or less complicated sound of a certain finite duration and wave form which, when made, raises in the mind of a hearer an idea or conception similar to that in the mind of the speaker.

In order that the word shall be correctly interpreted by the hearer, it is necessary that it shall be uttered with sufficient *loudness* and sufficient *clearness*. This implies that the sound waves must have adequate *amplitude* and sufficiently well defined *wave form* both in the terminal and medial portions of the wave train. The proper pronunciation of the terminal consonants in each syllable is important. Far too many people mumble or clip their words or run them together in speaking.

It is astonishing how few of those whose trade it is to speak in public, such as clergymen, barristers and politicians, are properly trained in the art of elocution.

2. TELEPHONE TRANSMITTERS.

The problem of transmitting speech to a distance, that is, the art of telephony, consists in arranging means by which the aerial vibrations constituting speech sounds which are uttered at one place can be reproduced at a distant place with sufficient amplitude and correctness of wave form to be heard and understood.

Although various attempts and suggestions for the solution of this problem had been made, no one had completely solved it until Alexander Graham Bell invented, in 1875, the speaking telephone, and this, coupled with the inventions of Edison, Hughes and others, as regards the carbon microphone transmitter, gave us practical telephony capable of operation in everyday life. Except in matters of detail, it is remarkable that the fundamental principles of the apparatus remain to-day what they were forty-six years ago.

Bell realised at a very early stage in his experiments that to achieve telephony by the aid of an electric current, the current in the wire must vary in strength with time exactly in accordance with the variations in air pressure made by the voice of the speaker at a point near his mouth. This means that the current must be an undulatory current.

Bell's solution of the problem of telephony was a remarkable stroke of genius, involving as it did the production of a novel yet most simple appliance which could act both as transmitter and receiver. He placed on the pole of a bar, or poles of a horseshoe-shaped permanent magnet, soft iron pole pieces wound over with insulated wire. Very near to these pole pieces was fixed a circular flexible disc of thin iron about $2\frac{1}{4}$ ins. in diameter (see Fig. 75). When the coils of wire are traversed by a fluctuating electric current the magnetic poles are either weakened or strengthened a little. The disc, or diaphragm, as it is called, is therefore cupped, or bent in a little more, or else springs back suddenly. The amplitude of motion of the centre of the diaphragm is in any case extremely small, never exceeding 1/100th of a millimetre, yet the blow it inflicts on the air is sufficient to create an air wave, and therefore an audible sound, and the movements of the disc respond so quickly to changes in the current that the receiver can impress upon the air waves of a complex wave form which yield intelligible speech sounds.

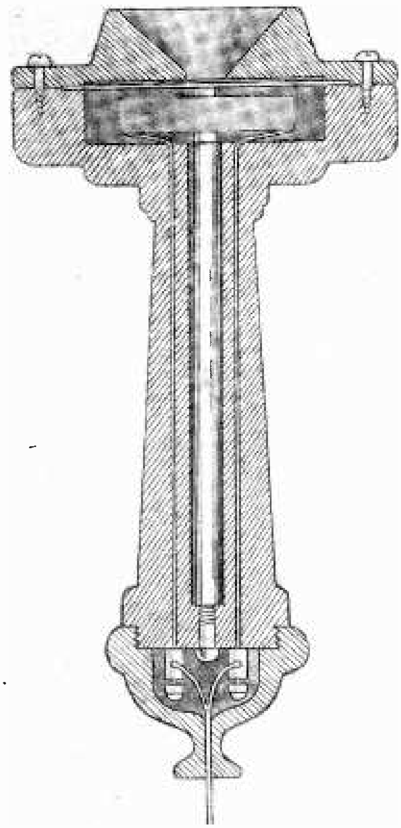


Fig. 75. Section of a Bell Magneto Telephone.

On the other hand, if we speak to the diaphragm the changes of air pressure made by the speech waves against the disc press it in or out. When the iron disc is moved nearer to the magnet poles it increases the pole strength slightly, and this creates an induced electric current in the surrounding coils of insulated wire, the variation in which copies to a certain extent the motion of the disc.

Hence, if two similar telephones have their coils joined by a pair of transmitting wires, speech made against the diaphragm of one telephone is faintly repeated by the diaphragm of the other, and the arrangement conveys audible speech to a distance.

It was, however, soon found that although the above-described Bell telephone is a remarkably good speech reproducer, it is not very effective as a transmitter, and it was soon replaced in this respect by the carbon microphone resulting from the discoveries and inventions of Edison and of Hughes.

In this transmitter the movements of the disc or diaphragm created by the speech sounds is made to compress more or less some granules of graphite or hard conductive carbon, and this pressure varies the electric conductivity of the mass of granules. Hence, if this carbon forms part of the electric circuit of a voltaic battery, changes of current will take place in that circuit corresponding to the movements of the diaphragm.

Without entering into details of development we may describe one or two modern microphone transmitters as used in telephony, both with wire circuits and in wireless telephony as well.

In its usual form one of them is termed a "solid back" transmitter. It was invented by Mr. A. C. White in America. It comprises an ebonite trumpet-shaped mouthpiece, which may be replaced by a large metal cone, the function of which is to collect the sound waves and converge them on to a thin circular diaphragm or disc of aluminium, about 2½ ins. in diameter, and about 1/50 in. in thickness. This diaphragm is clamped at the edges between rubber rings, and the speech waves collected by the mouthpiece or trumpet set the disc in vibration, pressing it inwards in concave form to an extent which depends on the amplitude of the sound wave and on the wave form of the latter, or else causing it to bulge out again. Behind this diaphragm is a small flat circular metal box carried on a rigid cross arm. The bottom of this box is covered with a thin disc of hard carbon like a wafer. The lid or top of the box is a thin mica disc, to the inside of which is clamped a similar hard carbon disc. There is a very shallow space between the two carbon discs, which is partly filled with small granules of graphitic carbon or coke (see Fig. 76). Wires are connected to the two carbon discs, and the centre of the mica diaphragm is connected by a metal screw with the centre of the aluminium diaphragm. Hence, when the latter is set in vibration by the speaking voice it causes a similar movement of the top carbon disc, and the carbon granules are more or less squeezed together, and their electrical resistance varied in the same manner as the movements of the outer diaphragm.

The electrical resistance of the carbon granules may be about 30 ohms in their normal condition, and it falls in resistance under the influence of the compression due to speech waves, but the actual variation of resistance in telephonic work is not more than about 5 or 10 ohms above or below the normal.

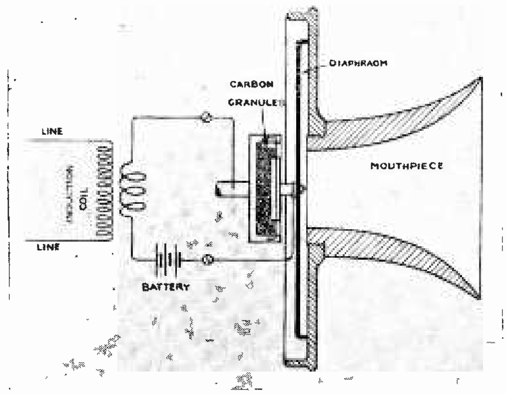


Fig. 76. A solid back granular Carbon Microphone Transmitter.

Another successful form of carbon transmitter is the Ericsson (see Fig. 77). In this

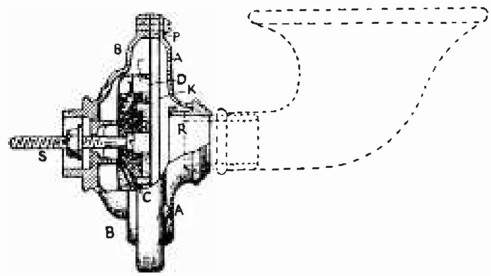


Fig. 77. An Ericsson Carbon Microphone Transmitter.

case the diaphragm which is acted upon by the speech sounds is a thin carbon disc 2.5 ins. in diameter and 0.04 in. in thickness. Behind this diaphragm is a carbon block, and a small interspace between the two is filled with small carbon granules. These are prevented from falling out by means of a ring of felt which encloses the circular carbon block. The normal resistance of this transmitter is 100 ohms, and it varies in operation between 50 and 170 ohms.

A trumpet-shaped mouthpiece is used to collect the sound waves and converge them on the diaphragm, and between the inner end of this trumpet and the carbon diaphragm is a disc of oiled silk to keep the moisture of the breath from entering the microphone chamber. In most carbon granule microphones trouble sometimes arises from the " packing " of the granules, and from the sticking together of these granules, either due to moisture from the breath entering the granule chamber or from heat produced by the current.

The slight compressions due to speech movements of the diaphragm then fail to make the necessary variations in resistance. Great ingenuity has therefore been expended in the invention of liquid microphones, such as those of Q. Majorana and J. Vanni, or by using continually renewed supplies of carbon granules as in the falling carbon powder microphone of Marzi. Nevertheless, the only type of telephone transmitter which has obtained extensive use in practical telephony is the carbon granule microphone.

In arrangements for wireless telephony employed before the application of the thermionic valve as a generator of continuous waves, it was necessary to modulate rather large currents of 5 or 10 amperes by a microphone transmitter.

The carbon granule telephone transmitters in ordinary use, such as those above-described, will not operate satisfactorily with more than about half an ampere of current passing through them. Hence many arrangements were suggested for using a number of transmitters in parallel or together, but it is extremely difficult to secure an equal division of current between the instruments so that all the microphones shall take an equal share of the duty of modulating it. These arrangements need not be described, as they are now rendered unnecessary by the powers and remarkable properties of the thermionic valve as described later on. It is, however, necessary in nearly all cases to associate with the microphone an induction coil for the following reasons.

The variation in resistance of the carbon granule microphone is, in general, only a fraction of its normal resistance, which may be from 30 to 100 ohms. Suppose, then, that such a microphone, in series with a few cells of a battery, is placed in a circuit which has a much higher electrical resistance than the microphone itself. It will be evident that any variation in resistance of the microphone produced by speech made against the diaphragm will only vary the total resistance of the circuit by a much smaller percentage than that by which the resistance of the carbon microphone itself is varied (see Fig. 78).

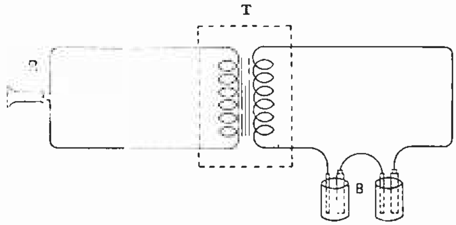


Fig. 78. A diagram illustrating a simple telephone circuit. M is the carbon microphone transmitter, B is the battery, T the telephone induction coil, and R is the receiving telephone.

This difficulty is overcome by the use of an induction coil as first suggested by Edison. We provide a small induction coil T, consisting of two insulated wires wound over a small bundle of iron wires (see Fig. 78). The resistance of one primary wire may be about 1 ohm, and the resistance of the other, or secondary wire, may be about 25 ohms. If, then, we join in series the primary wire and the carbon microphone M and a battery B of a few low resistance cells, it will be evident that any variation in the resistance of the carbon microphone due to vibrations of its diaphragm will create variations in the current flowing through the circuit of nearly equal percentage to the variations in microphone resistance. Then any changes in the current flowing through the primary wire of the induction coil will create corresponding variations in the electromotive force induced in the secondary wire.

The line wires are attached in ordinary wire telephony to the terminals of this secondary circuit, so that the current transmitted is an induced current, and this passes through the receiver telephone R at the listening end.

In the case of wireless telephony, as will be explained later on, the secondary electromotive force is used to vary the potential of the grid of a thermionic valve called a control valve.

A method which avoids the use of an induction coil is to join a number of microphone transmitters in series so that they are all equally affected by the voice, but the total resistance variation is then the sum of the variations of each microphone separately.

The construction of the Bell magneto-receiving telephone has been the subject of numerous improvements in details of construction. In place of a single steel bar magnet as originally used, two bar magnets made of tungsten steel are used, which are fixed parallel to each other at a little distance apart, and connected at one end by an iron distance piece. Or else an elongated horse-shoe magnet is employed (see Fig. 79). On

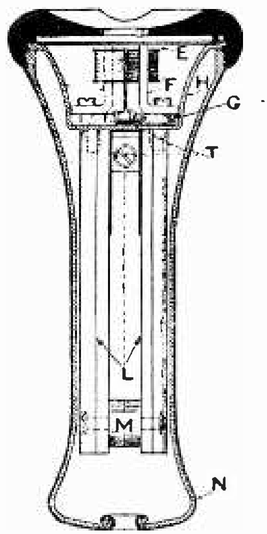


Fig. 79. British Post Office type of Magneto Telephone receiver.

the free outer poles are fixed L-shaped soft iron pole pieces on which coils of insulated wire are wound. The magnets are contained in a non-magnetic metal tube, which is wider at the outer end. On this outer end is fixed a thin disc made of a steel called "Stalloy," which contains about 2.75 per cent. of silicon. This steel disc is about $2\frac{1}{4}$ ins. in diameter, and 1/100th in. in thickness. This diaphragm is so fixed that there is an interspace of about 0.016 in., or about 1/60th of an inch between the flat ends of the pole pieces and the inner surface of the metal disc. The lines of magnetic force which spring from one pole of the magnet pass across this air gap through the iron diaphragm, and back across the air gap to the other magnet pole. The circular diaphragm is therefore sucked or cupped in at the centre, due to the magnetic pull of these poles. If, then, an electric current is sent through the coils of wire wound on the pole pieces it will either increase or else weaken this attraction. If we call H the magnetic force due to the magnet alone, and h the magnetic force due to the current in the coils, then the force can vary from $H+h$ to $H-h$, according to the direction of the current. The attraction or pull on the diaphragm varies as the square of the magnetic force or flux, as it should be called, and hence the attractive force varies between $(H+h^2)$ and $(H-h^2)$. The difference is 4 Hh, and hence depends on H as well as h. It is therefore important to have magnets in the receiver as strong as possible. The material generally used for them is steel containing 5 or 6 per cent. of tungsten, and 1 or 2 per cent. of chromium. The finished magnets are made very hard by quenching from a red heat in ice-cooled water to give them the power of retaining magnetism. Recently a type of steel has been invented at Sheffield called *cobaltcrom*, containing about 15 per cent. of cobalt and 15 per cent. of chromium. It has a much higher magnetic coercive force than tungsten steel. Moreover, it stores up about double the magnetic energy for the same volume of metal.

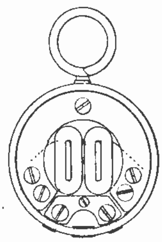


Fig. 80. Watch form of Magneto-Telephone receiver with the diaphragm removed to show the magnet and the coils.

It has the great advantage that it does not require hardening from a red heat in a liquid, and hence the finished magnets are not so liable to be warped out of shape in quenching.

It is important that the small air gap between the magnet poles and the diaphragm should remain of perfectly constant width. The coils of wire wound on the soft iron pole-pieces are made of fine silk-covered copper wire, and may be of resistance between 60 ohms and 4,000, according to the purposes for which the receiver is used.

In wireless telephony the type of receiver generally employed is called a double head telephone. It has two receivers of watch-shape, attached by flexible joints to a steel or aluminium head-band, which passes over the top of the operator's head and holds the two receivers against the ears.

The receivers are in circular watch-shaped cases, made of ebonite or aluminium (see Fig. 80). The magnets are flat rings of steel, with L-shaped soft iron pole pieces screwed to them, on which are wound rectangular shaped coils of extremely fine silk-covered copper wire (No. 40, or even No. 60, standard wire gauge), so as to obtain a very high resistance of 2,000 to 4,000 ohms. The two receivers on the headband have their coil circuits in parallel (see Fig. 81).

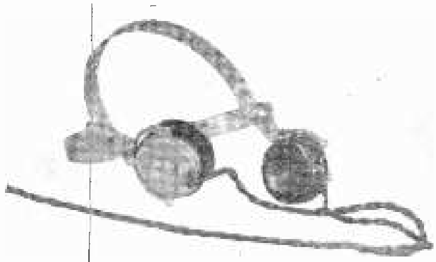


Fig. 81. Double head telephone receiver with spring head band (S. G. Brown).

In the case of loud-speaking receivers the construction is the same as in the portable receivers, but the magnets and diaphragms are larger, and a trumpet-shaped sound projector, like the horn of a gramophone, is attached. A very good example of this type of instrument is the loud speaker of Mr. S. G. Brown, by which telephonic speech can be heard by several hundred persons at once in a large theatre (see Fig. 82).

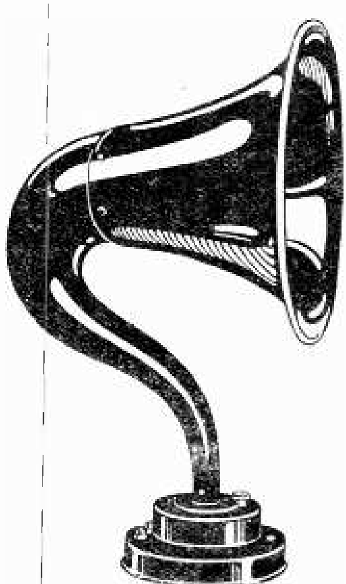


Fig. 82. Loud speaking Telephone of S. G. Brown.

Mr. Brown has also invented very excellent forms of double head telephones which are in extensive use for wireless telegraphy and telephony. He has devised a form of aluminium head-band and self-adjusting swivel receiver holders which are comfortable to wear on the head, and by which the receivers are kept gently pressed against the ears (see Fig. 81). The electrical construction of the receivers, as used for wireless telegraphy, is somewhat different to the standard magneto pattern. In place of an iron diaphragm there is an iron reed, or strip of iron, the natural vibration frequency of which can be adjusted by a screw within limits. To this is screwed an aluminium diaphragm, which is coned and spun into a special fitment, which is covered by an ebonite cap with holes in the centre (see Fig. 83). The resonance frequency of this receiver can therefore be adjusted to suit the musical note of the wireless signals in telegraphy.

In the case of receivers for wireless telephony this adjustment is not required, but the resonance frequency is adjusted to agree with the mean or standard telephone frequency, generally about 800 or 900 cycles per second. The coils of receivers for wireless telephony in use with valve or crystal receiving sets are now always wound with a direct current resistance of about 4,000 ohms.

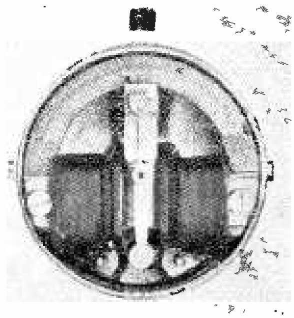


Fig. 83. Interior Construction of the resonance telephone receiver of S. G. Brown, showing the vibrating steel reed.

(To be continued)

The Transatlantic Transmitting Station 5 WS on View.

THE transmitting station 5 WS, erected by the Radio Society of Great Britain for the Transatlantic Tests, will no doubt be of particular interest to members of the Society, especially in view of the success reported on page 478 of this issue. It has therefore been decided to open the station to visitors who are members of the Society or of affiliated societies on January 8th, 9th and 10th, from 2 p.m. to 7.30 p.m. Between the hours of 6.30 p.m. and 7.30 p.m. on each of these three days it is hoped to show the station running.

The station is located at the Electric Power Station of the County of London Electric Supply Company at Wandsworth. A building to house the apparatus and the use of the site for the aerial has very kindly been loaned by the Company, and in this connection it is desired to take the opportunity of mentioning that in previous announcements the name of the Company has been incorrectly given. It is hoped that all who can do so will visit the station.

The site is not ar from Wandsworth Bridge and Wandsworth station, and the address of the power station is The Causeway, Wandsworth.

Readers are reminded that an experimental lecture on the Elementary Principles of Radio Telephony will be given by Mr. G. G. Blake, M.I.E.E., on January 12th, at 6.30 p.m., at the Institution of Electrical Engineers. This lecture has been specially arranged by the Radio Society of Great Britain for the benefit of Associates of the Society and others new to wireless. Tickets for admission may be obtained on application to the Hon. Secretary, 31, Quex Road, W. Hampstead, N.W.6.

Wireless Club Reports

NOTE.—Under this heading the Editor will be pleased to give publication to reports of the meetings of Wireless Clubs and Societies. Such reports should be submitted without covering letter and worded as concisely as possible, the Editor reserving the right to edit and curtail the reports if necessary. **The Editor will be pleased to consider for publication papers read before Societies. An Asterisk denotes affiliation with the Radio Society of Great Britain.**

Correspondence with Clubs should be addressed to the Secretaries direct in every case unless otherwise stated.

Glasgow and District Radio Club.*

Hon. Secretary, Mr. W. Yuill, 93, Holm Street, Glasgow.

Membership is now well over 200. On November 16th Captain Norman Turner lectured on his army experiences.

Mr. McLennan, on November 30th, lectured on the "Elementary Principles of Wireless Communication." He treated the subject practically from the beginning in as simple terms as possible, and this was no doubt one of the most instructive lectures of the season.

On December 14th, Mr. A. F. Gray, another Vice-President, demonstrated a two-valve set which he had constructed.

The next meeting was on December 21st, and was an open night. As the matter of fading in connection with transmissions of telephony from the broadcast stations has been causing club members a considerable amount of trouble, six members had arranged to listen in specially to the full programme of Manchester broadcasting station on a particular night. These reports are being tabulated by Mr. Pick, of the Committee, who has kindly consented to open a discussion on this subject.

On January 11th, 1923, a lecture on "Grid Potentials" will be given by Mr. Pick.

Hackney and District Radio Society.*

Hon. Secretary, Mr. E. R. Walker, 48, Dagmar Road, E.9. *(Letters only.)*

On December 14th, at the Y.M.C.A., Mare Street, Hackney, the Vice-Chairman, Mr. Cunningham, presided. A very interesting discussion took place on radio subjects in general. The Secretary, Mr. Walker, invited questions and replied.

New members are joining. On January 1st, 1923, the new subscriptions came into force, as follows :—Senior members (18 years of age and over), 10s. per annum, entrance fee 5s.; junior members (under 18), 5s., entrance fee 2s. 6d. New members and visitors are always welcome, especially ladies.

"High Frequency Currents and Tesla Coils" was the title of lecture by Mr. A. Valins on December 21st. Experiments were carried out in darkness in order to show the best effect.

Belvedere and District Radio and Scientific Society.*

Hon. Secretary, Mr. S. G. Meadows, 1, Kentish Road, Belvedere Kent.

The evening of December 15th was devoted to a discussion, led by Mr. S. G. Meadows, on "The Difficulties Experienced by the Radio Amateur."

This being the first whole evening given to discussion, the Secretary acquainted the meeting with the rules governing discussions.

At 9.45 p.m. the Marconi concert was tuned-in.

It was proposed to make discussions a regular feature, and to set aside one evening in each month for this purpose.

Durham City and District Wireless Club.*

Hon. Secretary, Mr. Geo. Barnard, 3, Sowerby Street, Sacriston, Durham.

There was a large and varied programme on December 15th. Mr. Geo. Barnard lectured on "Transmitters Using Valves." The Chairman, Mr. F. Sargent, F.R.A.S., then commenced the question period. A special three-valve circuit submitted by Mr. Chapelon was criticised. The arrangement was entirely new to all the members, and it has been decided to bring the circuit up again at some future meeting.

Apparatus brought by Mr. Clarke and Mr. Renney was inspected.

New members are welcome every Friday night at 7.30 p.m. in the Y.M.C.A., Claypath, Durham.

Smethwick Wireless Society.*

Hon. Secretary, Mr. R. H. Parker, F.C.S., Radio House, Wilson Road, Smethwick, Staffs.

A meeting on December 8th unanimously decided to hold a series of public demonstrations of telephony during the following week. Those responsible were accorded a hearty vote of thanks by the members at a meeting on December 15th.

The Society has purchased several books with a view to forming a library. Mr. C. M. Kay was appointed librarian.

On January 12th the Society opens with a general meeting.

The President, Mr. R. W. Hutchinson, M.Sc., A.M.I.E.E., F.R.G.S., F.G.I., will give his presidential address on January 19th. Also Mr. Harry Garrett, B.Sc. and Mr. J. Stoney, B.Sc., A.M.I.M.E., (Vice-Presidents), have promised to give lectures. There is an excellent syllabus arranged for the 1923 session.

Wolverhampton and District Wireless Society.*

Hon. Secretary, Mr. J. A. H. Devey, 232, Great Brickkiln Street, Wolverhampton.

On December 6th, a short paper was given by Mr. G. W. Jones. This was a continuation of the previous week's meeting at which members gave five to ten-minute papers on any wireless subject.

Southend and District Radio Society.*

Hon. Secretary, Mr. A. L. When, 4, Wimborne Road, Southend-on-Sea.

A meeting was held at the Technical Institute on December 15th. A lecture was given by Mr. Percy Barnes on "Cathodic Bombardment." He demonstrated by means of X-ray apparatus. A lecture and demonstration on the Reinartz tuner with two valves note magnification was also given by Mr. F. A. Mayer.

It has been decided to alter the name of the Society from Southend and District Wireless Club to Southend and District Radio Society.

West London Wireless and Experimental Association.*

Hon. Secretary, Mr. Horace W. Cotton, 19, Bushey Road, Harlington, Middlesex.

The third annual general meeting was held on December 5th.

The President, Mr. George Oxford, said that the membership had more than doubled its number since the last annual meeting. He thanked the Vice-President, Mr. F. E. Studt, for the very hard and instructive work he had done during the past session, and presented to him, on behalf of the Association, a case of pipes.

The Secretary gave a short outline of the work accomplished by the Association and its members during the past year.

The various reports having been received, the following appointments were made:—President, Mr. George Oxford; Vice-Presidents, Mr. F. E. Studt and Mr. F. O. Read; Hon. Secretary, Mr. H. W. Cotton; Hon. Treasurer, Mr. A. Labram; Instrument Steward, Mr. A. P. Dobson: Librarians, Messrs. C. and R. Hillyer: Committee, Messrs. J. F. Bruce, R. Cole, T. L. Mullings, L. Shepherd, W. T. Fair, and P. Harms. The following gentlemen were also elected as the Association's delegates to attend the meetings of the Radio Society of Great Britain:—Messrs. F. E. Studt, J. F. Bruce, L. Shepherd and A. P. Dobson. Alterations to rules were next proceeded with, the principal alteration being the reduction of the annual subscription to fifteen shillings.

Bradford Wireless Society.*

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

A meeting was held in the club-room, Randallwell Street, on December 15th. Mr. W. C. Ramshaw was in the chair. A demonstration on broadcasting apparatus was given by Messrs. Garlick and Robertshaw, Leeds and Bradford representatives of the Metropolitan Vickers Electrical Co., Ltd., respectively. The Manchester broadcasting station was tuned in and good signals obtained.

The next meeting on December 29th was the annual general meeting of the Society, when the election of officers and committee took place.

Stoke-on-Trent Wireless and Experimental Society.*

Hon. Secretary, Mr. F. T. Jones, 360, Cobridge Road, Hanley.

At a meeting on December 21st, the construction of the Tuner for the Society's multivalve receiver was proceeded with. A coil holder and a variable condenser was assembled and several inductance coils were wound.

A programme of lectures for next quarter has been arranged.

Leeds and District Amateur Wireless Society.*

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

An Instructional Meeting was held on December 15th at the Grammar School. Mr. S. Kniveton, F.R. Met. Soc., lectured on "Construction of Condensers"—Fixed and Variable.

Announcements were made relating to transatlantic amateur communications; five members had received broadcast and/or amateur transmissions up to date. In two cases reception was effected with single valve receivers.

Paddington Wireless and Scientific Society.

Hon. Secretary, Mr. L. Bland Flagg, 61, Burlington Road, Bayswater, W.2.

At the General Meeting held on December 14th, the President, Mr. A. G. Cook, M.A., A.M.I.E.E., took the chair.

A discussion took place as to the advisability of admitting into the Society experimenters and enthusiasts not already members of the Paddington Technical Institute. It was moved by Mr. A. Hoban and seconded by Mr. G. Turton that Rule 3 which refers to the admission of members, be altered and extended to cover this arrangement.

Mr. G. Turton informed the Meeting that whilst listening in for American amateurs he had, on three different occasions, heard very fair music and speech on a wavelength approximating that of **WJZ** between 1 a.m. and 3 a.m. but had been unable to get call signals. It was decided that the Society should confirm this as soon as possible.

A short lecture was given by the Hon. Secretary on the "Elwell Plug and Jack System."

Derby Wireless Club.

Hon. Secretary, Mr. R. Osborne, The Limes, Chellaston, Derby.

The Annual General Meeting was held on December 28th, at 35, St. Mary's Gate, Derby.

The following business was enacted: Officers for the New Year were elected, the Secretary's Report and Balance Sheet was presented; arrangements were made for spring session; affiliation with the Radio Society of Great Britain was discussed.

Dewsbury and District Wireless Society.

Hon. Secretary, Mr. F. Gomersall, 1, Ashworth Tce, Dewsbury.

The First Annual Meeting of the Dewsbury and District Wireless Society was held on December 7th. The President, Mr. S. S. Davies, gave a good report of the year's working. The Membership now totals over 60. Mr. S. S. Davies was re-elected President and Mr. J. T. Foggo was re-elected Vice-President. The Secretary, Mr. Horsfall, retired, and Mr. F. Gomersall, A.S.A.A., was elected in his stead. The new Treasurer is M. F. Dransfield, B.Sc.

A Coffee Supper was held on December 21st, in the Society's rooms in Church Street. During the evening the transmissions from Manchester Broadcasting Station were received.

Kingston and District Radio Society.

Hon. Secretary, Mr. J. C. C. Berry, 57, High Street, Hampton Wick, Middlesex.

Mr. F. P. Sexton (President) was in the chair on December 13th. It was decided that the making up of the club set be commenced the following week. Mr. J. Scheire kindly promised to supply the components of the first panel. The Chairman announced that, as previously arranged, Mr. R. C. Older would lecture on "The Selection of an Aerial System."

Prospective members are welcomed weekly at 45, Surbiton Road, Kingston.

Leeds Y.M.C.A. Wireless Society.

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

On December 18th, Mr. R. Toynbee took the chair. Mr. N. Whiteley lectured on "Wireless in the Mercantile Marine." The lecture was illustrated by lantern slides.

A demonstration licence having been obtained, the lecture was followed by an exhibition and demonstration of apparatus.

Mr. G. Boocock was elected Chairman for the meeting on January 1st.

The Hon. Secretary will be glad to hear from anyone interested in the Society, but points out that intending members must already be members of the Y.M.C.A., or on joining the Wireless Society must become members of the Y.M.C.A.

Birmingham Experimental Wireless Club.

Hon. Secretary, Mr. A. Leslie Lancaster, c/o Lancaster Bros. & Co., Shadwell Street, Birmingham.

Mr. Dore lectured on "Primary Batteries"; this was particularly devoted to the Leclanche dry cells.

Redditch and District Radio Society.

Hon. Secretary, Mr. A. W. Reeves, M.I.M.E., The Elms, Alvechurch.

A public demonstration and exhibition was held in the Temperance Hall, Redditch, on December 13th, and proved a great success. The Rev. S. Maddock presided, and the demonstration was given by Mr. Reeves and Mr. Entwistle, both of the Western Electric Co. The Birmingham concert party gave an excellent programme from Witton. The meeting was overcrowded.

At the meeting on December 15th, several new members were elected. The next meeting was arranged for January 5th, 1923, when it was hoped to proceed with the series of lectures that had been unavoidably postponed.

It is hoped to give a further radio demonstration in January, the proceeds of which will be handed to the Unemployment Relief Fund.

Heckmondwike and District Wireless Society.

Hon. Secretary, Mr. P. Hanson, Longfield Road, Heckmondwike.

Mr. Denison, of Halifax, opened the session with a lecture on "Latest Developments in Wireless Telephony."

An exhibition held at the headquarters on November 10th and 11th proved very successful. An excellent display of apparatus was made by the sixteen exhibitors. Special transmissions of telephony were made by **2 AW**, **2 LA**, **2 KD**, **2 UZ** and **2 KQ**. A large number of people visited the exhibition, and the result shows a clear £24 10s.

A lecture and demonstration was given on November 21st by Mr. Liardet, of Bradford, who dealt with the subject of high frequency amplification.

Mr. Eskdale, of Bradford, visited the Society and lectured on "Wireless and Direction Finding as Applied to Aircraft," illustrated by lantern slides.

Maidstone and District Radio Society.

Hon. Secretary, Mr. H. T. Cogger, "Romleigh," Postley Road, Maidstone, Kent.

A general meeting was held at headquarters, The Pavilion, Athletic Ground, Maidstone, on December 15th, with the object of forming a radio society in the district. The number present was 21, and the meeting was very successful. Mr. F. Guy Monckton occupied the chair and the following officers were elected:—President, Mr. G. Foster Clark; Vice-Presidents, Lt.-Col. Winter, Major Craig, Messrs. J. N. Deakin, F. Guy Monckton, W. J. Sharp and W. A. Stevens; Chairman, Mr. F. Guy Monckton; Vice-Chairman, Mr. J. S. Welsh; Hon. Secretary, Mr. H. T. Cogger; Hon. Treasurer, Mr. E. Winterhalter; Committee, Messrs. S. B. Balcombe, P. T. Bishop, V. Lyle, W. J. Saveall, D. F. See and A. Styles.

Rules of the Society were read and adopted. Members' subscriptions were fixed at 10s. per annum and 2s. 6d. entrance fee. Associate Members' (under 16 years of age) subscription, 5s. and 2s. 6d. entrance fee.

It was decided to meet weekly on Tuesdays from 7 p.m. to 10 p.m. The first of such meetings to be held on January 9th, 1923.

Harrogate and District Radio Society.

Joint Hon. Secretaries, Mr. F. Peeks and Mr. J. L. Wood, Central Club Rooms, Beulah Street, Harrogate.

Meetings of this Society are held on Tuesday and Friday of each week at 8 p.m.

Several members are at present working on the Society's four-valve set, and hope to have it completed early in the New Year.

Pudsey and District Wireless Society.

Hon. Secretary, Mr. W. G. A. Daniels.

On December 14th last, in the club-room, a very considerable amount of business was transacted. It was decided that the Society should become affiliated with the Radio Society of Great Britain. Mr. Knapton moved to that effect and was seconded by Mr. Sheard; the motion was carried.

It was also proposed that the Society should have a receiving installation, and a subscription list was contributed to liberally.

In future the meetings will be held at the Mechanics' Institute, Robin Lane, Pudsey, on the first and third Mondays in the month.

Hornsey and District Wireless Society.

Hon. Secretary, Mr. H. Davy, 134, Inderwick Road, Hornsey, N.8.

A very successful meeting took place on December 11th; a fair proportion of the members attended.

Mr. H. Davy acted as chairman. Mr. Fleet demonstrated with a three-valve amplifier of his own construction. The reception of **2 LO**, **PCGG** and **2 WP** were enjoyed. A fair amount of howling from other amateurs in the district was noticeable; probably non-members of a Society, otherwise they would know better.

On December 15th Mr. H. Davy did not lecture on "Frame Aerials and Direction Finding."

It was decided that the next meeting be held on January 5th.

Civil Airship Wireless during 1921

DISCUSSION ON THE PAPER READ BEFORE THE RADIO SOCIETY OF GREAT BRITAIN BY LIEUT. DUNCAN SINCLAIR.*

The President.

Mr. Sinclair has given us an extremely interesting lecture, of the highest scientific value. I will just ask one or two questions which I should like cleared up. I would like to know how the errors are calculated; whether they calculate them on the airship, or at Croydon or Pulham. The error is very slight, but nevertheless means a distance of a great many miles. I should also like to ask whether there were many other observations taken between the times of those recorded in the paper, and if so, were they good observations, or had they errors?

This paper indicates clearly that good navigation has been effected in the air. I should like to ask if in the air you get night errors of 10, 20 or 30 degrees which are comparable to those on land. It is a very important point from a scientific point of view.

It looks also, from what Mr. Sinclair says, that you have a quadrantal error in transmission as well as in reception, but when it comes to an error of 2° maximum, can you attribute it to that? You might well have an error of two degrees without being a quadrantal error.

Mr. J. Scott-Taggart.

There are one or two points which interested me, and about which I would like to have a little further information if possible. I too wondered how Lieutenant Sinclair was able to determine the errors at different points along his flight. Of course, if he were over Paris he would know where he was—but on some of the flights, particularly the one over Cornwall and past the Channel Islands, there is only a very small proportion of the flight on which it would be possible to get accurate determinations of the position of the airship: and yet we find in his report detailed accounts of the errors at hours at which obviously the airship was over sea. Perhaps he can give us particulars of how he determined the accurate position, within one degree, of the airship. I would also like to ask whether the bearings were taken on telephony, tonic train, or C.W. On the longest range he informs us that telephony could not be heard, so I presume the bearings were taken on C.W., and owing to the difficulties which always attend the taking of bearings on continuous waves, I would like to know what precautions were taken, and what special apparatus, if any, was employed. I would also like to ask him whether he noticed any variation in the strength of signals over land and sea—whether he noticed the strength over the sea, and whether it remained appreciably the same over land.

Another point which occurred to me was the relative strength of signals during the night hours as compared with the ordinary daylight hours. I should imagine that the signals were considerably stronger at night.

In conclusion, I think that we should all be grateful to Mr. Sinclair for reading his paper tonight, because the chief thing which it does show is that navigation by D.F. methods is something essentially practicable.

Lieut. Duncan Sinclair.

Our President has raised some very important and quite natural points in connection with the paper, and so has Mr. Scott-Taggart. Let me run through them in the order in which they were asked. Firstly, how do we know what these errors were? How did we get at the errors? Were they calculated aboard? The answer is that they were calculated aboard, and they were done in two ways. Firstly, whenever circumstances permitted, the position of the ship was known to one of two navigating officers, or sometimes by both, from a direct observation of the point over which we were flying. That is a simple matter, I think you will agree. Then, the point upon which Mr. Scott-Taggart lays stress: How do we determine our errors over the water. These were determined by a consideration of the position as given to the Wireless Staff by the Navigating Staff, and when I say that we had two certificated and qualified aerial navigators aboard (one of whom was also a very excellent marine navigator), I think we need cast no aspersions upon the accuracy of the positions as they were given to me in the ship. Many other observations were taken on these flights, and I have purposely, in order to reduce the length of what would otherwise be a very long paper, missed out about two-thirds of the bearings, leaving only those which are comparatively simple to deal with. I may say, however, that those which I have missed out have not been missed out with any intention of slurring them over. They are all of a similar nature, and give us just similar results. There is one which shows an error of 18° actually, but I am inclined to think that that error is due to a personal error on the part of the man who took the bearing: in fact, that has afterwards been almost conclusively proved to be the case.

Then Admiral Sir Henry Jackson asks, are the night errors in the air of a nature of 20° or 30° comparable with those on the ground. Well, I think that although we do not get errors of such magnitude, yet our results generally speaking are of a very similar nature to those experienced by people working marine direction finding, as it is always bearing in mind that we have special conditions in the air with which to contend, and bearing in mind that we have work of almost a pioneer nature to do.

I think, relating to the fourth question, that our quadrantal error occurs both in transmission and in reception: but we must remember that there is a lot of work yet to be done on the airship programme itself.

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* See pp. 436-442 of issue of Dec. 30th, 1922.

Now with regard to Mr. Scott-Taggart's question on bearings taken on radio-telephony, tonic train, or pure C.W. transmission. We never used it. The only transmissions which were made were telephony and C.W. In the case of the telephonic transmissions, broadly speaking our telephony transmissions ended at P in the chart (page 440, December 30th issue) or thereabouts, and at T or thereabouts in the case of the continental flight, and they were continuous in the case of the continental flight. However, a programme was laid down for these trips, which involved the taking of bearings both by radio-telephony and by continuous wave. Our programme was to work on radio-telephony normally. At certain hours we shifted the wavelength from 900 metres, upon which we were working the radio-telephony, to 1,400 metres, on which we worked C.W. Of these two types of transmission I personally have noticed no particular variations in the bearings taken. Perhaps, if we are ever privileged to have airships again in the air with which to carry on experiments as far as wireless is concerned, I may be able to answer that question at some later date. We must remember, I think, that in all these programmes we had to squeeze in our wireless work. The consideration firstly was to prove that the airship, apart from being an article of warfare, could be of definite commercial value, and though we did a considerable amount of wireless work, yet we had to squeeze it in with the ordinary routine which was being carried out.

There was no special apparatus employed. As far as I have noticed, there is not any marked difference in the signal strength over land and sea.

We had just ordinary wireless apparatus to use, and perhaps that is not sufficiently sensitive to answer the question whether the signals at night were stronger than those during the day, but as far as I know, I think they are slightly stronger at night.

The Radio Society of Great Britain

The 52nd Ordinary General Meeting of the Society was held on Wednesday, December 20th, at 6 p.m., at the Institution of Electrical Engineers. After the minutes of the previous meeting had been read and confirmed, the President said :—

Before calling on the lecturer to deliver his lecture this evening, there is some formal business.

I announced at the last meeting that Sir Henry Norman was going to be our President next year. He now much regrets he has had to cancel this arrangement, owing to the great pressure of political and other business which he has before him. The Chairman only received this information last evening.

The principal business is to re-elect the officers of the Society. You have before you a list of the Committee of the Society. No other names have been put forward, and I therefore take it that these members have your approval.

The next matter to consider is the balance sheet, and I will ask the Treasurer to make a brief statement on the subject.

Mr. L. F. Fogarty (Hon. Treasurer).

The account submitted herewith is in respect of the ninth year of the Society's activities.

I desire to remind members that the account takes the form of a Cash Statement, and therefore indicates the actual income and the total of the expenditure items for the period under review.

It will be observed that the most important item is that for printing and distributing the Journal. With a view to greater economy the Committee has given special attention to this point and has decided that the Journal shall be published half yearly in future, a change from which considerable saving is expected.

The account shows that the expenditure exceeded income by £34 1s. 4d., and in consequence the balance carried forward this year is less than in the previous accounting period.

In view of the extended work which the Society is now called upon to perform I am of the opinion that it is very desirable that the income should exceed expenditure by a reasonable amount, in order to provide for any emergency that may arise.

Members can facilitate the Committee's work in this direction by paying subscriptions promptly and as early in the year as possible, for if every member and affiliated Society will make a point of so doing, the Committee will be able to meet the present expenditure out of income, and perhaps at the same time carry over a small surplus to reserve.

Members can assist in consolidating the financial position by introducing new members whenever possible.

CASH STATEMENT.

For Year ending October, 1922.

Dr.	£	*s.*	*d.*
To Balance brought forward, October, 1921	213	0	7
,, Subscriptions	407	18	8
,, Suspense Account	1	8	6
	£622	7	9

Cr.	£	*s.*	*d.*
By Printing and Distribution of Journal	228	6	3
,, Printing List of Members and Book of Rules	13	15	0
,, Hire of Lecture Hall and Refreshments at Meetings	63	10	1
,, Printing and Stationery	33	10	6
,, Furniture Storage, Rent and Removal	16	9	0
,, Postages and Clerical Assistance	79	0	11
,, Purchase of Filing Cabinets	5	19	7
,, Sundries, Cheque Books, Rubber Stamp, etc.	1	8	8
	442	0	0
Balance in Bank	180	7	9
	£622	7	9

The item shown under Suspense Account represents money paid into the Society's bank account and for which receipts had not been written at the date when the books were closed for audit.

I should like to take this opportunity of thanking Mr. John Ockleshaw, F.C.A., for auditing the accounts, and for help in the preparation of the Statement. As honorary auditor, Mr. Ockleshaw has performed this responsible task since the formation of the Society in 1913.

After the cash statement had been duly approved by the meeting a vote of thanks was accorded to Mr. John Ockleshaw for his services as Honorary Auditor.

Mr. F. Hope-Jones.

There is one other pleasant duty at the end of each financial year, and that is to thank our most hospitable hosts, the Institution of Electrical Engineers, for so kindly granting us the use of this excellent lecture hall. They have always been good friends to this Society, and I believe we should have met here continuously since the Society was formed had the Government not commandeered the building during the war. I have great pleasure in proposing a vote of thanks to the Institution of Electrical Engineers for their kindness in granting us the use of this hall. (Applause.)

The President.

I will now ask Mr. Duncan Sinclair to give us his lecture on "Civil Airship Wireless in 1921."

(For a full report of the lecture, see pages 436 to 442 of December 30th issue, and for report of discussion, see page 476 of this issue.)

At the conclusion of the discussion the President announced that the following had been elected to membership of the Society :—

Members.—Bernard J. Littledale, Jack Louis Goldsman, Oswald Western, Wm. Edward Allen, Rowland Ed. Baldry, Thos. Dixon Ridley, John Stanley Rowe, Josiah Alexandre, A. G. Seaman, Rowland William Leader, Percival Alphonse Ward, Wm. Robert Gough, Eric Ashwell Rogers, Charles E. A. Hall, Capt. Simon Orde, Harold Annison, Vivian Ernest Thomas Swain, John Augustine Elliott, Capt. Ian Fraser.

Associate Members.—Robert Henry Herbert, Patrick Edwin Alexandre.

It was also announced that the following Societies had been accepted for affiliation :—

The Maidenhead and District Wireless Society, North Lincs Wireless Society, Ackworth School Wireless Society, Falkirk and District Radio Society, The Oxford and District Amateur Radio Society, Colwyn Bay Llandudno and District Radio Association, Blackburn and District Radio and Scientific Society, The Port Talbot Amateur Radio Society, The Newton-on-Ayr Wireless Society.

Continuing the **President** said :—

I think you would like to know that a great many American stations are being received in England.

A wireless message has also been received by Mr. R. H. Ridley from an American station conveying this message : "Merry Christmas, happy New Year, and good luck to you in your tests."

A lecture of an elementary nature will be given here by Mr. G. G. Blake, at 6.30 p.m., on January 12th. It is for Associates and those who do not profess to have any great wireless knowledge, but all are invited—not necessarily only those who are members of this Society, but all who are interested in broadcasting.

Tickets without charge will be issued by the Honorary Secretary to anyone desirous of attending.

The next meeting will be on the fourth Wednesday in January—the Annual Conference in the afternoon, and a Presidential address, we hope, in the evening.

The meeting adjourned at 7.40 p.m.

The Transatlantic Tests

CONGRATULATIONS ON SUCCESS OF BRITISH AMATEUR TRANSMITTERS.

In connection with the Transatlantic Tests of which particulars have already been given in this publication, the following wireless message has been received by Mr. P. R. Coursey, who has organised the tests on this side, from Mr. F. H. Schnell, the Traffic Manager of the American Radio Relay League :

PLEASE ACCEPT HEARTY CONGRATULATIONS OF AMERICAN AND CANADIAN AMATEURS ON WONDERFUL SUCCESS BRITISH AMATEURS PERFECT SCORE OF RECEPTION DURING TEN NIGHTS SCHNELL.

A detailed report of these receptions will be published in these pages as soon as it is possible to summarise the results of competitors from the very large amount of matter available.

At the same time it is hoped to publish a report of the receptions of American Broadcast Telephony transmissions. An enormous number of such reports have been received, and whilst the majority relate to the reception of WJZ, a number of other stations are represented.

Notes

Dr. W. H. Eccles to be President of the Radio Society of Great Britain.

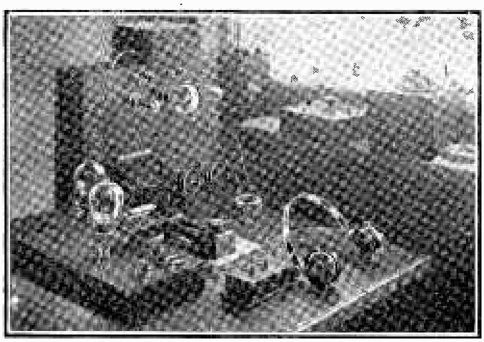
Dr. W. H. Eccles, A.R.C.S., M.I.E.E., has accepted the Presidency of the Radio Society in succession to Admiral of the Fleet Sir Henry B. Jackson, who retired from that office at the conclusion of 1922. Dr. Eccles was previously for many years a Vice-President of the Society, and has been Chairman of the Wireless Section of the Institution of Electrical Engineers.

Birmingham Broadcasting Station New Call Sign.

The new call sign of the Birmingham broadcasting station is **5 IT**.

Club at King's Norton.

Messrs. Morris and Smith, 5, Kingsley Road, King's Norton, Birmingham, intend commencing a wireless club in their district. Application for membership should be addressed directly to them.



The above set, belonging to Mr. N. Hendry of Newcastle-on-Tyne, consists of 2 H.F., 1 Detector, 3 L.F. valves, with switches for cutting out valves to desired degree of amplification. Mr. Hendry gets **WII, WQK, WCI** *and* **NSS.**

Proposed "Feltham, Ashford and District Radio Club."

Persons interested in the formation of a Club in the Feltham and Ashford district are invited to communicate with Mr. Nettleton, "St. Albans," Feltham, Middlesex, or with Mr. H. G. Moss, 48, High Street, Feltham.

Campaign Against Oscillating Valves.

The method adopted by the Halifax Wireless Club of helping to minimise the nuisance caused by amateurs who allow oscillating valves to interfere with other people's reception is education. A small book has been prepared, which may be obtained for the sum of sixpence, in which a selection of diagrams is given, together with practical suggestions.

Broadcasting a Prize Fight.

In the article by Mr. Sleeper in our issue of September 9th, 1922, the broadcasting in the United States of a prize fight between Dempsey and Carpentier was referred to. It was stated that the arrangements had been carried out by the Westinghouse Company. Our American contemporary, *The Wireless Age*, advises us that the arrangements were carried out on that occasion by *The Wireless Age* and the Radio Corporation of America.

Apparatus for French Schooners.

It is reported that 200 French fishing schooners are to be equipped with radio apparatus ranging from ¼ to 1 kW. capacity.

New Company in Belgium.

La Société Belge Radio-Electrique has been formed in Brussels with a capital of four million francs. This new Company is associated with several well-known concerns, including Marconi's Wireless Telegraph Company, Ltd., and La Compagnie Générale de Télégraphie Sans Fil.

President of the Radio Corporation of America.

The new President of the Radio Corporation of America is Major-General J. G. Harbord. He succeeds Mr. E. J. Nally, who was recently appointed Managing Director of International relations, with headquarters in Paris.

Removal.

We are advised that owing to a considerable increase in business Messrs. Radio Components, Ltd., have moved to larger and more commodious premises at 19, Rathbone Place, Oxford Street, W.1, to which address all further enquiries should be sent.

Dimensions of Mica Dielectric Condensers.

The following table was compiled by Mr. Burdis, a member of the Newcastle and District Amateur Wireless Association, and included in a paper which he read before that Association. It shows the necessary data in a most convenient form, and should prove of great value to experimenters who constantly wish to make up fixed condensers to a given value. It should be borne in mind that the values are based on the use of best ruby mica as the dielectric.

DIELECTRIC.—MICA 0·002″.

No. of Plates	Sizes of Plates. Cms.			
	2×1	3×1	4×1	4×2
2	·0002	·0003	·0004	·0008
3	·0004	·0006	·0008	·0016
4	·0006	·0009	·0012	·0024
5	·0008	·0012	·0016	·0032
6	·001	·0015	·0018	·004
7	·0012	·0018	·0024	·0048
8	·0014	·0021	·0028	·0056
9	·0016	·0024	·0032	·0064
10	·0018	·0027	·0036	·0072
11	·002	·003	·004	·008
12	·0022	·0033	·0044	·0088

Half the thickness of mica doubles the capacity, and *vice versa*.

Calendar of Current Events

Friday, January 5th.

Edinburgh and District Radio Society.

Lecture on "Capacity and Inductance," by Prof. F. G. Baily, M.A.

Leeds and District Amateur Wireless Society.

General Meeting. Lecture on "Transmission of Photographs by Wireless," by Mr. T. Brown Thomson.

Sheffield and District Wireless Society.

At 7.30 p.m. Lecture on "Design and Construction of an Amateur Receiving Station," by Mr. Brindley.

Sunday, January 7th.

At 3.5 p.m. *Daily Mail* Concert from **PCGG**, The Hague, on 1,050 metres.

Monday, January 8th.

9.20-10.20 p.m. Dutch Concert, **PCGG**. The Hague, on, 1,050 metres.

Ipswich and District Wireless Society.

At 8 p.m. At 55, Fonnereau Road. Lecture on "Wireless in Camp," by Mr. C. H. Brace.

Wireless Society of Hull and District.

At 7.30 p.m. At Signal Corps H.Q., Park Street. Lecture on "The Construction of Fixed and Variable Condensers," by Mr. G. H. Strong (President).

Tuesday, January 9th.

Transmission of Telephony at 8 p.m., on 400 metres, by **2MT**, Writtle.

Wednesday, January 10th.

Malvern Wireless Society.

Lecture on "Transformer Coupling and Tuned Anode."

Halifax Wireless Club.

Lecture on "A.C. Circuits, Motors and Switchgear," by Mr. M. F. Farrar.

Edinburgh and District Radio Society.

At 8 p.m. At R.S.S.A. Hall. Business Meeting. Lecture on "Multiplex Telegraphy," by Mr. W. P. Morris.

Thursday January 11th.

At 9.20-10.20 p.m. Dutch Concert from **PCGG**, The Hague, on 1,050 metres.

Edinburgh and District Radio Society.

Visit to *Scotsman* Building. Conducted by Mr. W. P. Morris.

Glasgow and District Radio Club.

Lecture on "Grid Potentials," by Mr. Pick.

Ilford and District Radio Society.

Lecture on "Elementary Electrostatics," by Mr. F. C. Grover.

Oldham Lyceum Wireless Society.

Lecture on "Amplification with reference to High Frequency," by Mr. J. R. Halliwell, of Manchester.

Dewsbury and District Wireless Society.

Lecture by Mr. Denison of Halifax.

Luton Wireless Society.

At 8 p.m. At Hitchin Road Boys' School. Lecture by Mr. S. Moody, A.M.I.E.E.

Friday, January 12th.

Sheffield and District Wireless Society.

At 7.30 p.m. Elementary Class.

Leeds and District Amateur Wireless Society.

Lecture on "Some Apparatus Used in Telegraphy," by Mr. R. E. Timms (Hon. Treasurer).

Belvedere and District Radio and Scientific Society.

Lecture on "Construction of H.F. Amplifier," by Mr. S. Burman.

Correspondence

To the Editor of The Wireless World and Radio Review.

Sir,—We have been hearing a good deal lately about the reception of wireless signals from transmitting stations a great distance off.

In this connection I have been making a few experiments, except that, in my case, I have reduced the size of the frame coil which is used as an aerial, and the following result may be of interest.

The Birmingham Broadcasting Station speech was received on a frame aerial 2¾ ins. diameter; it was in fact the "B" coil of Messrs. Gambrell's "Efficiency Coils."

This with a 1-jar condenser in parallel formed the primary circuit, this was coupled to a secondary circuit comprised of Gambrell "C" Coil, and a 1-jar condenser in parallel.

No H.F. valves were in use. One rectifying valve and two note magnifying valves only.

The speech received was very clear and every word could be understood. It was of course not very loud—strength 6 on the usual scale of Morse signal strength.

Yours truly,
N. H. Hamilton.

5, Cranley Gardens, London, S.W.7.
December 13th, 1922.

To the Editor of The Wireless World and Radio Review.

Sir,—We notice in the issue of your journal dated 16th inst., you state that the wireless operators employed by this Company are graded as officers, and that a senior operator ranks with a second officer. We would point out that wireless operators in this Company's vessels are members of the Company's staff and are therefore accorded treatment and status similar to that of other of our officials. This does not necessarily make them officers.

With regard to the uniform, we would mention that we have a system of grading and that each grade has its own distinguishing marks. Operators are posted to vessels by grades—the grade of operators so posted being dependent upon the class to which a vessel belongs. It does not therefore follow that a first operator will wear two gold bands.

In view of the fact that your journal is read by the majority of wireless operators, we shall be glad if you will kindly publish the above in order that misunderstandings will not arise.

Yours faithfully,
The Cunard Steam Ship Company, Ltd.,
Cunard Building, Liverpool. H. L. Serjeant,
December 18th, 1922. *Wireless Superintendent.*

Book Received

The Practical Engineer Electrical Pocket Book and Diary, 1923 edition. (London: *Oxford Technical Publications*, 1 and 2, Bedford Street, W.C.2. Price, cloth, 2s. 6d. net. Pluviusin, 3s. net.

The Paris "Radiola" Concerts.

THE accompanying photograph (Fig. 1) shows the apparatus used for the transmissions of the Paris "Radiola" Concerts.

The first Radiola Concert transmission took place on November 6th, from the offices of the Société Française Radio-electrique, at 79, Boulevard Haussmann, Paris. The studio of this station is located in a room which has the walls specially draped in order to keep out external noises.

The actual location of the transmitter is on the banks of the Seine, near the towns of Neuilly and Levallois-Perret. The wavelength of the transmissions is 1,565 metres, and the power 2 kilowatts in the aerial.

The transmitting apparatus which is shown in Fig. 1 comprises three metal cabinets of similar appearance. From left to right these cabinets contain (1) modulating valves; (2) the rectifying valves for transforming into continuous current the alternating current with which they are fed; (3) the oscillator valves producing the high frequency current. The fourth cabinet which is shown on the right contains the inductances for controlling the wavelength of the aerial. The aerial consists of five wires supported by the two metal towers of 65 metres each shown in Fig. 2, but at the time this photograph was taken, the present aerial had not been erected.

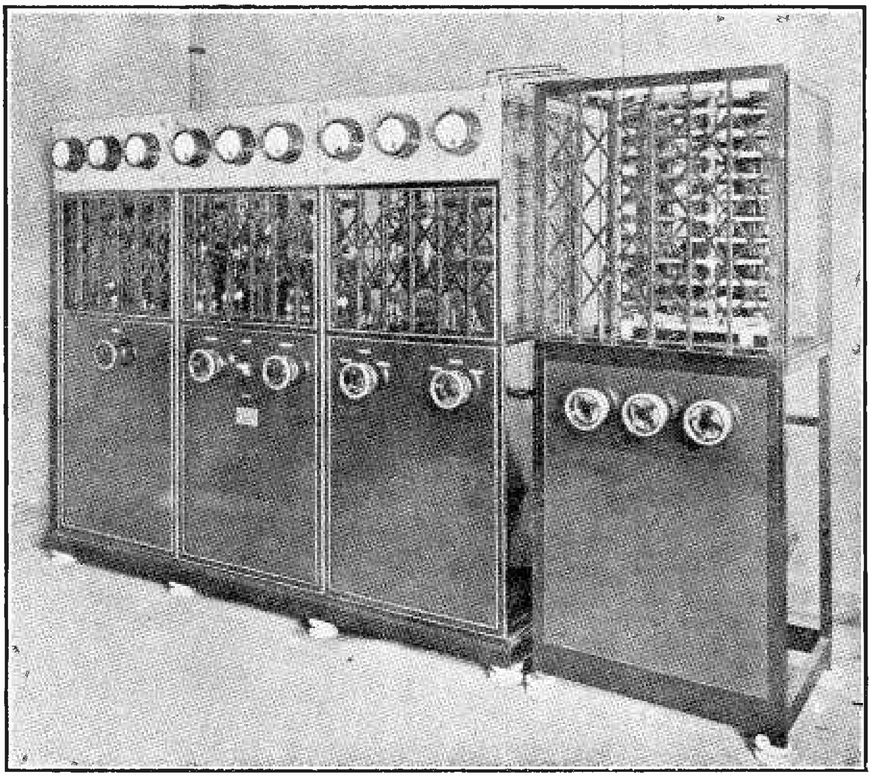


Fig. 1. The valve telephony transmitter of the "Radiola" Concerts.

The lead-in is taken from the further mast and is led down to the building in which the transmitter is installed.

The concerts take place daily from 8.45 to 10 p.m., and are contributed to by many of the most celebrated French artistes.

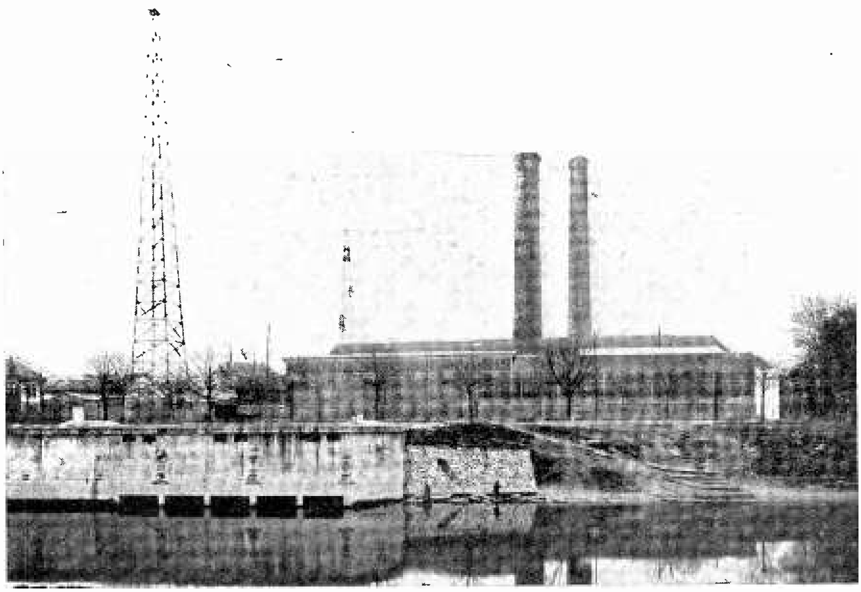


Fig. 2. The Masts supporting the Aerial of the "Radiola" Concerts Transmitter at Levallois.

Post Office Statement on Broadcasting.

The following is the text of a statement issued on December 21st from the General Post Office :—

From representations which have reached the Postmaster-General it appears that the conditions under which wireless receiving apparatus is licensed in connection with the broadcasting scheme are not fully understood.

As indicated in the broadcast receiving licence (which is now obtainable at any Head or Branch Post Office) apparatus used under this licence must bear the trade mark of the British Broadcasting Company.

This Company is an association of wireless manufacturers who have combined to erect stations for broadcast transmission under a licence from the Postmaster-General extending for a period of two years, during which they have undertaken to maintain regular and satisfactory programmes of music and other matter. Membership of the Company is open to any bona fide British manufacturer of wireless apparatus upon the purchase of at least one £1 share in the Company, and the lodging of a deposit of £50 as security for the proper performance of the conditions of membership. One of these conditions is the payment to the Company of a moderate royalty on sets of apparatus sold by the manufacturer to the public, as a contribution towards the expense involved in the erection and maintenance of suitable transmitting stations and the maintenance of regular programmes.

In view of these arrangements, which have been formulated both in the interests of the users of the receiving apparatus and of British manufacturers generally, the Postmaster-General has agreed that sets used under the broadcast licences shall be limited to types submitted for approval by members of the Company, and that for a period of two years apparatus made only in this country shall be sold by them, with the exception of certain parts which, for the present, are confined to batteries, accumulators and outside aerial equipment.

The trade mark of the Broadcasting Company indicates that the apparatus is of a type approved by the Post Office as conforming to the technical requirements necessary to prevent interference. This approval does not, however, imply a guarantee of the efficiency or workmanship of any particular set.

Questions and Answers

NOTE.—This section of the magazine is placed at the disposal of all readers who wish to receive advice and information on matters pertaining to both the technical and non-technical sides of wireless work. Readers should comply with the following rules :—(1) Each question should be numbered and written on a separate sheet on one side of the paper, and addressed "Questions and Answers," Editor, THE WIRELESS WORLD AND RADIO REVIEW, *12 13, Henrietta Street, London, W.C.2. Queries should be clear and concise. (2) Before sending in their questions readers are advised to search recent numbers to see whether the same queries have not been dealt with before. (3) Each communication sent in to be accompanied by the "Questions and Answers" coupon to be found in the advertisement columns of the issue current at the time of forwarding the questions. (4) The name and address of the querist, which is for reference and not for publication, to appear at the top of every sheet or sheets, and unless typewritten, this should be in block capitals. Queries will be answered under the initials and town of the correspondent, or, if so desired, under a "nom de plume." (5) In view of the fact that a large proportion of the circuits and apparatus described in these answers are covered by patents, readers are advised before making use of them, to satisfy themselves that they would not be infringing patents. (6)* **Where a reply through the post is required every question sent in must be accompanied by a postal order for the amount of 1s., or 3s. 6d. for a maximum of four questions.** *(7) Four questions is the maximum which may be sent in at one time.*

"B.G.D." (East Ham) *submits a sample of wire, and asks (1) Whether it is suitable for the secondary of a telephone transformer. (2) For particulars of the primary winding.*

(1) The sample of wire submitted is No. 38 D.S.C., and could be used as the secondary winding. (2) The primary winding may consist of 10,000 turns of No. 44 S.S.C. copper wire, and is wound on first.

"F.A.M." (Coventry) *submits a diagram, and asks (1) For criticism. (2) Is the tuned anode method of H.F. coupling efficient when receiving long wavelengths. (3) Which is the best of the proposed arrangements.*

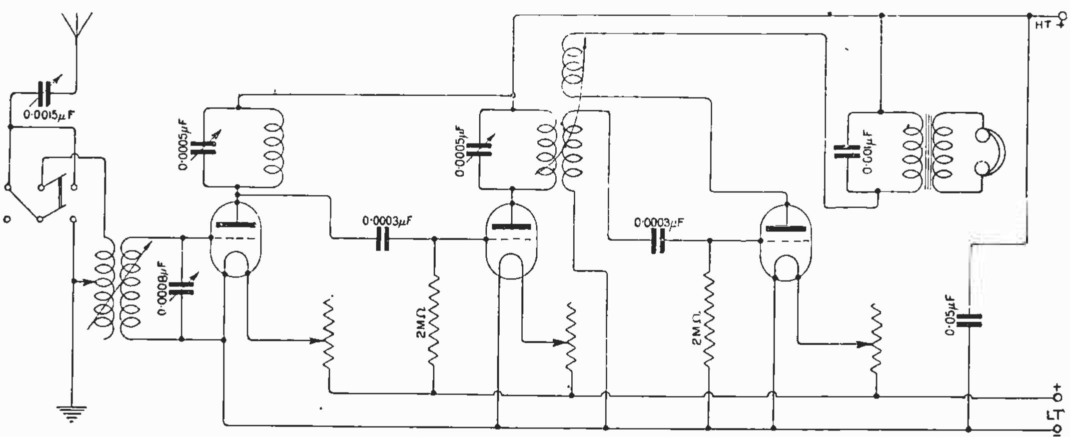


Fig. 1.

(1) The single valve circuit is correct, but the three-valve circuit contains several errors. See Fig. 1. Suitable values are indicated in the figure. (2) The tuned anode method of H.F. coupling is quite efficient over the whole wavelength range, provided suitable values of coil and condenser are used. When receiving long wavelength signals the anode tuning condenser may have maximum value of 0·0005 mfds. without loss of signal strength. (3) The resistance capacity method of coupling H.F. valves is quite suitable when receiving on wavelengths over 2,000 metres, and requires no adjustments, but the tuned H.F. transformer method will probably give louder signals if the additional adjustments are not objected to.

"JAYPEE" (Lancs.) *asks (1) Whether he will be granted a broadcast licence, having constructed his own set, or whether he can have his set marked B.B.C. (2) How many plates of a particular pattern are required to give a variable condenser of maximum value 0·001 mfds. and 0·0005 mfds.*

(1) A person wishing to use apparatus which he has constructed himself is regarded by the Post Office as an experimenter, though if the aim of the individual is not to have any serious interest in the technicalities of the science, he is compelled by the Postmaster General to purchase made-up apparatus, owing to his non-acquaintance with the subject, in order that he may not cause interference by the use of an incorrectly designed receiver. (2) The 0·001 mfds. condenser will require a total of 63 plates, and the 0·0005 condenser should have 33.

"ULTRA FIXED" (Rugby) *asks* (1) *For a diagram of a choke control for a telephony transmitter.* (2) *The windings for the telephone transmitter described in the issue of June 3rd.* (3) *How to use reaction in such a manner that oscillating energy will not be transferred to the aerial.*

(1) See Fig. 2. The aerial coil may have 40 turns of No. 8 copper wire wound to fill a former 7″ in diameter and 12″ long. The closed coil may be 30 turns of No. 12 copper wire on a former 5″ in

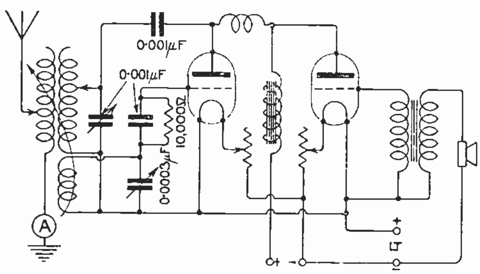


Fig. 2.

diameter and 10″ long. The condenser should be oil insulated, and have a maximum capacity of about 0.001 mfds. The grid coupling coil may consist of a winding of No. 22 D.C.C. on a former 3½″ in diameter and 2″ long. (2) The windings given are for about 1,000 metres. We suggest you halve the number of turns in the windings. (3) The reaction coil could be coupled with the anode coil of the first valve as described in a recent issue of this journal.

"J.S." (E.C.).—It is quite possible to light the filaments of your receiving valves from the alternating current supply mains using a "step-down" transformer, but we consider you would have an objectional hum in the receivers. As an alternative you could purchase a rectifying apparatus, which however is rather expensive, and would probably cost more than you are prepared to spend. We think probably the most satisfactory arrangement would be the purchase of a set of accumulators possessing a larger ampere hour capacity. We suggest the use of a 60 actual ampere hour capacity accumulator. The cost will then be much less than that of the alternating current supply arrangement, and the results would be far more satisfactory.

"G.J." (Highgate) *asks which of several diagrams is best for his purpose.*

We consider the diagram Fig. 4, on page 36, is the most useful for your purpose. The H.F. valve is coupled to the detector valve by means of a tuned transformer, and the anode of the second valve contains a tuned anode coil. This arrangement will work very well provided suitable values of components are used in the set. The proposed winding for the H.F. transformer is suitable, but that for the L.F. transformer is not quite satisfactory. The primary winding should consist of 10,000 turns of No. 34 S.S.C. wire, and the secondary should consist of 15,000 turns of No. 46 S.S.C. wire.

"G.A.W." (W.1.) *asks for a diagram of a 2-valve receiver.*

A suitable diagram of a two-valve set is given on page 217, November 11th issue. A switch may be connected in the aerial circuit for connecting the aerial tuning condenser and aerial tuning inductance in series or parallel. It is better to have them in series when receiving short wavelengths. The first valve is coupled with the second valve by means of a tuned anode condenser and leak. In the anode circuit of the second valve is a reaction coil and telephone transformer. The reaction coil is coupled with the tuned anode coil. Using this method of reaction, it is not possible to easily set up oscillations in the aerial circuit. Very good results are possible from a set of this description.

"R.G." (Antwerp) *asks for constructional details of L.F. intervalve and telephone transformers.*

We would refer you to the constructional article which appeared in the issue of August 19th. The wire used is No. 46 S.S.C., which has a diameter of 0.0610 mm. The telephone transformer may have a secondary winding of No. 36 S.S.C. (diameter = 0·1930 mm.) and should fill up the whole winding space.

"NIB" (Liverpool) *asks* (1) *The sizes and material of samples of wire submitted.* (2) *The resistance of an "Ora" valve.* (3) *For a circuit using crystal rectifier and two valves.* (4) *The range of the set.*

(1) Sample 1 is No. 30 S.W.G. copper wire enamel covered.
,, 2 ,, No. 38 ,, ,, ,, ,,
,, 3 ,, No. 31 ,, ,, ,, ,,
,, 4 ,, No. 30 ,, copper wire D.S.C.

(2) The anode filament impedance depends upon

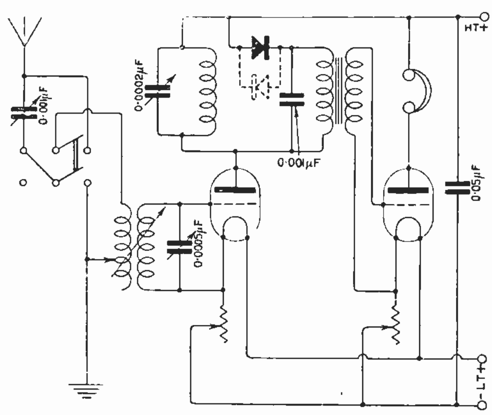


Fig. 3.

the filament emission and plate and grid potentials, and therefore varies greatly while in use. An average value is 45,000 ohms. (3) See Fig. 3. The tuned anode method of H.F. amplification is used, and the potentials are passed on by the crystal through the L.F. transformer. (4) You will hear local amateur transmissions, ship stations, high power transmitting stations, and broadcast telephony.

"ROGO" (Eccles) *has a 4" former wound with No. 22 D.C.C., and asks* (1) *What wavelengths are covered, using a 0·0005 mfds. tuning condenser.* (2) *The size of a suitable reaction coil.* (3) *Whether the circuit on page 615, August 12th issue, is suitable for broadcast reception.*

(1) Tap at 10th	turn	80	to	220	metres.
20th	,,	130	,,	400	,,
30th	,,	210	,,	550	,,
40th	,,	250	,,	670	,,
50th	,,	300	,,	800	,,
100th	,,	350	,,	1,250	,,
150th	,,	400	,,	1,600	,,

(2) A suitable reaction coil would be a winding of 80 turns of No. 28 D.C.C. on a former 3" diameter with 3 tappings. (3) The circuit referred to is suitable for this purpose.

"L.W." (Brighton) *submits a wiring diagram and asks* (1) *For a theoretical diagram.* (2) *and* (3) *Whether the Post Office will allow him to use this circuit.*

(1) See Fig. 2. (2) The use of a circuit which may cause oscillations to be set up in the aerial circuit is not permitted by the regulations.

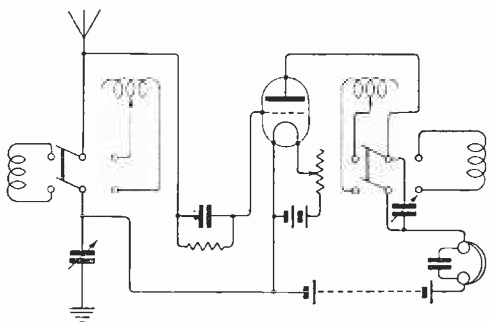


Fig. 2.

"E.D." (Sheffield) *asks* (1) *The inductance of certain honeycomb coils.* (2) *How to use the coils.* (3) *The capacity of fixed condensers, particulars of which are submitted.* (4) *The issues in which appeared descriptions of H.F. and L.F. transformers.*

(1) Unfortunately you have not given us the essential dimensions of the coils in question, and we cannot therefore calculate their inductance values. We would refer you to the reply given to **"H.W.C.M." (Clapham)**, page 252, November 18th issue. (2) The reaction coil should be the smallest, the aerial coil of the intermediate size, and the closed circuit coil the largest. (3)

The capacity of (1) = 0·00018 mfd.
,, ,, ,, (2) = 0·0005 mfd.
,, ,, ,, (3) = 0·0015 mfd.

Condenser (2) would be suitable for use as a grid condenser. (4) The issues are: August 19th, September 2nd, September 16th and September 30th.

"J.B.C." (London, W.C.2) *asks for a design of a H.F. transformer.*

A H.F. transformer suitable for your purpose is described in the issue of September 23rd, page 828. Full constructional particulars are given in this article, and you should experience no difficulty in the construction of the transformer.

"POWER" (Ireland) *asks* (1) *Whether the circuit given on page 880, September 30th issue, is suitable.* (2) *Whether good telephony reception should be possible from London, Paris and The Hague.* (3) *Whether a three-coil holder is suitable for mounting the H.F. transformer and reaction coil.* (4) *For particulars of the construction of the L.F. intervalve transformer.*

(1) This circuit is quite suitable for your purpose, but we recommend the reaction coil be coupled with the secondary winding of the H.F. transformer. (2) You should hear transmissions from the stations mentioned without any great difficulty. (3) A three-coil holder is very suitable for the purpose. The centre coil should be the secondary winding of the H.F. transformer and the reaction coil an outside coil. The primary and secondary coils should have approximately an equal number of turns, although sometimes it is possible to utilise a few per cent. more turns in the secondary winding. (4) The design for a L.F. transformer was dealt with in the issue of August 19th, page 659. Briefly, the core consists of iron wire, and is 9½" long by 7/18" diameter. The cheeks are 7/16" thick and 2" diameter, and are mounted 2" apart. The primary winding of No. 46 S.S.C. is wound on until the diameter is 13/16" and the secondary winding is put on over this until the diameter is 1¾". A total of 5 ozs. of No. 46 S.S.C. copper wire is used, and the turn ratio nearly 1 : 2.

"E.A.W." (France) *asks* (1) *Whether the diagram given on page 840, September 23rd issue, is suitable for receiving the Dutch Concerts.* (2) *Whether a tuning condenser is required in the aerial circuit.* (3) *The size of coils suitable for receiving British broadcasting.*

(1) The circuit referred to is suitable, but we suggest you use an aerial and closed circuit. (2) It will be better to use a 0·001 mfd. variable condenser in the aerial circuit, and a 0·0005 mfds. tuning condenser in the closed circuit. (3) The aerial coil could consist of a winding of No. 22 D.C.C. on a former 4" diameter and 4" long with 10 tappings, and the closed circuit coil will be a winding of No. 26 D.C.C. 3" diameter and 4" long.

"W.S.F." (Staffs.) *holds an experimental licence and asks whether he must modify his single valve set, which at present uses reaction coupled to the aerial circuit.*

The use of a receiver of this type during broadcasting is permitted, provided the user holds an experimenter's licence, it being a condition that the holder shall not allow his receiver to set up oscillations in the aerial circuit. We suggest you abandon the reaction arrangement, or reconstruct the set according to information which may be obtained from several recent issues.

"K.B." (Hucknall) *asks* (1) *How many turns to wind on an iron core to give about 1 henry of inductance.* (2) *Dimensions of a coil with inductance of 5 millihenries.* (3) *The gauge of wire to use in 1,250 and 1,500 turns duolateral coils.* (4) *How to make a resistance of 12,000 ohms.*

(1) We suggest 3,000 turns of No. 38 D.S.C. copper wire. (2) The coil could be a winding of No. 32 S.S.C., 5" long and 3" diameter. (3) We suggest No. 28 D.C.C. (4) The resistance could conveniently be made of a coil containing 500 yards of No. 38 Eureka wire.

D

"**PUZZLED**" **(Evesham)** *submits particulars of his set and asks* (1) *Does this set conform with the Post Office regulations.* (2) *Is the H.F. transformer suitable for all wavelengths.* (3) *Why speech is not clear.* (4) *Whether* **PCGG** *should be heard.*

(1) If you hold an experimenter's licence, the circuit is suitable. The fact of holding an experimental licence indicates that the Post Office consider you to possess a sufficient knowledge of wireless to handle the reaction in such a manner that interference is not caused. (2) One H.F. transformer, unless tapped, will not be suitable for all wavelengths. Unfortunately you do not give particulars of the H.F. transformer in use, therefore we cannot estimate the wavelength range over which it could be used. (3) Speech is not clear, probably, because of bad adjustments. (4) You may hear this station when the set is properly adjusted.

"**CYMRU**" **(Swansea)** *asks for a diagram of a four-valve set, with the values of the condensers.*

See Fig. 3. The values of condensers are marked. With a set of this description you should be able to amplify signals sufficiently to operate a loud speaker. The reason you are unable to tune below 600 metres is because the tuning coils are too large, or the tuning condenser is in parallel. You should try connecting the tuning condenser in series, and if you cannot reduce the wavelengths sufficiently, use a smaller coil.

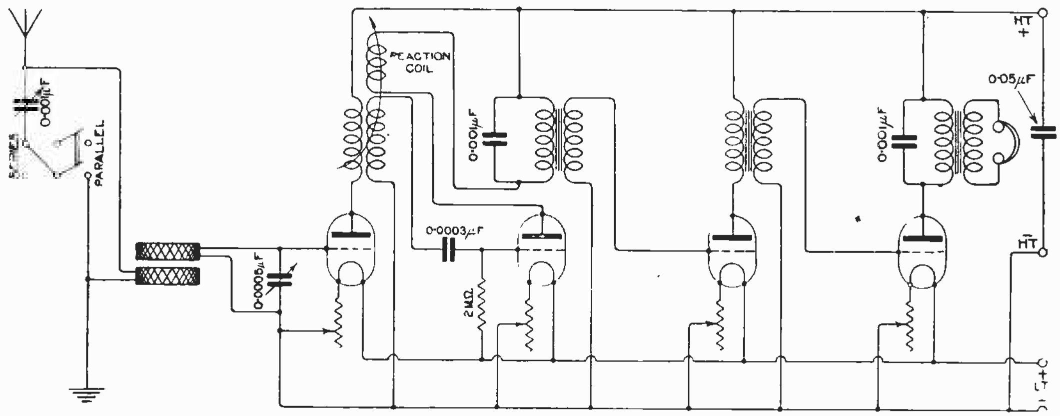


Fig. 3.

"**W.H.P.**" **(Manchester)** *asks* (1) *The dimensions of circuit condensers having capacities* 0·01 *mfds.,* 0.001 *mfds., and* 0·0002 *mfds.* (2) *Which is better, H.R. telephones, or a telephone transformer and L.R. telephones.* (3) *Where to purchase clips to hold* "*V24*" *valves.*

(1) Assuming the thickness of the mica is 0·005 cms. (22 mils)

0·01	=	15 foils,	overlap	= 4 × 2 cms.
0·001	=	7 ,,	,,	= 2 × 1 ,,
0·0002	=	2 ,,	,,	= 2 × 1 ,,

(2) It is better to use a telephone transformer and L.R. telephones when connection is desired to a valve set. (3) Clips can be purchased from wireless dealers.

"**P.S.B.**" **(Walsall)** *submits a diagram of his set and asks* (1) *For a diagram showing another H.F. valve connected.* (2) *Details of winding for H.F. transformer.* (3) *Number of turns to wind in coils.* (4) *Whether samples of wire submitted are suitable.*

(1) See Fig. 1, page 249, November 18th issue. (2) We suggest you make the transformer exactly as described in the issues of September 2nd and 16th. (3) and (4) The samples of wire submitted are (1) No. 28 D.S.C. copper, and (2) No. 38 D.S.C. copper. Using the No. 28 D.S.C., wind coils ½″ wide of 30, 50, 70 and 100 turns on a former 2½″ diameter.

"**RADIO**" **(Southport)** *asks* (1) *The dimensions of a coil for broadcasting.* (2) *Why he hears C.W. stations with no earth connection.* (3) *Whether a certain arrangement will be suitable for reception.*

(1) The coil could be constructed of No. 22 D.C.C. wire on a former 8″ diameter and 4″ long, with 8 tappings. (2) We cannot say without a knowledge of your set. If the transmitting station is near by, you would not need an earth connection, or perhaps you are using a small value condenser in the earth lead. (3) The arrangement proposed will work as you suggest, but why not use one of the normal arrangements described in recent issues ?

"**H.L.S.**" **(United States).**—A Venner time switch may be purchased from Venner Time Switches, Ltd., 45, Horseferry Road, London, S.W.1. We cannot say where "R" type valves may be purchased in France, but the manufacturers in this country are the M.O. Valve Co., Brook Green, Hammersmith, London, W., to whom you should apply for further information. The circuit given on page 435, July 1st issue, is a good three-valve Reinartz tuner circuit, and suitable values are: A.T.C., maximum value 0·0015 mfd.; C.C.C., 0·0005 mfd.; anode condenser first valve, 0·0003 mfd.; grid condenser, 0·0002 mfd. The coils may have dimensions similar to those described in the issue of May 13th. Good signals should be obtained when the set is connected to a frame aerial, the strength of course depending upon the power of the transmitting station.

"A.N.W." (Kent).—We suggest you modify the set according to the Fig. 4. The coupling between the coils G and Q will then provide for reaction. The coil E, as you suggest, is a choke coil, and is connected across the aerial and earth for the purpose of preventing the tuning condenser accumulating a charge of electricity through the aerial becoming charged with atmospheric electricity. We suggest you leave it connected in circuit. The intervalve transformer shown in the note magnifier panel should have a ratio of primary to secondary turns of 2 or 2½ : 1, therefore we do not think you will find any use for the 20 : 1 ratio L.F. transformer.

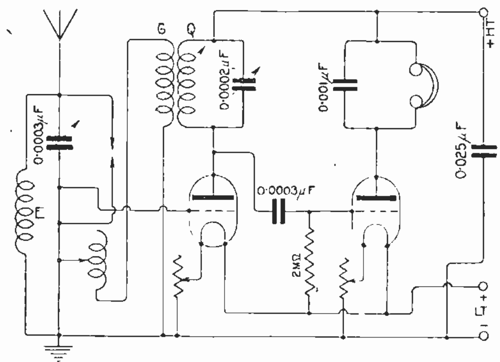


Fig. 4.

Fig. 5 indicates the method of connecting up the two-valve telephony transmitter, using the choke control method. The choke D may consist of 3,000 turns of No. 36 S.S.C. wire on an iron core ½″ diameter and 4″ long, the core being closed. The coil B is an H.F. choke, and may consist of a winding of No. 36 S.S.C. wire on an ebonite former 1″ diameter and 4″ long. Resistance E should have a high value of the order of 0·5 mehogms. If a buzzer and key is inserted in place of the microphone, the transmission will be tonic train or interrupted C.W.

"M.H.W." (Yorks).—We quite agree with your remarks concerning the operation of the two valve set when the first filament is disconnected. While the circuit will work under these conditions, it is quite obvious that no one will attempt to build the set including a capacity of the order of 5 cms. between the secondary circuit and the grid circuit of the second valve, because signals would be very much distorted, and adjustments would be very difficult to make. When the two valves are working together in a proper manner, the only effect which the capacity between the grid and plate can have is that it is added to that provided by the anode tuning condenser. Since there is no coupling between the aerial circuit and circuit containing the amplifier energy, it is not possible for oscillating energy to be transferred to the aerial circuit. The only current which flows in the closed circuit is the grid current, which is so small that it results in a very small oscillatory current in the aerial circuit. If you have had experience with capacity reaction, you will understand that a small reaction coupling of the order of 5 centimetres produces little effect.

"H.E.P." (Birmingham) *submits a diagram of his receiver and asks for our advice. He cannot tune out local transmissions in favour of long distance transmissions on similar wavelengths.*

We have examined the diagram of your set submitted to us, and we think the interference experienced will be quite eliminated by using a 3 coil holder or 3 coil tuner. The secondary circuit should then be connected to the filament and grid of the first valve.

In addition you will find a great improvement results when the aerial tuning condenser is connected in series with the aerial tuning inductance. You may find it convenient to connect a double pole throw-over switch in the aerial circuit for the purpose of connecting the A.T.C. and A.T.I. in series or parallel. Interfering stations may be tuned out by adjusting the coupling between the aerial tuning inductance and the closed circuit inductance, and by fine tuning.

"W.T." (Birmingham) *submits a diagram of his receiving set and asks our advice.*

We have examined the connections of your set submitted, and they are correct with the exception that no provision is made for joining the aerial tuning condenser in series or parallel with the aerial tuning inductance. When receiving short wavelengths, it is better to connect them in series. As you hold an experimenter's licence, we think you should use a three-coil holder. The centre coil should be the closed circuit inductance, and the outer coils would then be the aerial tuning coil and the reaction coil. The only alteration necessary would be the provision of a 0·001 mfd. tuning condenser in series with the aerial coil as shown. Terminals A and B would then connect with the closed circuit coil; but we cannot definitely say why you are not getting good results, as we have

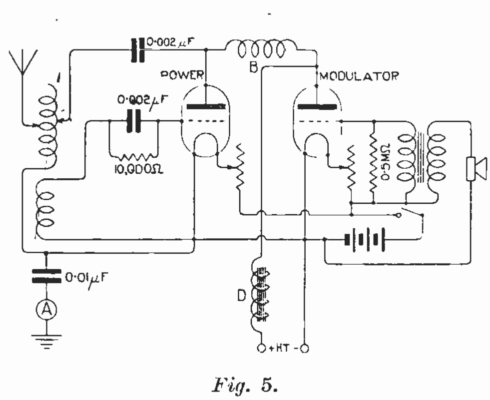


Fig. 5.

no knowledge of the transformers, grid condenser and leak used in the set. We suppose the telephone transformer is connected in the right direction? The general scheme of connections, however, is quite correct. We think you should certainly secure better results than at present. We understand, as you hold an experimenter's licence, the Post Office will offer no objection to the use of this circuit.

"F.A.R." (Belgium) *asks in which issues the construction of H.F. transformers is described.*

A variable H.F. transformer is described in the issue of September 23rd, page 828. Short wave-length transformers are described in the issues of September 2nd and 16th.

"H.R." (Highgate) *asks* (1) *For a circuit of a two-valve Armstrong super-regenerative receiver.* (2) *Whether the H.T. can be taken from the 240 v. D.C. mains.* (3) *Whether the Armstrong circuit will give louder signals than a two-valve* (1 *detector and* 1 *L.F.*) *receiver.*

(1) See Fig. 6. Full particulars of the construction of an Armstrong super-regenerative receiver are given in the issues of October 21st and 28th. (2) See article entitled "Methods of Deriving Valve Current from Public Supply Mains," on page 344, June 17th, 1922. (3) We think you should certainly hear louder signals when using the Armstrong circuit. We would point out this receiver should only be used in conjunction with a frame aerial.

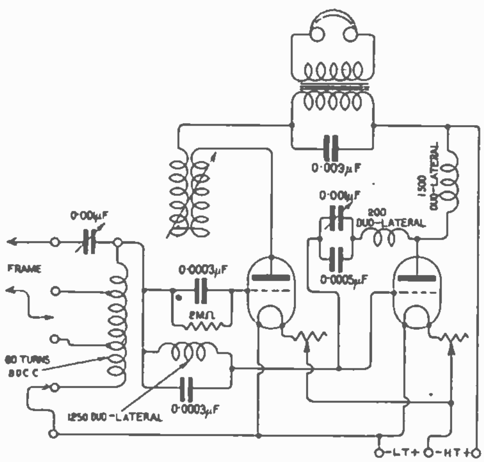


Fig. 6.

"C.P." (W.).—We suggest you do not use the glass condensers. Vernier condensers may consist of two fixed and one moving plates. The 0·0003 mfd. tuning condensers should consist of a total of 19 plates, and the 0·001 mfd. tuning condenser should have 61 plates. The capacity of two foils with an *overlap* of 2″ × ¾″, and mica 0·002″ thick, is 0·000844 mfds. The capacity shunted across the H.T. battery may have any value over 0·01 mfds. If the dielectric of the condenser referred to will withstand the H.F. potential, it is quite suitable. The secondary could be wound with No. 26 D.C.C. wire on the former 2½″ diameter and 4½″ long. Tappings should be taken at six points about equally spaced. It is not very satisfactory to rely upon tuning the secondary circuit by tappings only. The reaction coil could be a coil of No. 30 D.C.C. wire on a former 2″ diameter and 3″ long, with 3 tappings. The circuit will tune from 300 metres to 700 metres. With reference to the accumulators, we think you will find it better to keep them in condition by regular charging and discharging. The discharging can be carried out through a resistance wire and suitable taps.

"AJAX" (Leigh) *asks* (1) *What exactly is a "tuned anode."* (2) *Is it necessary to use a high frequency transformer when using a tuned anode.*

(2) When a valve is used as a voltage amplifier it is necessary to include in the anode circuit of a valve a circuit of high impedance. The higher this impedance, the higher will be the voltage amplification obtained from the valve. A convenient method of obtaining this is to use an inductance coil tuned with a condenser. When the anode circuit is tuned to the frequency of the incoming signal, the effective impedance in the circuit is resistive only, and a very high voltage variation takes place across the coil. The potential variations are transferred to the grid of the next valve through a condenser, and the grid of the valve is maintained at a suitable negative potential by connecting a leak resistance between the grid and one side of the filament. It is better to connect to the positive side of the filament, in order that a small grid current may flow and cause a little damping in the circuit. The effect of this damping can then generally be properly controlled by the use of reaction coupling to the anode coil. The anode tuning condenser should not have a valve exceeding 0·0002 mfds. when receiving short wavelengths, but when receiving longer wavelengths, this condenser may reach a maximum value of 0.0004 mfds. (2) It is apparent, therefore, that a high frequency transformer will not be required when the tuned anode method of high frequency amplification is employed. We would refer you to Fig. 1, page 249, November 18th issue. It will be seen the first valve has a tuned anode circuit, and the reaction coil is coupled with it.

SHARE MARKET REPORT.

Prices as we go to press on December 29th, are:—

Marconi Ordinary	£2	5	0
,, Preference	2	1	6
,, Debentures	102	0	0
,, Inter. Marine.. ..	1	3	0
,, Canadian		10	7½
Radio Corporation of America :—			
Ordinary		14	3
Preference		12	3

Marconi's Wireless Telegraph Company, Limited, Dividend.

The following dividends are announced:—

A Dividend of 7 per cent., less Income Tax, upon the 250,000 7 per cent. Cumulative Participating Preference Shares. An Interim Dividend of 5 per cent., less Income Tax, upon the 2,750,000 Ordinary Shares issued. These dividends will be payable on the 1st February next to shareholders registered on the 20th December, 1922, and to holders of share warrants to bearer. The Transfer Books will be closed from the 21st to the 27th December, 1922, inclusive.

THE
WIRELESS WORLD
AND RADIO REVIEW
THE OFFICIAL ORGAN OF THE RADIO SOCIETY OF GREAT BRITAIN

No. 178 [No. 15 VOL. XI.] JANUARY 13TH, 1923. WEEKLY

Low Frequency Amplification

A REVIEW OF THE DESIRABLE FEATURES TO BE FOUND IN TRANSFORMERS.

MAXIMUM power output is obtained from a valve when the impedance of the apparatus connected in the anode circuit is equal to the internal impedance of the valve. The output power, which is electrical energy modulated to give morse or telephone signals, may be required to energise the input circuit of another valve to secure further amplification, or to operate a telephone receiver or other device capable of response, and able to effect the senses in a manner necessary for the reception of intelligence. In the case of the valve, we require the input voltage to be as high as possible, since the amplifying valve is a voltage operated instrument. The telephone receiver (or other device) is of course energy operated, and its impedance, it should be noted, ought to be approximate with that of the circuit to which it is connected for maximum effect. Thus telephones possessing high impedance are connected in the anode circuit of a valve, or across the crystal detector, because the latter have high impedance.

It may be pointed out here that impedance (Z) is expressed in ohms, and is the equivalent resistance set up by the electrical properties of a circuit thus:

$$Z \text{ ohms} = \sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}$$

where $R =$ the ohmic resistance, $\omega = 2\pi \times$ frequency, $L =$ inductance in henrys, and $C =$ capacity in farads.

As the valve is amplifying low frequency currents, its self capacity will have little effect, and the plate filament impedance is resistive only. That is, it may be regarded as resistance only. The effective impedance of inductive apparatus such as a transformer, is composed of the primary impedance plus that due to the secondary and load transferred to the primary. The load resistance may be considered as in series with the primary impedance, while the losses due to charging or magnetising the apparatus should be considered in parallel with the primary impedance.

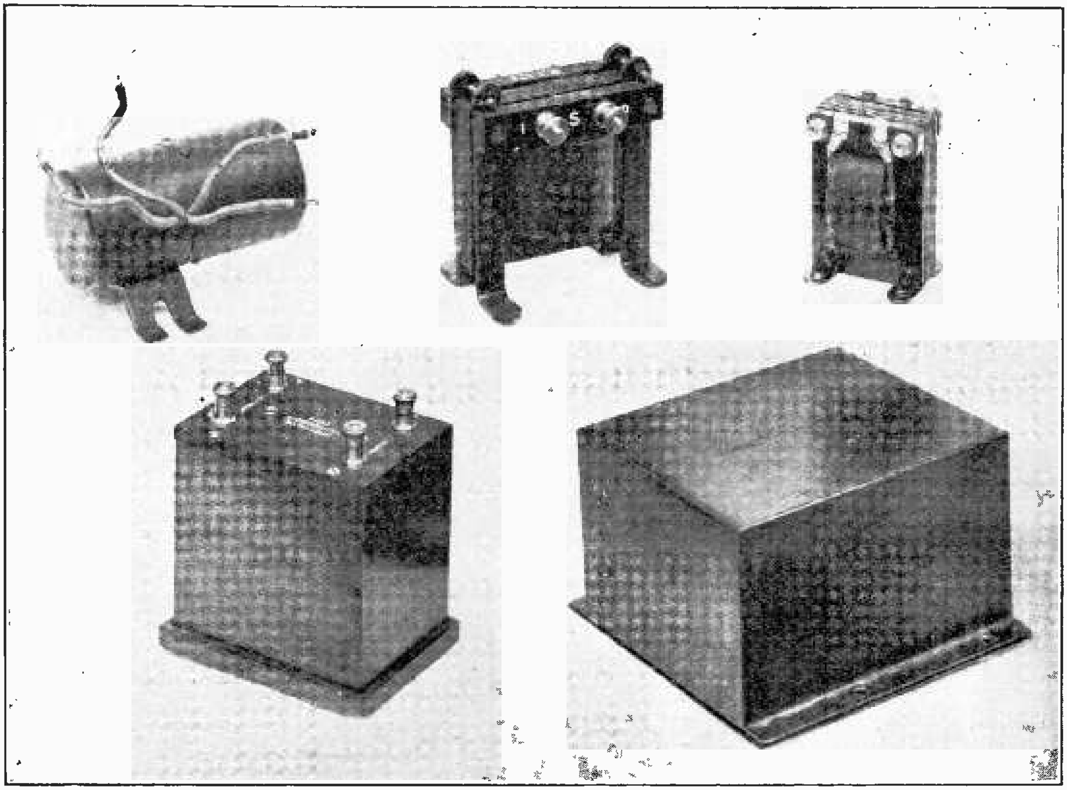
Due to the large difference in the internal impedance of the output and input circuit of a valve, it is essential for good amplification to use apparatus to match the impedances. A transformer is generally used for this purpose; and as the energy to be amplified is of audible frequency, the transformer should have an iron core.

It is now proper to consider the amplification per stage, which is defined as the ratio of the signal voltage applied to the second valve (V) to that applied to the first valve (v), that is $\frac{V}{v}$.

The consideration is complicated by the requirement of distortionless amplification. The latter demands (1) the anode current-grid voltage characteristic of the valve, be linear over the portion affected by the signal. (2) The effective impedance of the transformer be so high that all the frequencies present in the signal shall be equally dealt with. (3) Negligible grid current shall flow.

(1) This condition is met by ensuring the impedance in the anode circuit is sufficiently

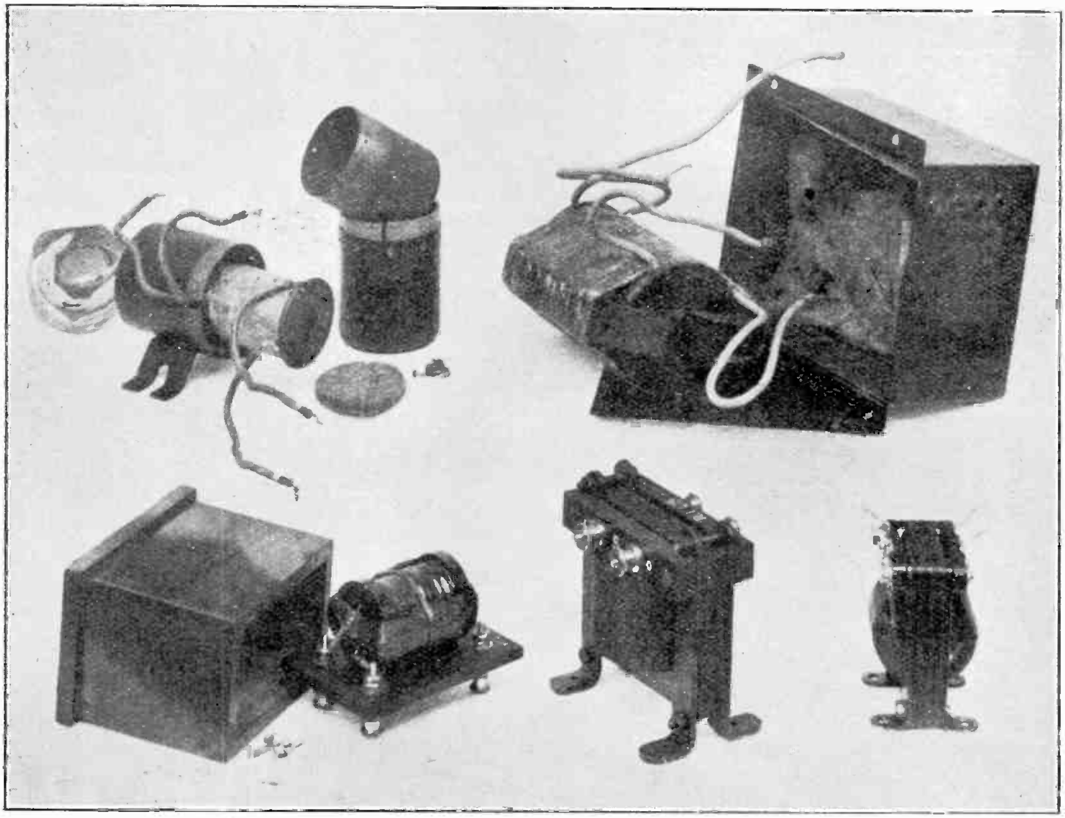
great, and by proper adjustment of the filament heating, normal grid and anode potentials. To straighten out the characteristic curve sufficiently, the impedance connected in the anode circuit must be at least equal to that of the internal impedance of the valve. This demands a large number of turns of wire, with an iron core of large cross section. In addition, the transformer must be properly made for minimum iron losses and minimum leakage. The grid potential should be adjusted so that its mean potential lies in the centre of the anode current-grid voltage characteristic. The filament temperature and anode voltage must be sufficiently high to ensure saturation shall not occur, and the peaks of the signals cut off. (2) The transformer must be built to have a flat frequency characteristic over the range required by the proper design of the windings and magnetic circuit. This requirement is met with a large iron section and a large number of turns, due allowance being made for the normal anode current which is producing flux. (3) The normal grid voltage should be such as to ensure that the most positive portions of the signal shall not cause an appreciable current. If grid current were permitted to flow, distortion would be caused for two reasons: (*a*) current which should pass to the anode circuit is diverted to the grid, and (*b*) the input voltage is lowered, due to the drop across the secondary winding of the transformer. For these reasons it is necessary to connect one end of the secondary to the negative pole of the filament battery, or to include small dry cells in the circuit, connected to increase the negative potential of the grid.



Examples of Low Frequency Transformers. The first Transformer in the upper row is a German Telephone Transformer, while the others are various types of Intervalve Transformers. It will be noticed that two of the Transformers are totally enclosed in metal screening cases.

To secure the maximum voltage per stage, the effective impedance of the primary of the transformer and output of the valve should be about equal, and the secondary winding should consist of as many turns as practicable, so that the largest voltage step-up is obtained.

Fortunately it is not necessary to match impedances exactly, and no great effort to this end should be made. The secondary voltage is limited through the self-capacity and resistance of the windings, and through magnetic leakage and iron losses. With careful design of the iron circuit, and the disposition of the windings, the losses due to the latter cause may be made negligible. The iron core should be made of laminations having high permeability and low losses. The transformers, to be small in size, are wound with a large number of turns of fine wire, and the resistance losses may be only reduced by increasing the size of the transformer, which is not economical. Self capacity is reduced by spacing the layers of the windings, and by choosing the right ratio of winding depth to winding length. The material used to impregnate the windings should be chosen to have the lowest specific-inductive capacity consistent with insulating and damp-proofing qualities.



The types shown indicate a variety of methods for constructing the cores. A study of the relative dimensions is of interest. The Telephone Transformer has two shells, one of iron and the other copper.

The secondary voltage is reduced by the charging current and by the magnetising current and leakage.

From the foregoing it will be understood the transformer primary will possess a large number of turns, and as it is not essential to match impedances exactly, the requirements for distortionless amplification should be met in preference to other desirable features.

The secondary winding consists of many more turns than the primary, but the number cannot be increased indefinitely, because beyond a certain point there is no increase in secondary voltage. When "R" type valves are used, a usual ratio is 1 to 4. The impedance of the valve may be varied by changing the filament current and high tension voltage, and by grid potential adjustments. It is therefore apparent that for good amplification, and in particular for minimum distortion, the transformer used to couple the detector valve and the next low frequency valve would have a very large primary winding. The ratio of a correctly designed transformer for this purpose would probably not exceed 1 to 1½ or 2. The impedance of the last low frequency valve is very much less under normal working conditions than that of the detector valve, therefore the primary winding of the transformer in the anode circuit need not have so many turns, but the wire should be larger to carry the heavier current. High ratio transformers should be avoided. It is better to use a transformer with a large number of primary turns and a small ratio, than one with comparatively few primary turns and a high ratio. The latter transformer, like a number at present in the market, would result in a reduction instead of a step-up of voltage. A good transformer then, will be large, so that the windings will be able to carry the working currents without overheating and undue losses, and the insulation good.

The iron core will have a large cross section for obvious reasons. The size, the current-carrying capacity of the windings, their insulation and their ratio are the points to be especially noticed when about to purchase low frequency transformers. A knowledge of the resistance of the windings is of little value as a guide unless one is comparing transformers of similar dimensions. When connecting transformers in circuit, it is as well to ensure the assistance of the capacity between the windings. If the windings are wound in the same direction, the beginning of the primary winding (I P) should be connected with + H.T., and the end of the primary winding (O P) with the plate. The beginning of the secondary winding (I S) should be connected with the grid, and O S with —L.T., but to prevent the low frequency amplifier setting up oscillations it is sometimes necessary to reverse the connections of the transformers. A common H.T. battery is largely used, and to prevent it through its internal resistance acting as a coupling between the transformers, it should be shunted with a large capacity condenser of the order of 2 to 4 mfds.

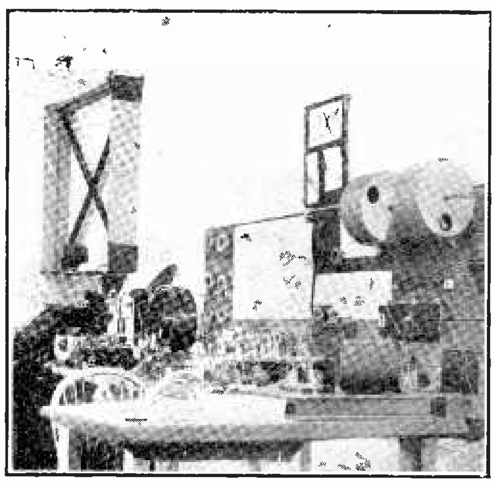
The reactance of a condenser of 2 mfds. to currents of a frequency of 800 cycles is of the order of 100 ohms.

W.J.

The Downside School Wireless Station.

The station shown in the accompanying photograph, was erected by the Downside Wireless Society, a Society run entirely by the students.

The main receiver may be seen in the middle of the bench. The tuner consists of Burndept inductances and home-made condensers, while the amplifier is composed of four H.F. valves (Sullivan transformers being used), a rectifying valve, and one note magnifier, built in two sections, a two-valve H.F. panel and a four-valve amplifier-detector panel. To the left is a separate heterodyne of novel design, and a 10 watt transmitting valve. The transmitter has worked on more than one occasion with Crowborough in Sussex, a full 120 miles from Bath.



The Apparatus embodies many interesting features and is a fine example of a station arranged for the purpose of conducting experimental work.

A two-wire aerial is used, having a mean height of 70 ft. The frame showing conspicuously in the photograph is also employed for reception, and gives very good results.

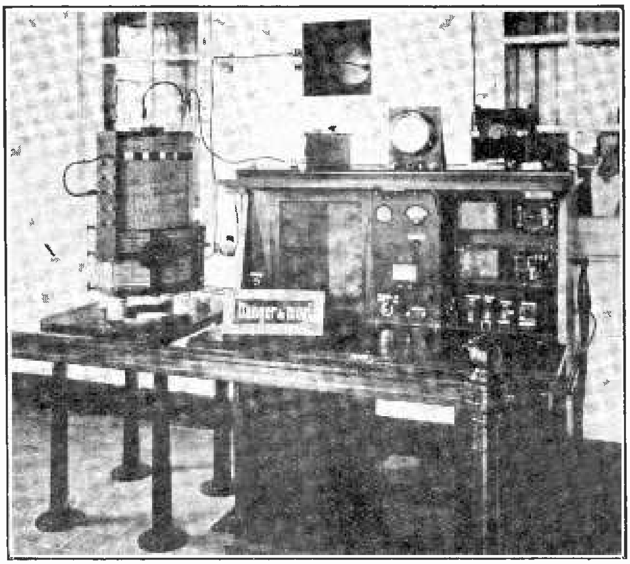
Of telephony amateurs received, 2 AZ (last year), 2 AW, and 2 BZ, are very good considering their distances, while 2 FL 2 AX, and others within a 25-mile radius are deafening.

General View. The Aerial and Transmitting Building are on the left and the Hangars on the right.

The Geneva Aerodrome Wireless Station

THE Geneva Aerodrome occupies a commanding position between the main range of the High Alps on the south and the subsidiary Jura Mountains on the north, the general direction of the lowlands lying between being north-east and south-west. The whole site was cleared and laid out by the unemployed of Geneva, who were also responsible for the erection on a very complete scale of the necessary buildings. These are up-to-date and comprise such accommodation as bedrooms for the pilots, including means for heating their clothes. The finished scheme forms a good example of a model aerodrome; it embraces many novel signs for attracting the attention of aviators, and is furnished with the latest instruments.

The wireless station constitutes a most important part of the equipment of the aerodrome. It provides facilities for efficient communication with aircraft, and with other ground stations and is fitted with a Marconi 1½-kW. transmitter and a directional receiver. A distance of about 200 metres separates the two stations, the transmitter being remotely controlled from the receiving station.



The 1.5-kW. Transmitter.

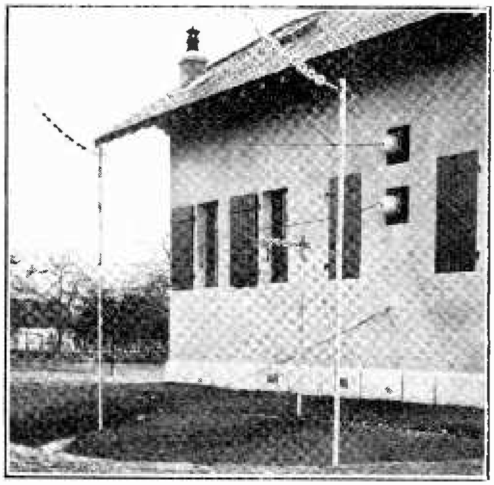
Facilities exist for connection to land lines as required, but at the present time no land line voice amplifier is fitted although this can be arranged if desired by the local authorities.

The transmitter is situated in a building in the north-east corner of the aerodrome, the apparatus consisting of a Standard Marconi 1½-kW. Cabinet Set, embodying a special A.T.I. fitted with a ratio tap in order to enable an earth screen to be employed. The receiver portion of the cabinet set has been removed and replaced by a relay panel and a local control unit panel. On the relay panel are fitted the various relays controlling the circuits, which are operated by a control panel situated in a distant receiving station, or alternatively by a local control unit mounted underneath the relay panel for testing purposes, or if it should be necessary at any time to operate the transmitter locally.

An additional sub-control attachment is provided for increasing the amplitude of the speech from the microphone, before being impressed on the grid of the main control valve in the cabinet set.

The aerial is supported on two 30-metre towers, and a ten-wire earth screen is employed.

The power mains from the local supply are led on to a rotary converter arranged to supply the correct output for driving a standard 1½-kW. motor generator, supplying the necessary alternating current to the cabinet set, whilst an emergency petrol-electric gene-



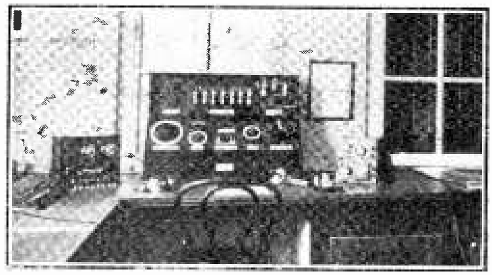
Aerial and Earth Screen Lead-in.

rating plant has also been installed for use in case of emergency.

This is situated in a building 200 metres south-west of the transmitter house and consists of a Marconi direction finding equipment, type 12A, the directional aerials for this station being supported on a 70-foot mast.

As mentioned, an operators' control panel has been installed which controls the functions of the transmitting station, viz., the starting up of the motor generator; the changing from "send" to "receive"; the selection of the type of transmission—telephony, C.W., telegraphy, tonic train—and the control of the necessary circuits for connecting through to the land lines. These functions are performed by a series of Kellog keys mounted on an appropriate panel.

Communication by telegraphy has been established between Geneva and Croydon, a distance of about 475 miles. The transmitting wave ranges are 900, 1,400, and 1,600 metres, and the receiving wave ranges are

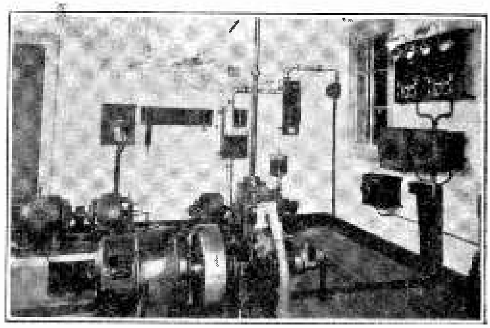


Receiving Apparatus. On the left are the Remote Control Keys of the Transmitter.

400-4,000 metres without heterodyne and 400-2,200 metres with heterodyne.

The receiver can be arranged for either all-round reception, "Sense," or normal directional reception.

It should be noted that an important advantage of this type of station lies in the almost instantaneous change-over from transmission



The Power Room.

to reception, thus allowing of efficient single-way working with any other telephone station possessing the same arrangements.

The operating conditions are ideal, as owing to the remote control arrangements, the noise of running machinery does not interfere with the satisfactory handling of traffic.

The Application of Loose Coupling to an Existing Single Circuit Set.

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

AT the present time the majority of amateurs are using tuners in which the reaction coil acts directly on to the A.T.I. In inexperienced hands this method of reception becomes a great annoyance to other stations in the neighbourhood. Owing to the fact that as soon as the reaction coil is brought too near to the A.T.I. oscillations are set up in the aerial, accompanied by radiation, it is almost impossible nowadays to hear the Dutch Concert through without having the music spoiled by innumerable squeaks and chirpings produced in this way by dozens of amateurs in one's neighbourhood.

The Post Office very properly wish to prevent this, and at one time they actually ceased to grant licences where the applicant sent in a diagram of his set showing reaction to A.T.I. They have recently withdrawn this restriction, as far as the experimental licence is concerned, excepting on broadcast wavelengths, and it behoves us, in our own and everybody else's interest, to be most careful not to make our aerials radiate.

In experienced hands reaction direct to the A.T.I. need not cause any trouble by radiation, but why should we adhere to the use of this method, when we have an alternative method, *i.e.*, "loose coupling," which has the following advantages :—

(1) Interference to neighbouring stations may be reduced.
(2) Greater selectivity is secured without loss of signal strength, when carefully tuned.
(3) Much lower plate voltage can be employed.
(4) Lower filament temperature can be used with consequent lengthened life of filament and less frequent charging of accumulators.
(5) The set receives much shorter wavelengths than was possible before.

I have carried out a number of experiments on loosely coupled circuits and the following information may perhaps be useful to many amateurs in converting their sets.

Fig. 1 shows the usual single valve "reaction to A.T.I." connections which are causing so much trouble in the ether. These are so well known that no detailed explanation is required.

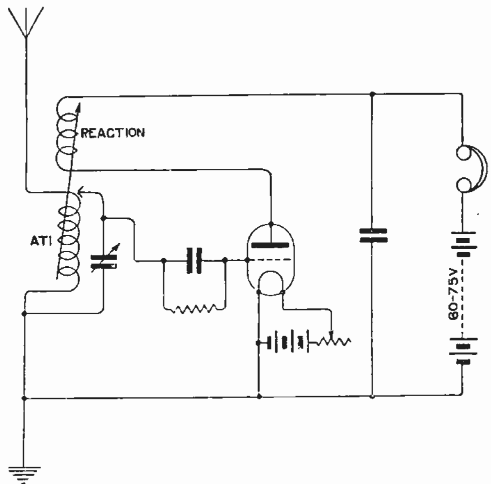


Fig. 1.

Fig. 2 shows the same set loosely coupled to a new A.T.I. tuned by a variable condenser, which may be connected either in series or parallel, according to the number of turns employed, and the range of wavelengths desired,

The coupling required is an extremely loose one, and I find that all that is necessary is to stand the new A.T.I. on the top or by the side of the existing set, without making any alteration at all thereto.

It makes little or no difference whether the old A.T.I., now called the secondary, is left connected to earth or not.

It will be noted that the H.T. now required to operate the set is much lower. I have succeeded in receiving ships comfortably with my new set, which has one valve as note magnifier in addition to the receiving valve, using H.T. of only twenty volts for the plate circuits of both the receiving and note magnifying valves.

To get results equal to, if not surpassing those obtained with the old "Reaction to A.T.I." connections, I find 30 volts H.T. the best.

I have received the Dutch Concert very nicely on this voltage and it is quite moderately audible on 15 volts.

The following results of a test made on 440 metres reception may be of interest.

Using the old "Reaction to A.T.I." connections, best signals were obtained with 60 volts H.T. and reaction ceased at 45 volts;

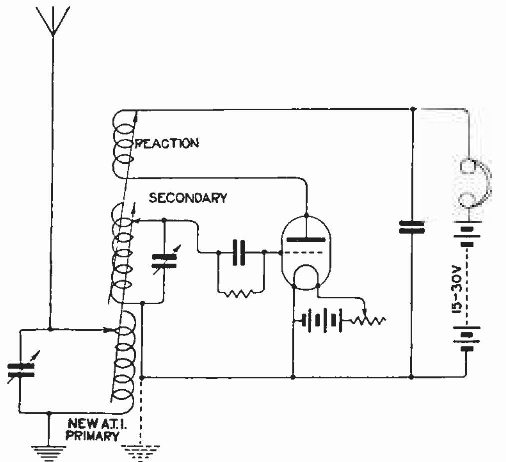


Fig 2.

signals were just audible on 15 volts. Using the same set as inductively coupled secondary to a separately tuned A.T.I., full efficiency was obtained with 30 volts H.T. and the set reacted on 15 volts, signals still being quite strong.

The fact of being able to operate our sets with a reduced plate voltage is not only an economy, but in itself reduces the risk of any serious radiation to a minimum. We no longer have such a large amount of energy available for the annoyance of our wireless friends.

Fig. 3 shows a photograph of my own set. I have fitted up my new A.T.I. and condenser in a small mahogany box, which stands on the top of my set. When placed in the position shown in the photograph, Fig. 3 (as indicated by an arrow), it is over the secondary inductance (the old A.T.I. of the set). This coupling is too tight, and in order to obtain the best results, I move it towards the other end of the box until the right degree of coupling is obtained.

A brief description of the rest of the photograph may be of interest. The panel on the left-hand side contains the controls of the transmitter. By means of a switch we can change over from telephony to C.W. or to tonic train, and I have designed the set to transmit with a voltage of only 220.

The space between the panels contains four "R" valves, one for transmission, one for modulation, one for receiving, and one for note magnification, and below this space is a change-over switch ("send to receive").

The right-hand panel contains all the usual receiving controls. The handle marked G.C. is a variable grid condenser which enables one to get fine adjustment of the amount of reaction without altering the tuning of the set. The Morse key is mounted on the front flap of the wooden case.

Now that I use my old A.T.I. as secondary inductance I find that to tune in any given station, it is necessary to search for it one stud higher up the secondary inductance than before, when it was employed as A.T.I.; so that stations which I used to tune in on Stud 1 now come in on Stud 2; this allows me to go down some 200 metres lower.

A few details of the new tuned A.T.I. may be useful. The inductance is wound with No. 18 double cotton covered wire on a cardboard former, 3 ins. in diameter, 144 turns with tappings at every twelfth turn, and this is tuned with a variable condenser having a capacity of 0·0005 mfd. A switch, not shown

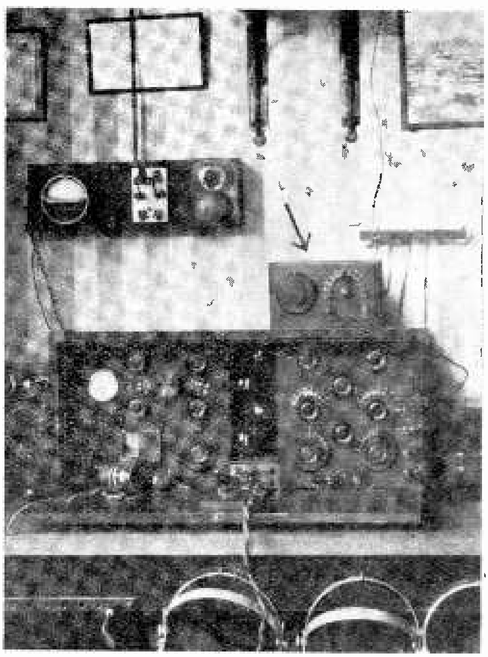


Fig. 3.

in figure, is used to connect the condenser either in series or in parallel with the inductance.

Another advantage can be reaped when employing this separate tuned A.T.I. circuit.

It is quite a simple matter to connect a crystal and phones across it, and so to use it independently of the valve set as a stand-by for reception of strong signals and telephony.

As the crystal detector also provides us with a very simple method of ascertaining if our aerial is radiating, a brief description may be useful.

Fig. 4 shows a valve set loosely coupled to a separate A.T.I. The A.T.I. is connected in parallel with a small variable condenser C_1 and (as a " stand by " for use when the valve set is not required for loud telephony and telegraphy), a crystal detector *D*, and a pair of high resistance telephones *T*, bridged with the usual blocking condenser C^1, are connected as shown. A switch *S* brings the detector into or out of action.

To ascertain if the aerial is radiating, the procedure for strong signals is as follows :—

(1) Having set a wavemeter to the wavelength of the station which we wish to receive, buzz it and tune the aerial circuit by adjusting the A.T.I. and variable condenser *C*. Then having picked up the signals with the crystal detector, cut it out of action by opening switch *S*.

(2) Next switch on valves, etc., and put the secondary circuit into action, taking care that the secondary inductance *I* is very loosely coupled to the A.T.I. (*i.e.*, at a considerable distance from it). Buzz wavemeter to the same wavelength as before and tune the secondary to the same wavelength by adjusting the closed circuit inductance and variable condenser C^2 and stop wavemeter buzzing.

(3) Tighten the coupling by placing the valve set nearer to the A.T.I. until incoming signals are clearly audible and leave set working.

(4) Switch on the crystal detector and receive signals on crystal once more.

(5) While still listening in with the crystal, commence to tighten up the coupling between the reaction coil *R* and the secondary inductance. A point will soon be reached where the signals heard from the crystal begin to increase. When this stage is reached it indicates that the aerial circuit is receiving energy from the secondary circuit and is beginning to radiate. The coupling must be reduced until no excess of signal strength is observable. When this adjustment is satisfactorily achieved, the crystal is switched out of action and the signals are heard on the secondary circuit.

In order to receive them at their maximum strength it may be necessary to slightly reduce the capacity of condenser C_2, to allow for the slight increase of capacity introduced into the secondary circuit by the tightening of the coupling between the reaction coil and the secondary inductance.

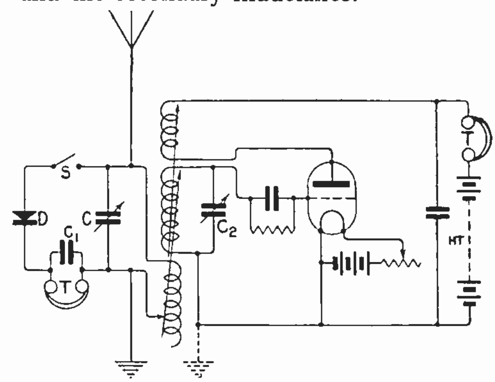
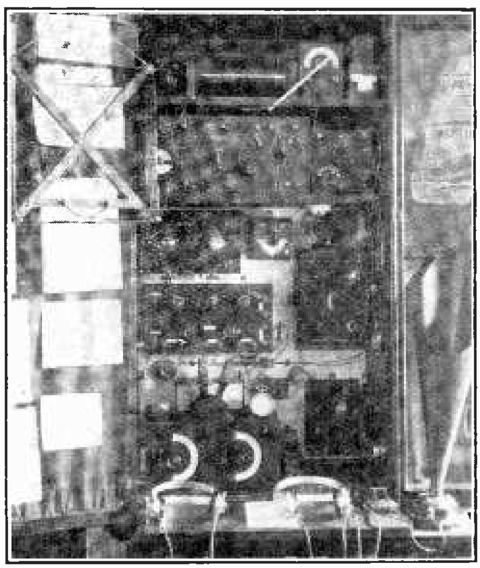


Fig. 4.

When it is desired to receive signals of too weak a strength to be heard with a crystal detector the procedure is practically the same, only in this case, when we wish to ascertain if our aerial is radiating, we must use the wavemeter all the time in making the tests with the crystal.

An Experimenter's Receiving Equipment.



This station comprising independent short and long wave sets with separate valve amplifiers, is that of Mr. Geo. F. Robinson, 9, Southgate, Sleaford, Lincs.

Electrons, Electric Waves and Wireless Telephony—XV.

By Dr. J. A. FLEMING, F.R.S.

The articles appearing under the above title are a reproduction with some additions of the Christmas Lectures on Electric Waves and Wireless Telephony given by Dr. J. A. Fleming, F.R.S., at the Royal Institution, London, in December and January, 1921-1922. The Wireless Press, Ltd., has been able to secure the serial rights of publication, and any subsequent re-publication. The articles are therefore copyright, and rights of publication and reproduction are strictly reserved.

VI.—TELEPHONY AND SPEECH TRANSMISSION.

3. Efficiency and Properties of the Telephone Receiver.

THE remarkable fact about a Bell magneto telephone is that the mere vibrations of a small flexible circular iron disc should be capable of impressing on the air waves having the very irregular wave form necessary to create speech sounds. When we consider the complicated nature of our own human organs of speech and the manner in which the larynx, throat muscles, variable mouth cavity, lips, tongue and teeth, are all brought into operation to create articulate sounds, it is wonderful that the mere to and fro motion of a small thin iron disc can do nearly the same thing in creating speech. Another striking thing is the very small electric currents which are capable of creating audible sounds in a telephone receiver, and the extremely small amplitude or extent of motion of the telephone diaphragm in creating such sounds. P. E. Shaw measured, in 1905, the amplitude of diaphragm motion for a just audible sound in a magneto receiver, and found it to be about one-fourteenth part of a millionth of a centimetre, or about one-thirty-fifth part of a millionth of an inch.

The diaphragm of a telephone has, however, a certain natural frequency to which it best responds. It resembles a violin string or harmonium reed in that there is no particular natural frequency at which it will vibrate and yield its fundamental note if it is struck and left to itself. This frequency is called its *resonance frequency*, and in telephones with iron diaphragms about 2 ins. in diameter and 1/50th in. thick, the resonance frequency is about 800 or 900. Hence, if we pass through the telephone coils an alternating electric current having this resonance frequency, the amplitude of motion of the diaphragm will be increased from 10 to 30 times when compared with that which it would have for the same current at a different frequency.

In connection with telephone work we require to give numerical values to the loudness of various sounds heard in the telephone. This is stated in terms of their *audibility*. If we pass an alternating current through a telephone of any frequency between, say, 100 and 2,000, we hear, on listening to the receiver, a more or less musical sound. If we apply across the terminals of the telephone a resistance called a shunt, which has no inductance, and gradually decrease this resistance, we shall at last reach a point at which the telephone sound is only just audible, because part of the current is shunted away from its coils. If the resistance of the telephone coils is R ohms, and the resistance of the shunt is then S ohms, then the *audibility* of the sound when the shunt is removed is expressed by the number $(R+S)/S$. Strictly speaking, we should say impedances and not resistances. Thus, suppose the telephone had an impedance of 100 ohms, and that we had to shunt the telephone with 2 ohms to just make the sound heard in the telephone inaudible to a normal ear, then the so-called audibility of that sound when the shunt is removed would be $102/2=51$.

Shaw found that if the audibility of a just perceptible sound is taken as unity, then the audibility of a loud sound would be about 1,400, and that of an overpowering sound 7,000 or more. Broadly speaking, we may say that the intensity of the sounds emitted may vary from 1, which denotes a just audible sound, to 1,000, which denotes a fairly loud sound.

The displacement or amplitude of motion of the diaphragm may vary from about half a micron ($= 5\times 10^{-5}$ cm.), which is about the wavelength of a ray of yellow light, to 8 or 10 microns, which is about 1/100th of a millimetre. Even in the case of loud telephonic sounds it is very small.

As regards the currents required to produce sounds of various audibilities, Werner Siemens long ago found that with a particular Bell telephone, the interruption of a current of 1/50,000th of a milliampere, when passed through the coils, caused the diaphragm to emit a just audible sound or tick. With more modern receivers the starting or stopping of a current of not more than 1/6th of the above could be detected. If, however, alternating currents are used, the current producing a just audible sound would depend upon whether the frequency of that current agreed with the telephone resonance frequency or not.

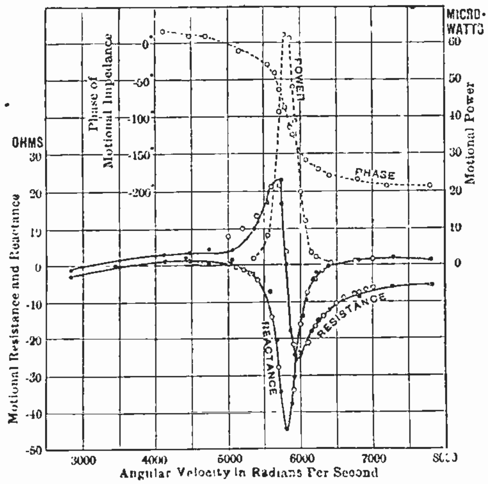
Another very remarkable quality of the magneto telephone is its astonishing inefficiency as an energy transforming device. We employ a magneto telephone to transform the energy of the varying electric currents sent through it into energy of aerial sound waves. But the fraction of the energy it so transforms is at most about 1/1,000th or 1/10th of 1 per cent., and, except at resonance frequency, may be only a few parts in 100,000.

The greater part of the electric power given to the coils of a telephone receiver is expended in producing heat in the wire coils and in the diaphragm, in mechanical work in bending the diaphragm and moving it to and fro, and in magnetic energy losses in it, and at most one or two parts in 1,000 of all the power applied is utilised in the production of the speech sound waves.

There is therefore a vast field for possible improvements, and it is curious that, with the exception of the hot wire telephone or Thermophone receiver of De Lange and O. Fischer, invented in Holland, there has been no great departure from the principles of Bell's invention made 47 years ago, although very considerable improvement has taken place in details and in manufacture.

Much research has also been conducted on the properties of the magneto telephone receiver. Many interesting monographs have been published by Prof. A. E. Kennelly and his associates in the Massachusetts Institute of Technology, U.S.A. Kennelly has made measurements, at various frequencies and with different receivers of standard types, of the true resistance, the reactance, and the impedance of the telephone coils.

In general the resistance of a telephone is reckoned as the resistance to direct currents. Thus we speak of a 60-ohm telephone, meaning one of which the coils measure 60 ohms with direct current. The speech currents are, however, alternating currents with a frequency varying from 100 to 2,000, and a mean value of about 800 or 900, corresponding to the resonance frequency of the telephone. The resistance R with high frequency currents is much greater, perhaps double or more, compared with the direct current resistance.

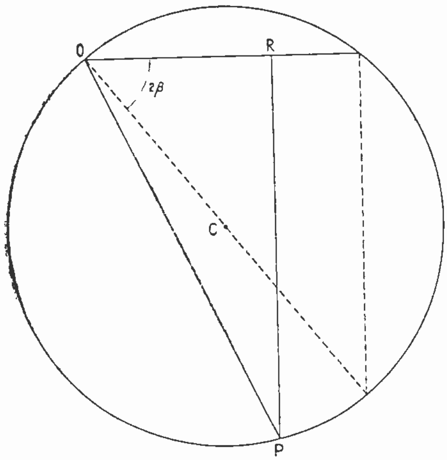


(a)

Fig. 84. Curves obtained by Dr. A. E. Kennelly for the Motional Resistance, Reactance and Power absorption of a Magneto-Telephone receiver. Note. The angular velocity signifies 6.28 times the frequency of the alternating current.

Again, if we measure the inductance L of the coils at any frequency n, then the product $2\pi nL = wL$ is called the *reactance* of the coils, and the quantity $\sqrt{R^2 + w^2L_2}$ is called the *impedance*.

If the resistance, reactance, and impedance of a telephone receiver are measured at the same frequency—first when the telephone is emitting sound, and secondly with the diaphragm clamped so that no sound is emitted—and if we subtract the second measurements from the first, the difference gives us the so-called *motional* resistance, reactance, and impedance of the telephone. If these are measured at different frequencies and the values plotted as the ordinates of a curve corresponding to the various frequencies as abscissæ, we obtain a set of interesting curves (see Fig. 84).



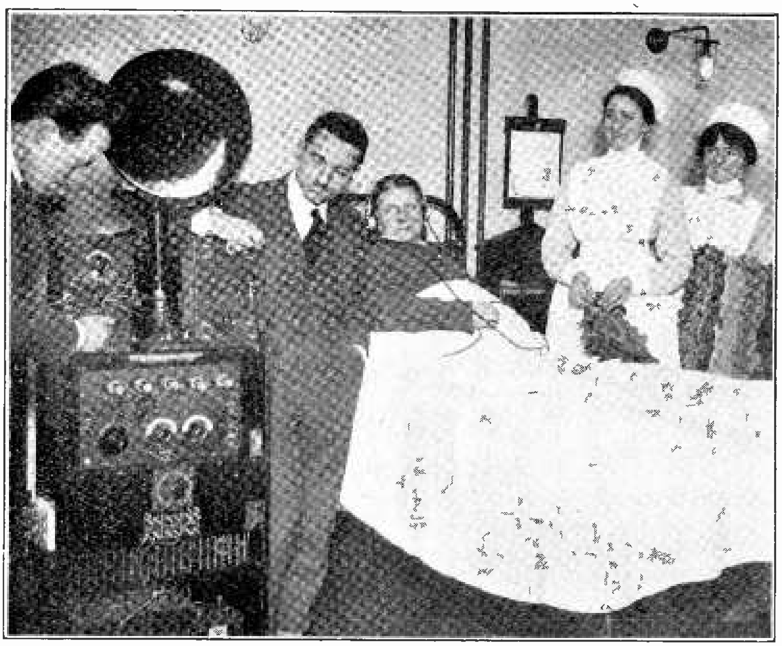
(b)

Fig. 85. Circle of motional impedance constructed by plotting the motional resistance horizontally OR and the motional resistance downwards vertically RP, the diameter of the circle measuring the impedance of the telephone.

The motional resistance at frequencies far from the resonance frequency is small, then it rises to a maximum, and then suddenly falls to zero at resonance, and passes to a negative maximum. The motional reactance is always negative and a maximum at resonance. The motional power is a maximum at resonance; that means when the frequency of the alternating current used in the measurement agrees with the natural frequency of the telephone diaphragm.

On the other hand, if we plot the motional resistance horizontally and the motional resistance downwards vertically (see Fig. 85), we obtain a circle called the *motional impedance circle*, the diameter of which measures the impedance of the telephone at resonance frequency. The angle which any chord of this circle makes with the horizontal line is called the *depression angle*, and this angle is double of the angle by which the magnetic flux in the telephone magnet lags behind the magnetising force.

(To be continued.)



Owing to the kindness of Mr. P. K. Morgan, who lent his apparatus for the occasion, the patients and nurses of the Middlesex Hospital were able to listen on December 23rd to Miss José Collins transmitting from **2 LO.**

How to Make Use of the Scientific Time Signals.

By W. G. W. Mitchell, B.Sc., F.R.A.S. F.R.Met.S.

WE shall now consider the rythmic beats or vernier time signals sent daily from Paris (FL), Bordeaux, Lyons and other stations.*

The purpose of the vernier time signals is to establish a standard of time measurement having the highest degree of accuracy possible over whole continents and ultimately over the whole earth. By this means very accurate determination of longitude may be made, for where a self-registering method of reception of vernier time signals is employed, an accuracy of the order of 1/1,000 sec. may be expected in the received signals. Now the problem of the determination of *exact* time over the globe, even if such an absolute standard was possible, ultimately resolves itself into the comparison of two standards. These two standards may be two clocks or a clock and a stellar transit, this latter being the passage of a given star across the meridian. But in any case the two standards have to be brought together for comparison, which necessitates the use of intermediary apparatus. All time errors are therefore, at the best, relative quantities, and when a discrepancy arises, the question of "bringing home the guilt" is a very intricate one. Furthermore, this limit of error, namely, 1/1,000 sec., is very near the limit of error of the astronomical observations upon which finally the transmission of exact standard time depends.

All time is measured by regularly recurring phenomena. Sidereal time or "star" time is therefore used throughout, in place of the more usual G.M.T. As this is usually a point of some difficulty, the reader is asked to consider carefully the following line of reasoning.

If we observe the sky at different intervals during the night, we find that the stars always maintain the same configurations relative to one another, but that their actual positions in the sky relative to the horizon are continually changing. Nevertheless, it is true that certain individual stars have a "proper motion" of their own. Such departures from the general direction of motion of the whole body of stars are extremely small, and require a lapse of centuries to give a measurable result. However, these stars having proper motions are not used as "clock stars," and so therefore do not enter into any of the results. With this exception, the stars appear to describe

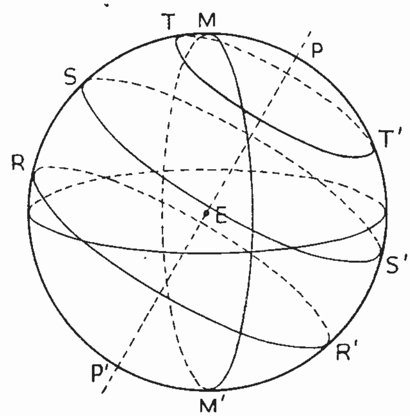


Fig. 1.

on the celestial sphere, circles (RR', SS', TT', Fig. 1), having a common pole (PP') very near to the Pole Star, and the revolutions are performed in the same period of time, namely about 23 hours 56 minutes of our ordinary time.

We may summarise the last paragraph into the following sentence :—

The earth rotates on its axis at a constant rate, and the time elapsing between successive passages of a star across any given meridian MM' is a sidereal day.

This is only one way of reckoning time and it is important to note that although clocks can be regulated to keep sidereal time, the system itself would be very inconvenient for general use. The phenomena of day and night (by which we roughly measure time) would bear no constant relation to the sidereal time system. For example, the time of noon would be 0h. on March 21st; 6h. on June 21st; 12h. on September 23rd; and 18h. on December 22nd, Fig. 2; in other words, the

* Reference should be made to previous articles appearing in this magazine (July 1st, 15th and 29th last) for details of transmission times, wavelengths used, &c.

time of apparent noon would get later by 24 hours in the course of a year. A clock whose rate is uniform cannot however be regulated to keep solar time, which is the time shown by a sundial and is known as apparent time, because the length of the solar day is not quite invariable. In Fig. 2, E is the earth, PP′ the celestial poles, PSP′ a given meridian, RR′ the celestial equator, and ABCD the ecliptic or apparent

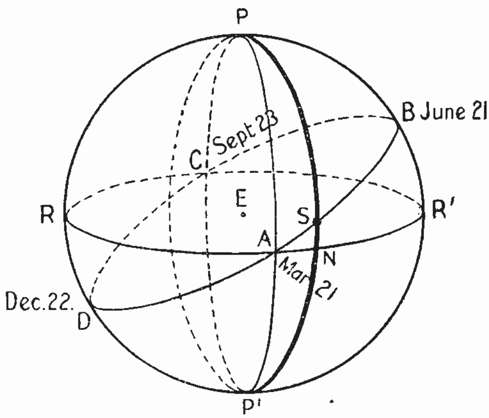


Fig. 2.

annual path traced out by the sun. We notice that the sun's position on the ecliptic is equal to its longitude, right ascension measured along the equator (RAR′C) on only four occasions during the year, namely on March 21st, June 21st, September 23rd and December 22nd. At other times this is not the case. For example, between March 21st and June 21st consider a position S of the sun on the ecliptic. AS is obviously greater than AN, *i.e.*, the sun's longitude is greater than its right ascension, and assuming S to move uniformly along the ecliptic, N will not increase quite uniformly; in other words, the apparent solar day measured along AN will not be constant. There is a further cause in the want of uniformity which is due to the fact that the sun's motion along the ecliptic is not quite uniform. This is expressed in Keplar's second law of motion; the rate of motion being everywhere such that the radius vector (*i.e.*, the line joining the earth to the sun) sweeps out equal areas in equal intervals of time. Hence, the length of the solar day is variable, and a clock cannot be regulated to always mark exactly 0h. 0m. 0s. when the sun crosses the meridian. To obviate these two disadvantages another kind of time, called *Mean Time* has been introduced. This is the time indicated by clocks and used for all ordinary purposes. Mean time is defined by what is termed the "mean" sun, which is simply a point imagined to move round the equator (*not* the ecliptic) in such a way that intervals AN, etc., are of equal length. Greenwich Mean Time (G.M.T.) is reckoned from Greenwich noon, which is the passage of the "mean sun" across the meridian of Greenwich. Astronomical time is at present reckoned from midday, while the civil day, for the sake of convenience, is reckoned from midnight, but commencing on January 1st, 1925, G.M.T. will also be reckoned from midnight instead of midday.

The sidereal day is therefore the period of a complete revolution of the stars about the pole relative to the meridian and horizon. It is an invariable and at the same time easily measurable unit of time free from "fictitious mean suns," but it is inconvenient as a practical standard unit of time. Like the common day, it is divided up into 24 hours, and these are subdivided into 60 minutes of 60 seconds each. The astronomical clock as used in observatories always indicates sidereal time.

(2) The highest degree of accuracy attainable being the prime object of these signals, it is almost axiomatic that the observer desiring to make use of them should himself be in possession of a reliable clock. For example, a timepiece which gains or loses 1 minute a week or roughly 10 seconds a day would alter its error as much as 0·03 seconds during the series of rythmic beats. The "rate" of the chronometer in this case exceeds the accuracy aimed at. The essential problem is to bring together for comparison the transmitted beats and the beats of the local time-keeper. The method by which local time is conveyed to the telephones requires considerable care in order to get a good, clear, controllable "tick." For this purpose a microphone may be placed within the clock chamber, or alternatively direct contact may be established with the pendulum as suggested on page 478 of the issue of July 15th. Some considerable practice will be necessary in counting and recording the beats and coincidences, and it is suggested that a graphical method such as was employed with the ordinary time signals be employed in this case.

(3) The procedure adopted in sending out the signal is :—

(*a*) *Preliminary Tuning Signals.* During the first minute a series of trial signals are sent thus • • • • • • • • • • • • • • • • • • etc.

Then for 50 seconds a series of calls — • — • — — • — • — — • — • —

followed by 10 seconds' silence.

(*b*) *The rhythmic beats* are sent during the next five minutes.

A series of 300 dots are transmitted, the spacing between successive dots being one beat of a clock adjusted so as to beat 50 times in 49 seconds of Greenwich sidereal time = 49/50 sidereal seconds = 44/45 mean time seconds (approximately). In this series of 300 dots, the 60th, 120th, 180th and 240th dots are suppressed in order to establish the indication for counting purposes.

(*c*) *Corrections.*

This series is heard at the Paris Observatory and compared with the standard sidereal clock by the coincidence method. The exact times of the first and last dots are transmitted the same day by FL immediately before the commencement of the ordinary semi-automatic time signals, at 1045 and 2245 (G.M.T.) as follows :—

Two groups of six figures each sent three times in succession and separated by the "break" sign. The hours are not sent in these groups.

Example :—

"Temps sidéral" — • • • — 302653 351971
— • • • — 302653 351971
— • • • — 302653 351971

(4) *Reception of the Rhythmic beats.* This will be made clear by the following example of working :—

From the corrections above—

		h.	m.	s.
Signalled time of last dot	=	10	35	19·71
Signalled time of first dot	=	10	30	26·53
∴Time of whole series	=	0	4	53·18
	=	293·18 sec.		

∴Mean interval between successive dots .. $= \frac{293 \cdot 18}{299}$ sec. $= 0{\cdot}9805$ sec.

		h.	m.	s.
Mean of first three values in Col. 5 = chronometer time of first dot	=	10	38	47·81
Signalled time of first dot	=	10	30	26·53
∴Error by first three coincidences	=		8	21·28

(1) Chronometer time of coincidences (at whole sec.).	(2) Number of dot at which coincidence occurred.	(3) Number of intervals between *first* dot and coincidence.	(4) Column 3 multiplied by 0·9805 sec.	(5) Chronometer time of *first* dot (Col. 1 minus Col. 4).
h. m. s.			s.	h. m. s.
10 39 28	42	41	40·201	10 38 47·799
10 40 18	93	92	90·206	10 38 47·794
10 41 10	146	145	142·173	10 38 47·827
		Number of intervals between *last* dot and coincidence.		Chronometer time of *last* dot (Col. 1 plus Col. 4).
10 42 00	197	103	100·992	10 43 40·992
10 42 50	248	52	50·986	10 43 40·986
10 43 40	299	1	0·981	10 43 40·981

		h.	m.	s.
Mean of last three values in Col. 5 = chronometer time of last dot	=	10	43	40·99
Signalled time of last dot	=	10	35	19·71
∴Error by last three coincidences	=		8	21·28

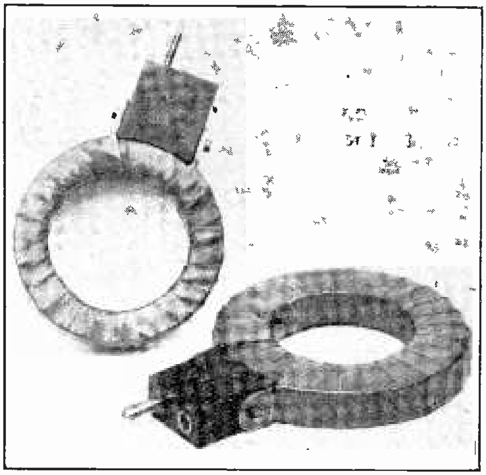
∴Local clock is 8m. 21·28s. *fast* on signalled time.

It will be apparent that by this means very accurate comparisons can be made. As the local clock or chronometer beats half seconds, coincidences between the two series of beats will occur generally at intervals of about 25 seconds apart, so that throughout the whole series 12 coincidences should occur. In practice it has been found better to disregard the half second beats of the local clock and to record every other coincidence, *i.e.*, those occurring at the whole seconds, as was done in the example given above.

The pendula employed in transmitting these signals have been illustrated in the issue of this magazine for July 29th. Although the pendula are kept adjusted so as to gain about 1 second in 50, this rate may vary slightly from day to day. It is therefore essential that the mean interval between the beats should be calculated each time the signals are taken. Again, in order to minimise the error due to the "rate" of the timepiece employed, the most accurate value will be obtained by using the first three coincidences to obtain the mean error at the time of the first dot, and the last three coincidences to obtain it at the time of the last dot and by finally taking the arithmetic mean between these values.

A New Type of Plug-in Coil.

The photograph shows the outward appearance of a new type of coil recently placed on the market. Numbers 1, 2, 3, 4 and 5 are wound pancake fashion with No. 18, 20, 20,

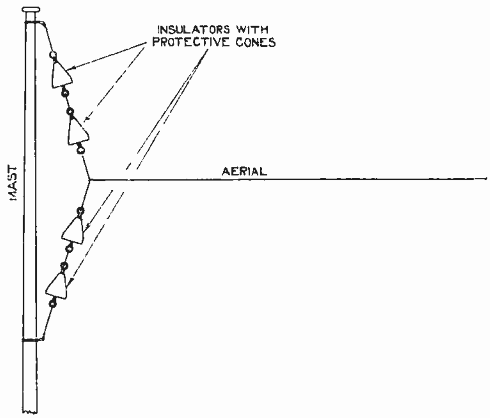


Two specimens of the new type coils made by the Rimar Coil Manufacturing Co.

24 and 24 S.W.G. wires respectively. The pancakes are made up into very solid and substantial coils without waxing or varnishing the wire at all. Numbers 1 to 3 are also supplied wound with 7/36 Litzendraht. The larger coils are cross-wound in such a manner that there are no cellular air spaces. As it has been found the self capacity of a cross-wound coil is to some extent a function of the coil width, these coils are wound about half an inch wide. The coils are fitted with machined ebonite plugs. The self capacity of the coils is low, and they are robust.

Suggestion for Arrangement of Insulators.

The accompanying illustration shows an arrangement suggested by Mr. G. H. Shaw for improving the efficiency of aerial insulators.



By so distributing the insulators, full advantage is taken of the shielding cones to protect the insulators themselves from the effect of rain.

The Theory of Resistance Amplification

By PAUL D. TYERS.

INTRODUCTION.

DURING the past few years the subject of resistance amplification has been dealt with in *The Wireless World*, either from a practical or mathematical aspect. The writer cannot call to mind any simple explanation of the principles involved, and it is assumed, therefore, that a non-mathematical consideration will be of interest to a number of readers. It should be remembered that resistances are utilised in conjunction with valves for a great many purposes other than those of amplification, and hence it is desirable that one should be fully acquainted with the mode of operation.

THE VALVE AS AN AMPLIFIER.

We may best understand the amplifying action of a three-electrode valve by referring to Figs. 1 and 2. Fig. 1 shows a typical curve such as would be obtained by plotting anode current against grid voltage in an ordinary hard valve. In Fig. 2 an oscillatory circuit

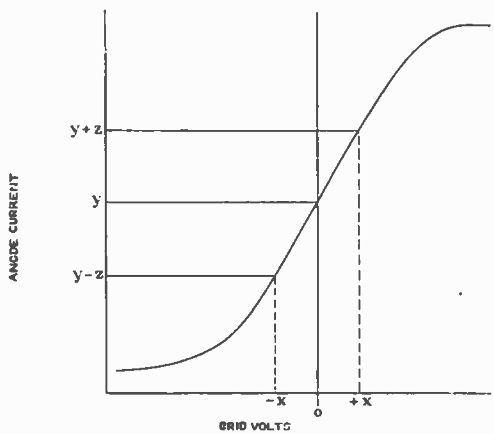


Fig. 1.

is connected across the grid G, and filament F, of a three-electrode valve V, which is supplied by the usual batteries B_1 and B_2. We will assume that the normal current flowing in the anode circuit is represented by y, Fig. 1, and it will be seen that this corresponds to approximately the mid-point of the straight part of the characteristic curve. Now it is desirable that this should be the value of the anode current when the grid voltage is zero. In practice this condition can be obtained by adjusting the potential on the anode, that is, by making the value of the anode battery variable, and also by adjusting the filament temperature.

Let it be assumed that oscillations are set up in the circuit L_1 C_1, such for example as would be the case if the circuit constituted an aerial tuning circuit of a wireless receiver. These oscillations will apply alternating potentials to the grid of the valve, thus rendering

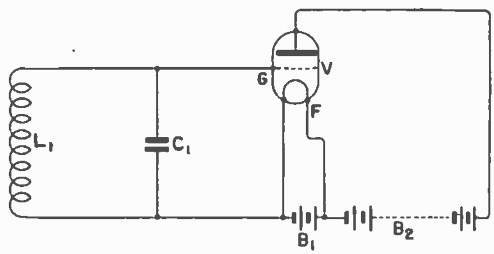


Fig. 2.

it alternatively positive and negative with respect to the filament. If we assume that the potentials are due to an undamped oscillation of symmetrical wave form, and if we neglect the damping of the grid circuit and other disturbing factors, we shall see that the positive potential communicated to the grid will be numerically equal to the negative potential. The actual value of the potential will be dependent on the strength of the oscillation.

By referring to Fig. 1 we can examine the effect of these potentials on the current in the anode circuit of the valve. We have previously assumed that the normal potential of the grid is zero, and that the corresponding anode current is represented by y, Fig. 1. We will suppose that the potentials applied to the grid are $+x$ and $-x$ respectively. We see that a potential of $+x$ on the grid causes the anode current to increase by a value z. Now since we have assumed that the positive potential is numerically equal to the negative potential, and also that the portion of the curve upon which the valve is working is a straight line, the potential $-x$ causes a decrease in the anode current of exactly z. Hence we see that theoretically the variations of the anode current are exactly proportional to the oscillations in the circuit L_1 C_1. It is obvious that these current variations may be made to control the grid potential of a subsequent valve, and moreover the potentials applied will be proportional to the current variations. Since we are now dealing with comparatively large currents, the potentials applied to a subsequent valve in a multi-valve amplifier are considerably greater than those applied to the original valve, and therefore an amplified effect is produced in the anode circuit of the second valve.

In a resistance amplifier, a resistance is inserted in the anode circuit of the first valve and the variations of the anode current produce varying potentials across the resistance, which are then applied to the grid and filament of the second valve. We may best understand this action by regarding the valve in a rather different light.

THE VALVE AS A VARIABLE RESISTANCE.

If we gradually increase the potential of the anode with respect to the filament we find that the anode current gradually increases, and similarly, if we increase the grid potential the anode current increases, as can be inferred from Fig. 1, provided, of course, the point of saturation is not reached. In other words, if the current through the same conductor varies it is equivalent to considering the conductor as a variable resistance. Hence for the purpose of our reasoning we may consider the anode circuit of a valve in a resistance amplifier to be composed of a fixed and a variable resistance, the anode filament path constituting the variable component. The anode resistance constitutes the fixed component, and it is the potentials produced across this which are applied to the next valve. We may best understand the production of these potentials by reference to Fig. 3.

A battery of voltage V is connected across a variable resistance AB in series with a fixed resistance BC. Let us examine the potential across the resistance BC. We will suppose that the resistance AB is equal to the resistance BC. Then the fall of potential V, along the path AC, will be distributed uniformly along AB and BC, and hence the potential across BC will be exactly half of V. Suppose now the resistance AB is lowered, the potential difference will still be V, but the distribution along the path AC will be altered. Since the value of AB has decreased there will be less volt drop along it, but since the total volt drop along the path AC is still V the potential difference across BC will increase. Similarly, if the resistance AB is increased, the potential across BC will be decreased. It can be shown that the greatest potential variations will be produced across BC when the resistance BC equals the resistance AB, and therefore the resistance of an anode resistance should be about equal to that of the valve with which it is used. Fig. 4 is really analogous with Fig. 3,

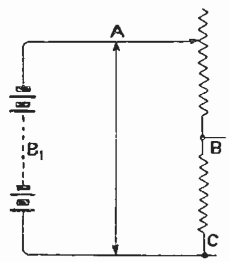


Fig. 3.

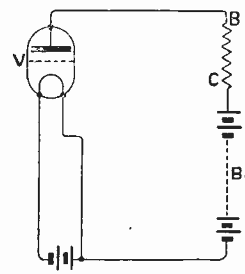


Fig. 4.

the variable resistance being replaced by the anode filament path of the valve, the value of which is varied by applying potentials to the grid.

A THEORETICAL AMPLIFIER.

We will now consider the circuit shown in Fig. 5, in which the potentials produced across the anode resistance BC are applied to a second valve, either for further amplification or rectification. The anode circuit of valve V_1 comprises the battery B_2, the resistance BC and the anode filament path. Normally a steady electronic current flows round this circuit, and in practice there will be a potential drop across BC of something of the order of 30 volts, due, of course, to the steady potential from the battery B_2. If the grid and filament of the valve V_2 were connected directly across the resistance BC, G_2 would be at a potential of about 30 volts, thus rendering V_2 inoperative. In order to prevent this we can insert either an opposing and balancing battery B_4, or if we wish to amplify pulsating or alternating currents we may insert a condenser.

Let us assume that G_1 is made positive by an oscillation in L_1 C_1. This potential will increase the anode current in V_1, or in other words, we can say that the resistance of the valve has decreased, as previously explained. The increased current through the resistance BC will naturally produce a greater potential across it. It might appear at first sight that the potential of G_2 would also become more positive. However, this is not the case, and we will understand this more readily if we regard the direction of the currents from the point of view of the electron theory. The increase of current in the anode circuit is due to an increase in the flow of electrons through the resistance from B to C. This means of course that the point B is now more negative with respect to C. Hence we see that by giving G_1 a positive potential, we give B a negative potential with respect to its former value. Since G_2 is connected to B the potential of G_2 is made negative with respect to its former value. The potentials produced across the resistance BC are very much greater than those due to the original oscillation and hence when they are applied to V_2 the variations in the anode current of this valve are considerably amplified.

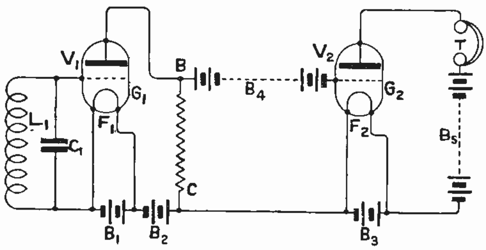


Fig. 5.

It is readily seen that when G_1 is made negative, the resistance of the valve increases, thereby decreasing the potential across BC and giving G_2 a positive potential. It is interesting to note that the current variations in the anode circuits of any two consecutive valves are theoretically in opposite phase relation, assuming of course, that they contain nothing but resistance. The circuit shown in Fig. 5 is really only of theoretical interest, but it serves to illustrate the principles involved. A practical arrangement is shown in Fig. 6, in which common batteries are employed, and the opposing grid battery is replaced by a condenser.

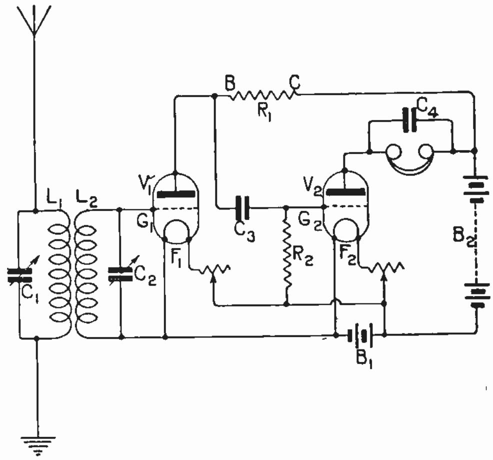


Fig. 6.

It should be remembered that the use of resistances in various circuits for various purposes is almost unlimited. However, in nearly every case the principle involved is fundamentally the same as that described above, and it would seem desirable, therefore, that every reader should be thoroughly acquainted with the subject, and it is hoped that these short notes will have served to remove any difficulties which may have existed.

ELEMENTARY INSTRUCTIONAL LECTURE.

An experimental Lecture dealing with the Principles of Radiotelephony, and primarily intended for Associates of the Radio Society of Great Britain, will be given by G. G. Blake, M.I.E.E., A.Inst.P., at the Institution of Electrical Engineers on January 12th, at 6.30 p.m. Tickets will be sent to Associates. All interested are invited, and tickets can be obtained by sending a stamped and addressed envelope to Mr. Leslie McMichael, Hon. Secretary, The Radio Society of Great Britain, 32, Quex Road, West Hampstead, N.W.6.

Wireless Club Reports

NOTE.—Under this heading the Editor will be pleased to give publication to reports of the meetings of Wireless Clubs and Societies. Such reports should be submitted without covering letter and worded as concisely as possible, the Editor reserving the right to edit and curtail the reports if necessary. **The Editor will be pleased to consider for publication papers read before Societies. An Asterisk denotes affiliation with the Radio Society of Great Britain.**

Correspondence with Clubs should be addressed to the Secretaries direct in every case unless otherwise stated.

Woolwich Radio Society.*

Hon. Secretary, Mr. H. J. South, 42, Greenvale Road, Eltham, S.E.9.

At the monthly meeting held at the Woolwich Polytechnic on December 15th, Captain C. T. Hughes, R.E., read a paper and demonstrated on the "Construction of Aerial Masts." He showed how it was possible to construct a lattice mast, 50 ft. in height, at a total cost of £1 4s. 5d. By means of a model and photographs, he showed how Mr. W. T. James and he had constructed such a mast, with the simplest of tools, in eight hours.

Mr. Dowling acted as Chairman.

This Society meets every Wednesday at the Y.M.C.A., Thomas Street, Woolwich, from 7.30 p.m. to 10 p.m.

The annual general meeting will take place at the Woolwich Polytechnic on Friday, January 26th, 1923, at 8 p.m.

Cheltenham and District Wireless Association*

Hon. Secretary, Mr. E. Cole, A.R.I.B.A., 28, Milton Road, Cheltenham.

The first annual meeting was held at the headquarters, United Services Club, on December 29th, the chair being taken by Councillor Welstead in the absence of the President, Capt. Unwin, R.N.V.C.

The report showed that the Association now numbers 63 members, the average attendance at the weekly meetings being about 40.

Messrs. H. P. Brown, W. G. H. Brown (**5 BK**), A. Moulder, R. Bloodworth and Capt. Jefford were re-elected on the committee, which was enlarged by the addition of Messrs. G. H. Ryland, S. Cox, F. Evans, C. Winters and F. Brunskill. Mr. H. Dean Poulton was re-elected Hon. Treasurer.

The new committee proposes to draw up a programme of lectures and demonstrations for the coming year, including if possible, a dance to radio music.

Bradford Wireless Society.*

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

The annual general meeting took place at headquarters on Friday, December 29th, at 8 p.m., the President, Mr. C. Wood, being in the chair.

The election of officers was proceeded with, Mr. A. Liardet being elected President for 1923, amidst general approval. The other new officers were as follows: Vice-Presidents, Mr. W. C. Ramshaw, Mr. A. Bever, Mr. Andrews; Hon. Secretary, Mr. J. Bever; Organising Secretary, Mr. N. Whiteley; Hon. Treasurer, Mr. E. Brown; Committee, Messrs. A. Barber, W. G. Daniels, N. Hammond, M. Eskdale.

Wolverhampton and District Wireless Society.*

Hon. Secretary, Mr. J. A. H. Devey, 232, Great Brickkiln Street, Wolverhampton.

The annual meeting of the Society was held on December 20th, at which officers and committee were elected for the coming year, Mr. D. P. Baker being in the chair. Minor alterations in the rules were effected, and the financial statement was presented by the Treasurer, Mr. F. G. Redhead. Improvements where necessary were suggested, and an individual expression of opinion was given by most of the members present.

Ilford and District Radio Society.*

Hon. Secretary, Mr. A. E. Gregory, 77, Khedive Road, E.7.

On December 19th, at headquarters, St. Mary's Parish Hall, High Road, Ilford, Mr. Reece, of Messrs. H. D. Butler & Co., lectured on "High Frequency Transformer Amplification." He explained the manufacture and working of various types.

A meeting was held on December 28th, with Mr. E. Nickless, A.M.I.E.E., as Chairman. Mr. E. E. Hall delivered a lecture on "Current Supply for Valves," and raised many interesting points which were fully discussed at question time.

Clapham Park Wireless Society.*

Hon. Secretary, Mr. J. C. Elvy, A.M.I.E.E., 12, Tavistock Street, Strand, W.C.2.

At the sixteenth general meeting of the Society, held on December 13th under the Chairmanship of Mr. A. L. Beadle, it was announced that a gift in shape of a 0·0005 variable condenser was presented by Messrs. R. and R. H. J. McCue, as a further contribution towards the Society's listening-in station. The Chairman appealed to members to assist in completing the set as soon as possible.

The efficiency of the Society's aerial was further discussed at some length, with the result that on the proposal of Mr. C. D. Richardson it was decided to approach the adjoining cinema with a view to securing an aerial support.

Mr. W. Brierley then gave a demonstration and an instructive lecture on the art of soldering and kindred subjects. He dealt with various metals and fluxes, advocating properly "killed" salts. Great stress was laid on the necessity for cleanliness of metals and soldering "bits," together with a good clean flame, preferably a bunsen gas flame. Likening soldering to the gumming of paper, he demonstrated with brass and copper strips, finally soldering the brass to steel strips.

He dealt with aluminium, impressing upon those present that "Aluminoid" and other aluminium solders were to be well rubbed into the aluminium under the oxidised surfaces of each piece with an old file. Aluminium solders consisted principally of zinc, a certain amount of phosphorous providing the flux.

Messrs. J. A. Daniells, C. D. Richardson, J. C. Elvy, A. H. James and R. H. J. McCue dealt with several important points in the course of a vigorous discussion. Objection was taken by some of the members who joined in the discussion to the use of salts, the main contention being that salts, being very slow in drying, were difficult to clean off, and that, especially in the case of small work, there was a risk of serious corrosion taking place.

The Radio Society of Highgate.*

Hon. Secretary, Mr. J. F. Stanley, B.Sc., A.C.G.I., 49, Cholmeley Park, Highgate, N.6.

On December 9th Mr. G. A. V. Sowter, B.Sc., gave a lecture on "Carrier Wave Telephony," this being a more correct term for what is often called "Wired Wireless." It was shown how ordinary telephony and telegraphy could be carried on simultaneously over the same wire, but if more than one telephony conversation is required, carrier waves must be used. The theory of this system was carefully explained, and diagrams of the circuits used were given. The practical difficulties, which limit the number of simultaneous conversations to about five or six for any given line, were explained, and in the course of a discussion after the lecture some experimental work in this direction by two or three members of the Society was brought to light.

An auction sale is being arranged to take place at the 1919 Club, Highgate, on Friday, January 19th, and it is hoped that members will send in all their old "junk." The Club set is being dismantled and rebuilt, and spare parts will be put up for sale.

Derby Wireless Club.*

Hon. Secretary, Mr. R. Osborne, "The Limes," Chellaston, Derby.

The annual general meeting of the Club was held on December 28th at 35, St. Mary's Gate.

In view of the increase in membership it was decided to form a junior and senior section, an arrangement which will be a distinct advantage to beginners. Facilities will also be given to those who wish to construct and test their own apparatus at the club headquarters, and for this purpose a Drummond lathe has been lent by one of the members. A Technical Committee was also formed to deal with difficulties experienced by members. The committee will, from time to time, carry out experiments with their own apparatus, and it is hoped that the data thus collected will be very useful to both beginners and the more experienced.

After a lengthy search the Committee have succeeded in obtaining a room in a central position, which will be used for all formal meetings. The present club-room at "The Court," Alvaston, will still be available for informal meetings and experimental work.

The following officers were elected for the coming year:—President, Mr. F. W. Shurlock, B.A.; Vice-Presidents, Messrs. T. P. Wilmshurst, M.I.E.E., S. G. Taylor and J. J. Spencer. Chairman, Mr. A. T. Lee; Hon. Press Secretary and Librarian, Mr. F. Harrison; Committee, Messrs. E. F. Clark, B.Sc., M.A., A.M.I.E.E.; E. V. R. Martin; J. Lowe; S. J. R. Allwood; F. J. Cowlishaw; F. J. Allen. Technical Committee: Messrs. F. J. Allen; E. V. R. Martin; E. F. Clark, B.Sc., M.A., A.M.I.E.E.; R. F. Jolley.

Tottenham Wireless Society.*

Hon. Secretary, Mr. R. A. Barker, 22, Broadwater Road, Bruce Grove, N.17.

At a special general meeting held at Bruce Grove Schools on December 13th, the Provisional Committee and officers resigned, and offered themselves for re-election, permanent officers being then elected for the year 1922-23. Mr. Barratt acted as Chairman for the evening. As a result of the voting, the following officers were elected:—Chairman, Mr. F. Bourne; Hon. Secretary, Mr. R. A. Barker; Hon. Treasurer, Mr. Baker; Committee, Messrs. Winter, Kaine-Fish, Bower and Honeybone.

It was decided that the Society should make its permanent headquarters at the Institute, 10, Bruce Grove, where a permanent aerial for the Society set could be erected. It was arranged that the Morse buzzer practice class should be held from 7.30 p.m. to 8 p.m., and that certificates for speed should be granted by the Society.

A very successful dance was held at the Municipal Hall on Friday, December 15th, when Mr. Capon very kindly lent his apparatus so that the company present could enjoy wireless music during the intervals. There was also a fine show of wireless instruments by Messrs. G. L. Wilson & Co., Ltd., of Tottenham.

The Society is now growing into an important one, and it is hoped that all prospective members will join as soon as possible, and take advantage of the next series of lectures.

Sheffield and District Wireless Society.*

Hon. Secretary, Mr. L. H. Crowther, A.M.I.E.E., 62, Bromwich Road, Sheffield.

The rapidly growing interest in wireless progress in Sheffield was amply demonstrated on New Year's Eve, when, at the invitation of Mr. F. Lloyd, President of the Sheffield and District Wireless Society (assisted by Mr. H. Lloyd), a number of prominent people united in making the wireless transmission of New Year messages an unqualified success. The transmission took place from Mr. Lloyd's experimental station (2 UM), Ventnor Place, Nether Edge, messages being sent by the Bishop of Sheffield (Dr. Hedley Burrows), the Rev. G. H. McNeal (Superintendent of the Sheffield Wesleyan Mission), Mr. Arthur Neal (ex-Parliamentary Secretary of the Ministry of Transport), Alderman A. Cattell (an ex-Lord Mayor), and Mr. Cecil Wilson (one of Sheffield's Labour M.P.'s.). Dr. Burrows, Mr. Lloyd announced, was believed to be the first English Bishop who had wished the citizens of any prominent city a happy New Year by wireless.

The Bishop, who confessed he had never before addressed an unseen audience, said he was impressed by the wonderful possibilities of the new discovery in spreading knowledge of all kinds.

Mr. H. L. Cooper (Editor of the *Yorkshire Telegraph and Star*), in proposing a vote of thanks to Mr. Lloyd, advised the members of the Society not to get rid of a President who had interested the Church and the State in Sheffield in wireless, and had even converted the local press.

Mr. Lloyd announced the receipt of telephone messages from the Lord Mayor (Alderman W. C. Fenton) and Col. Charles Clifford, asking him to express on their behalf greetings to the citizens of Sheffield.

The Fulham and Putney Radio Society.*

Hon. Secretary, Mr. J. Wright Dewhurst, 52, North End Road, West Kensington, London, W.14.

At a crowded meeting held at headquarters on December 22nd, a large and interesting collection of wireless apparatus and parts made by the members was on view. These exhibits were to compete for prizes offered by B. C. Calver, Esq., and Bruce Houstoun, Esq., the first prize being a pair of Brown's 8,000 ohms telephones, the second a single valve panel. The exhibits covered a wide range of apparatus from coil holders to seven-valve sets.

The first prize went to Mr. Wooding for his very fine seven-valve unit set. Mr. Wooding gave a demonstration, and explained the various types of coils and transformers with which he had experimented. The second prize went to Mr. J. W. Dewhurst, who exhibited a fine example of short wave tuner with low frequency amplification. The design followed the latest American practice, and the workmanship was excellent.

At a meeting held on Friday, December 29th, details were discussed for the Society's Public Exhibition and Demonstration of Wireless Apparatus, to be held at the Fulham Town Hall.

Lowestoft and District Wireless Society.

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

The Society's report of the work done during the last quarter is an interesting record of activity.

On October 10th a competition was held under the direction of Mr. H. Trent. The members were given components for the assembling of a single valve and a two-circuit crystal set, the winners being two associates of the Society.

On October 24th Mr. R. Giles lectured on "Land Line Telephony."

On November 7th Mr. H. C. Trent gave a lecture and demonstration on his telephony transmitter, communication being established with **2 MD.**

On November 21st Messrs. C. Garrood and L. Burcham gave a demonstration and lecture on "The Armstrong Regenerative Circuit."

On December 5th another competition was held, the items including (1) Soldering simple joints; (2) Reproduction of a two-valve L.F. receiver diagram; (3) Finding faults on a single valve panel. The prizes were awarded to associate members.

On December 19th Mr. C. Chipperfield gave a lecture from his station **2 MD**, and afterwards provided some music.

Warrington Radio Association.

Hon. Secretary, Mr. J. Barton, 266, Lovely Lane.

A meeting was held on December 28th at 7.30 p.m. in the Y.M.C.A., Market Gate, with the kind permission of Mr. Featherstone, the Secretary. Mr. F. V. L. Mathias was in the chair. The business of the Association having been dealt with, Mr. Nadin discussed the merits of H.F. and L.F. amplification, and answered a large number of questions regarding wireless generally. Subsequently the question of permanent quarters for the Association was inquired into, and there are strong reasons to believe that an arrangement with the local Y.M.C.A. is probable. The meeting terminated with the feeling that the future of the Association was distinctly rosy.

The Stratford-on-Avon and District Radio Society.

Hon. Secretary, Mr. Knight, Park Road. Stratford-on-Avon.

The eighth general meeting of this Society was held on Monday, January 1st, with Mr. Tompkins in the chair. After minutes had been passed, the question of building a Club unit set was discussed, and the Secretary was authorised to purchase the necessary material. As a result of several enquiries it was decided to admit lady members to the Society. The President, Captain West, R.N., has been successful in obtaining an experimental permit for the Society. Mr. F. A. Sleath has kindly consented to become a Vice-President, and has presented the Society with the first unit of the apparatus, in the form of a detector panel. The first annual general meeting is to be held on January 29th, 1923.

Radio Society of Birkenhead.

Hon. Secretary, Mr. R. Watson, 35. Fairview Road, Oxton, Birkenhead.

On December 21st a meeting was held at headquarters, 36, Hamilton Square, Mr. H. I. Hughes (Technical Adviser) taking the chair.

Mr. Hill lectured on "H.F. Currents and their Application to Radio," illustrated by lantern slides kindly lent by Professor Marchant.

The chief object of Mr. Hill's lecture was to show the various ways in which oscillations could be set up in circuits, for the purposes of transmission.

A demonstration of telephony reception from Manchester and Birmingham broadcasting stations was given by Mr. Reade on his Marconi unit set.

Buzzer practice was held from 7.15 to 8 p.m.

Mount Pleasant Radio Society.

Hon. Secretary, Mr. W. R. Fleming, 156, Upton Park Road, Forest Gate, E.7.

At a meeting of the Society on December 1st, Messrs. W. D. Keiller and W. A. J. Smith explained and illustrated the working of a five-valve receiving set kindly lent by them for the occasion. There was another meeting on December 7th, when Mr. F. E. Wright gave a detailed lecture on "The Thermionic Valve," which was greatly appreciated.

On December 15th several small wireless parts were on exhibition, including a crystal receiving set and Mr. W. D. Keiller gave a lecture on condensers, explaining the method of calculating capacity.

Isle of Man Radio Society.

Hon. Secretaries, Mr. J. P. Johnson, 16, Hildesley Road, and Mr. J. S. Craine, 6, Belmont Terrace, Douglas.

At a meeting held on December 19th, after considerable discussion, the constitution of the Society was established. The following additional officers were appointed :—President, Mr. F. R. Grundey, B.Sc., F.C.S., Director of Education (I.O.M.); Joint Secretary, Mr. J. S. Craine; Treasurer, Mr. A. Gore; Committeeman, Mr. R. Cannell. An excellent syllabus has been arranged by the Committee who have entered upon their work with great enthusiasm.

Bournemouth Radio and Electrical Society.

Hon. Secretary, Mr. L. O. Sparks, "Maranoa," 3, Cotlands Road, Bournemouth.

The above Society has now been formed, and all those interested in wireless and electrical matters are invited to communicate with the Secretary.

Darwen Wireless Society.*

Hon. Secretary, Mr. T. H. Mather, 8, Hawkshaw Avenue, Darwen.

At the December meeting several new members were enrolled, with the result that the membership now exceeds 50. Rooms have been secured in the centre of the town and will shortly be ready for occupation as the headquarters of the Society.

Several prominent local gentlemen have rendered very active assistance to the Society, and it is hoped to commence a series of lectures for the less experienced members within the next few weeks. Many promises of apparatus have been made towards the receiving set now being installed, including a 4-valve panel and loud speaker.

New members will be welcomed and every assistance given them at the Society's rooms or on application to the Hon. Secretary.

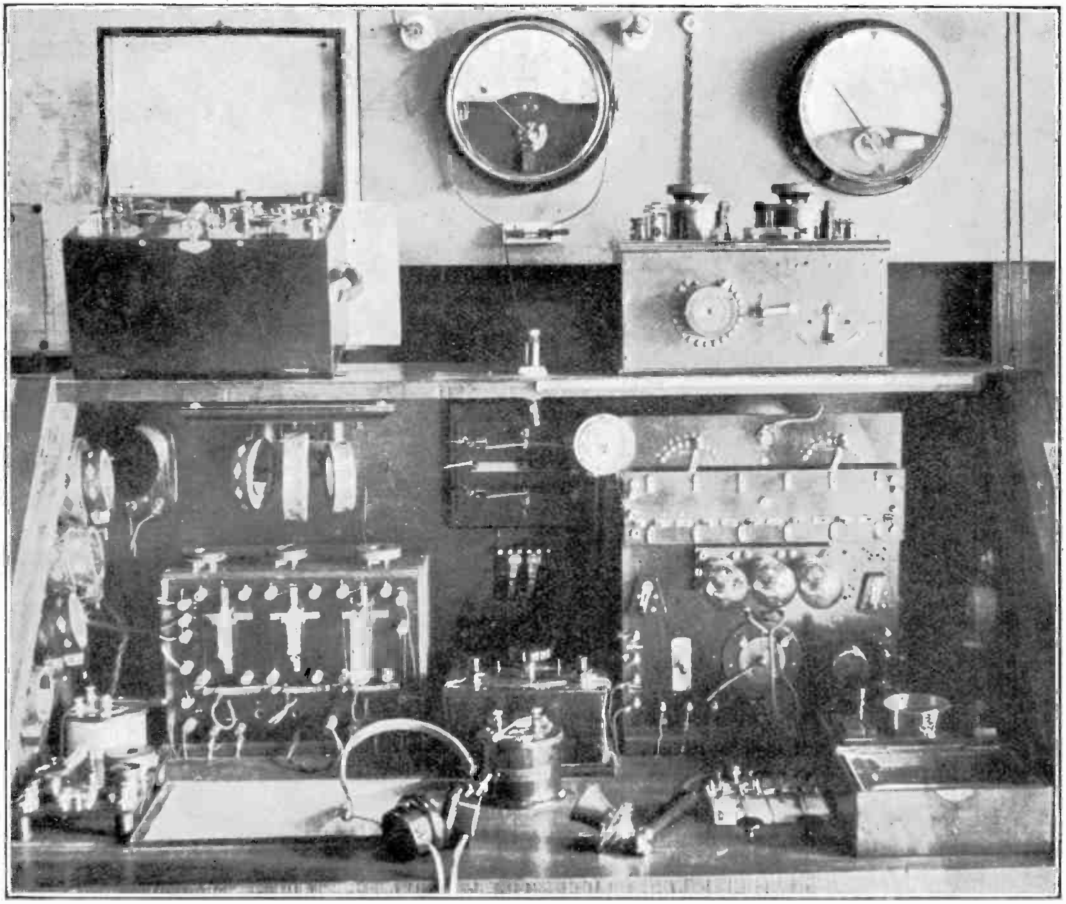
Felixstowe and District Radio Society.

The Society is still progressing, and more members have recently been enrolled. Instructive lectures by Messrs. Carter, Douthwaite and the Secretary have been given and greatly appreciated by the members.

A Club single-valve set has been made, and only awaits receipt of an experimental licence from the P.M.G. to be brought into use.

Abuse of reaction in the locality is a source of great annoyance, and the Society invites those responsible for the trouble to come along to the club-room and get a few hints on this subject from its technical members. The Society holds its meetings on Fridays from 7 to 10 p.m., at St. Andrew's Church Hall, Gainsboro' Road Felixstowe.

AN AUSTRALIAN EXPERIMENTAL STATION.



The station of Mr. C. Maclurcan at Sydney, N.S.W. Successful communication tests employing C.W. and Tonic Train have been carried out with S.S. "Montoro" at distances of 420 and 705 miles on power estimated as only 8·7 watts.

Notes

The Physical Society of London and the Optical Society. Annual Exhibition.

The thirteenth annual exhibition was held on Wednesday and Thursday, January 3rd and 4th, at the Imperial College of Science, South Kensington. Amongst the exhibits shown were several of wireless and allied interest. A description of some of these exhibits will appear in our next issue.

A Resignation.

The Managing Director of the Marconi Company of Canada, Mr. Arthur Hyatt Morse, has resigned from that office. He was formerly European Superintendent.

Misuse of Call Sign.

An amateur in Liverpool reports that his call sign **5 GB** is being used by another transmitter for spark transmissions, and it is hoped that by means of the publication of the fact the practice may cease.

Ringing in the New Year by Wireless at **2 LO.** *Mr. Burrows (left), Mr. K. Ellis (right).*

New Wireless School.

At Rotherham a school for the study of wireless telegraphy and telephony is about to be opened. Mr. J. Willey, President of the Rotherham Radio Society, will be in charge.

Proposed Society for Keswick.

It is proposed to form a Wireless Society in Keswick and district, and Mr. H. Rhodes, of Ratcliffe Place, Keswick, will be glad to answer enquiries.

A Wireless Year Book for the Amateur.

Our publishers announce that this year, in addition to the well-known "Year Book of Wireless Telegraphy and Telephony," they are publishing for 1923 an amateur edition' particulars of which will be announced shortly. It is promised that this book will contain all the information which the amateur most needs at a very reasonable price. Amongst special features will be included a very up-to-date list of experimental transmitting stations.

Wireless at Merchant Venturers College.

Mr. W. A. Andrews, B.Sc., A.I.C., of the Institute of Radio Engineers, is to conduct a course of ten lectures at the Merchant Venturers Technical College, on "The Elementary Principles of Wireless Telephony." These lectures are given on Wednesday evenings, and commenced on January 10th. Mr. Andrews was head of the Cardiff Technical College, Department of Wireless Telegraphy.

Prize for Transatlantic Reception.

The Wireless World and Radio Review has received a communication from Messrs. Burndept, Ltd., to the effect that they are offering a prize of £10 to the first English amateur who is successful in the reception of the American Station, **WDAP**, of the Mid-West Radio Central Inc. This station now operates with 1 k.W. in the antenna and this will shortly be increased to 2½ k.W. The wavelength is 360 metres. For those who enter this competition the only stipulation made with regard to apparatus used is that not more than three stages of high frequency amplification shall be employed. The times of transmissions from **WDAP** are—

Tuesday and Thursday evenings, 10 p.m. to 1 a.m.
Saturdays, 10 p.m. to 2 a.m.
Sundays, 8.30 p.m. to 10.30 p.m.

It must of course be borne in mind that these times refer to the times of transmission in America, and must be corrected for times of reception in England.

A Change of Address.

Messrs. Leslie McMichael Ltd., have recently taken new offices and showrooms. Their showrooms are now at 179, Strand, W.C.2 (at the corner of Norfolk Street), and the Head Offices at Hastings House, Norfolk Street, W.C.2.

A New Magazine.

Under the title "Modern Wireless" there appears in the advertisment columns of this Journal the announcement of the first number of a new monthly wireless magazine to be published on January 15th by the Radio Press, Ltd. The editor is Mr. John Scott-Taggart, F.Inst.P., who has formerly contributed to *The Wireless World and Radio Review*, and is the author of publications particularly relating to the thermionic valve. In this connection he was at one time in charge of valve design at the Ediswan Lamp Works. He is in charge of the Patent Department of the Radio Communication Company, Ltd., and acts as patent adviser to C F. Elwell, Ltd., and the Mullard Radio Valve Company, Ltd.

Reception of Ongar (GLO) in Java.

The chief of the Radio Department, Bandoeng, Java, reports that having seen a description of the Marconi High Speed European Services in *The Wireless World and Radio Review* he listened in on the stated wavelength of 4,350 metres at 9 o'clock Central Java time, or 1340 G.M.T. In the latter part of the night the signals were quite strong on an aerial of only 45 ft. length and 15 ft. above ground with a two-valve set.

It is stated that the signals are audible almost every night, the distance being approximately 7,500 miles.

Death of a Pioneer of Wireless.

Sir John Gavey, who was for several years consulting engineer to the Post Office, and who was closely concerned with the installation of the first wireless telephone in this country, died on January 1st at the age of 80 years.

Christmas Eve Reception of American Stations.

The reception of broadcasting from American stations on Christmas Eve by Captain H. J. Round, of the Marconi Company, is of particular interest in view of the conditions under which the result was obtained. The aerial employed was a frame 2 ft. square. The rest of the apparatus consisted of a six-valve amplifier and double note amplifier, with Amplion loud speaker. At Captain Round's house at Muswell Hill, a pianoforte solo broadcasted from **WGY** (Schenectady, U.S.) was heard loudly through the loud speaker. Christmas carols were also received from America, and other speech which was of exceptional quality.

American Stations Received on December 21st.

Mr. J. H. D. Ridley, of Burndept, Limited, recorded on a Dictograph on the morning of December 21st the following American stations:— **1 CMK**, **WDAF** (Kansas City) and **WDAM** (New York City, Western Electric Co.).

Calendar of Current Events

Friday, January 12th.

SHEFFIELD AND DISTRICT WIRELESS SOCIETY.
At 7.30 p.m. Elementary Class.

LEEDS AND DISTRICT AMATEUR WIRELESS SOCIETY.
Lecture on "Some Apparatus used in Telegraphy," by Mr. R. E. Timms (Hon. Treasurer).

BELVEDERE AND DISTRICT RADIO AND SCIENTIFIC SOCIETY.
Lecture on "Construction of H.F. Amplifier," by Mr. S. Burman.

Saturday, January 13th.

LAMBETH FIELD CLUB AND MORLEY COLLEGE SCIENTIFIC SOCIETY.
At 7.30 p.m. Practical night.

Sunday, January 14th.

At 3.5 p.m. *Daily Mail* Concert from **PCGG**, The Hague, on 1,050 metres.

Monday, January 15th.

ILKLEY AND DISTRICT WIRELESS SOCIETY.
At the Regent Café, Ilkley. At 7.30 p.m. General Meeting and Lecture by Mr. J. Croisdale on "The Armstrong Super-Regenerative Receiver."

MANCHESTER WIRELESS SOCIETY.
Lecture by Mr. A. G. Gregory on "Arc Transmission."

IPSWICH AND DISTRICT WIRELESS SOCIETY.
At 55, Fonnereau Road. At 8 p.m.
9.20–10.20 p.m. Dutch Concert **PCGG**, The Hague, 1.050 metres.

Tuesday, January 16th.

LOWESTOFT AND DISTRICT WIRELESS SOCIETY.
At St. Margaret's Institute, Alexandra Road, Lowestoft. Public Demonstration and reception of broadcast music.

PLYMOUTH WIRELESS AND SCIENTIFIC SOCIETY.
Meeting.
Transmission of Telephony at 8 p.m. on 400 metres, by **2 MT**, Writtle.

Wednesday, January 17th.

MALVERN WIRELESS SOCIETY.
Lecture: "Reaction and Heterodyne."

HALIFAX WIRELESS CLUB.
Elementary Instruction Evening.

EDINBURGH AND DISTRICT RADIO SOCIETY.
At the R.S.S.A. Lecture by Professor R. Wood on "Photography of Sound Vibrations," and Mr. C. N. Kemp, B.Sc., on "Properties of Selenium and Applications."

Thursday, January 18th.

STOKE-ON-TRENT WIRELESS AND EXPERIMENTAL SOCIETY.
At 7.30 p.m. Lecture by Mr. L. F. Fogarty, on "Rectifiers."

ILFORD AND DISTRICT RADIO SOCIETY.
Informal meeting.
At 9.20–10.20 p.m. Dutch Concert from **PCGG**, The Hague, on 1,050 metres.

Friday, January 19th.

THE RADIO SOCIETY OF HIGHGATE.
At the 1919 Club, South Grove, Highgate. At 7.45 p.m. Sale of apparatus.

LEEDS AND DISTRICT AMATEUR WIRELESS SOCIETY.
Lecture by Mr. H. F. Yardley,

SHEFFIELD AND DISTRICT WIRELESS SOCIETY.
At the Department of Applied Science, St. Georges Square. At 7.30 p.m. Mr. Brookes on "Practical Construction of Wireless Apparatus."

Saturday, January 20th.

LAMBETH FIELD CLUB AND MORLEY COLLEGE SCIENTIFIC SOCIETY.
At 7.30 p.m. Lecture by Mr. J. J. Denton, A.M.I.E.E., on "Epochs in the Development of Wireless."

BROADCASTING STATIONS.

Regular evening programmes, details of which appear in the daily press, are now conducted from the following stations of the British Broadcasting Company :—

London	2 LO	369 metres.
Birmingham	5 IT	420 ,,
Manchester	2 ZY	385 ,,
Newcastle	5 NO	400 ,,

To the Editor of THE WIRELESS WORLD AND RADIO REVIEW.

SIR,—I read with interest the article by Mr. E. H. Robinson on Chemical Rectifiers for plate voltage supply, in the current issue of *The Wireless World and Radio Review*. Having made a considerable number of experiments on similar lines I am convinced that it will ultimately be possible to operate a receiving set entirely from alternating current, using some form of rectifier.

The purpose of the present communication is to draw your attention to one or two improvements which can easily be added, and which are doubtlessly already known to your contributor. In the first place, by winding the transformer for a sufficiently high secondary voltage, and providing a middle point tap, it is possible to reduce by half the number of cells shown in his diagram Fig. 4. The transformer will cost a little more, but confers the advantage of reducing the number of cells which have to be renewed from time to time.

My own experience with ammonium phosphate has not been satisfactory, and I should be interested to know whether Mr. Robinson has any oscillograph curves taken on rectifiers using this solution. In any case this particular salt is very corrosive to brass fittings, such as are suggested in (*b*) Fig. 5. I recognise that the presence of a layer of paraffin oil will to a large extent restrict the evolution of corrosive fumes, but on the other hand this layer of paraffin can only be used on rectifiers run at extremely light loads, for any tendency towards heating up will bring in its train a chemical action between the solution and the paraffin which will destroy the rectifying properties of the former. For this reason I prefer to cover the aluminium electrode with an ebonite or rubber tube at the point where it enters the solution. Small rubber tubing similar to that used for bicycle valves is readily obtainable, and in my opinion is more convenient than the paraffin layer.

Dene Cottage, L. F. FOGARTY.
Ruislip, Middlesex.

Questions and Answers

NOTE.—This section of the magazine is placed at the disposal of all readers who wish to receive advice and information on matters pertaining to both the technical and non-technical sides of wireless work. Readers should comply with the following rules :—(1) Each question should be numbered and written on a separate sheet on one side of the paper, and addressed "Questions and Answers," Editor, THE WIRELESS WORLD AND RADIO REVIEW, *12/13, Henrietta Street, London, W.C.2. Queries should be clear and concise. (2) Before sending in their questions readers are advised to sea½ch recent numbers to see whether the same queries have not been dealt with before. (3) Each communication sent in to be accompanied by the "Questions and Answers" coupon to be found in the advertisement columns of the issue current at the time of forwarding the questions. (4) The name and address of the querist, which is for reference and not for publication, to appear at the top of every sheet or sheets, and unless typewritten, this should be in block capitals. Queries will be answered under the initials and town of the correspondent, or, if so desired, under a "nom de plume." (5) In view of the fact that a large proportion of the circuits and apparatus described in these answers are covered by patents, readers are advised before making use of them, to satisfy themselves that they would not be infringing patents.* (6) **Where a reply through the post is required every question sent in must be accompanied by a postal order for the amount of 1s., or 3s. 6d. for a maximum of four questions.** (7) *Four questions is the maximum which may be sent in at one time.*

"**T.W.H.**" **(Cockermouth)** *submits a diagram and asks* (1) *Whether it is suitable.* (2) *How a series-parallel switch is connected.*

(1) The proposed wiring diagram is suitable, but there is no need to use two H.T. batteries. We have redrawn the circuit showing one H.T. battery. (See Fig. 1.) This also indicates how switching may be carried out. The switching controls the filament supply to the valves, as well as throwing over the grid connection. The Post Office regulations state that reaction should not be used for the broadcasting wavelengths while broadcasting is in progress, and the Post Office rely upon you to see that this regulation is adhered to. If you hold an experimenter's licence, the circuit is quite suitable, but care must be taken that reaction does not set up oscillations in the aerial circuit. To make sure of this you should couple the reaction coil with the anode coil of the first valve, in which case it is not possible to set up oscillations in the aerial circuit. (2) The figure shows how a series parallel switch may be connected to a tuner. Should you find any difficulty in manipulating the set, perhaps a stand-by and tune switch would be useful, and we have indicated the connections.

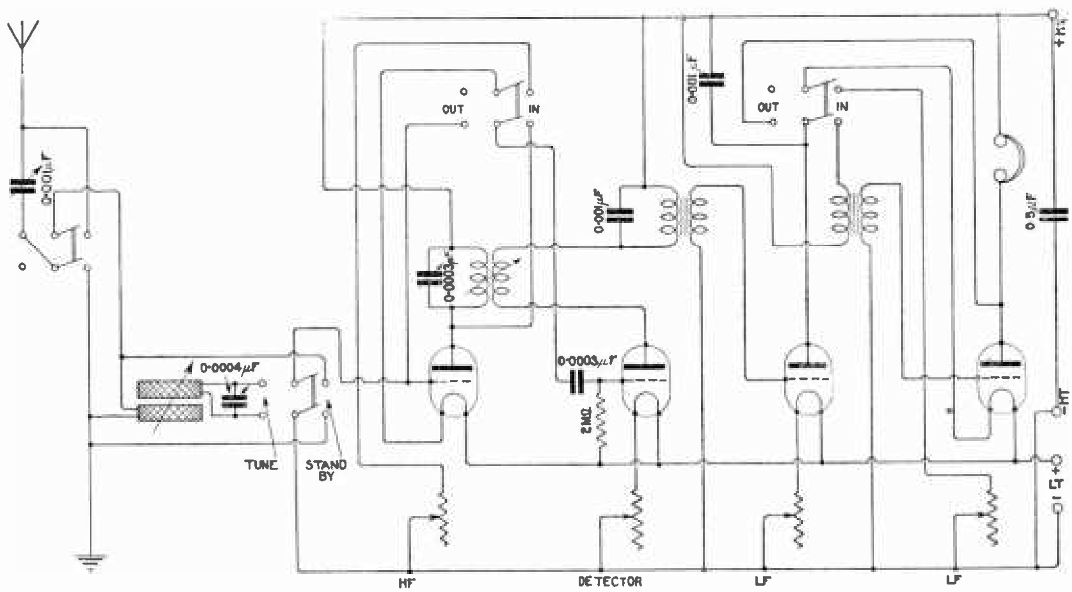


Fig. 1.

"**W.H.L.**" **(Larne)** *submits a diagram and asks whether it will function as a combined autodyne detector and amplifier.*

The circuit is very unusual, and we do not think it would successfully perform the above functions. Why not try a standard arrangement of apparatus that you know will work well, and then experiment with other circuits.

"W.T." (N.7).—The coil in the anode circuit of the high frequency valve could be 3" diameter and 4" long, wound with No. 36 S.S.C. wire, and eight tappings could be taken, but it would be better if you constructed several coils and connected them in the anode circuit as required, otherwise you may experience trouble due to dead end effects, and almost certainly not secure the maximum amplification possible. This anode coil should be tuned with a condenser of 0·0002 mfds. maximum value when on short wavelengths—say up to 1,000 metres. On higher wavelengths, the maximum value of the condenser may be 0·0005 mfds. without seriously decreasing the efficiency of the arrangement. We do not think you would find a ball form of reaction coil suitable for use with the coil above mentioned, and we suggest you wind a tube 2" diameter and 4" long full of No. 36 S.S.C. wire with eight tappings for the coupling coil. The terminals marked 2 × 1 in the diagram to which you refer are for the purpose of adding extra inductance in the reaction coil circuit, in order to roughly tune that circuit, and you can make provision for the same purpose for use on the longer wavelengths. This arrangement involves the use of a large and cumbersome sliding reaction coil, and we suggest you connect the high frequency amplifier with reactance to the primary of the M.T.1. Although a variometer can be used for tuning the anode circuits of the H.F. valve, we consider it is more convenient in this case to use a tapped coil with the variable tuning condenser.

"E.C." (Doncaster).—The elimination of interference due to inductive disturbances is a difficult matter. We suggest you employ a frame aerial, with H.F. connected valves, and 1 detector valve. If you would care to communicate with us again on the subject, stating which transmissions you wish to receive, and if you are prepared to make the above alteration, we shall be pleased to furnish a diagram of connections. However, the arrangement indicated in Fig. 2 will meet your requirements. The values are marked in, and you will notice the positions of the grid leaks.

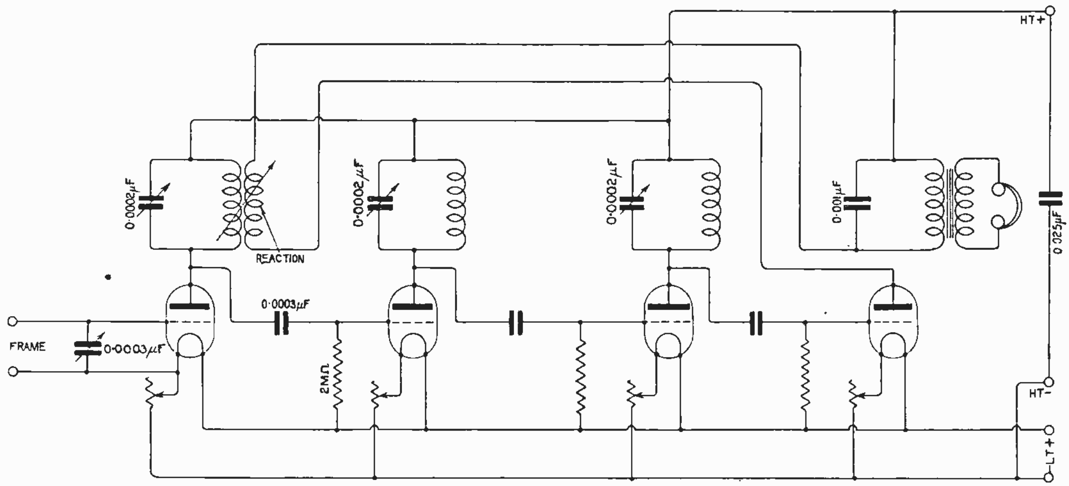


Fig. 2.

"V.J.T." (Woodside) *asks whether the short wave receiver described in the issue of June 3rd may be adapted for use with a crystal detector.*

The tuner referred to is quite suitable for use with a crystal detector. See Fig. 3. Tuning condensers will not now be required, as tuning may be effected with the variometer and fine tapping switch.

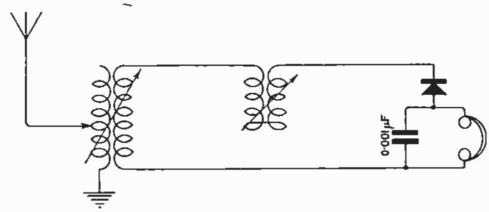


Fig. 3.

"A.K." (Sussex).—We do not think you will be able to satisfactorily use the alternating current supply in connection with the receiving set. The transformer will be expensive, and rectifying apparatus and a smoothing system would be necessary if reception is to be free from hum. We think the best plan would be for you to use an accumulator for heating the filament battery. If you cared, you could of course charge the accumulator yourself by means of any of the rectifiers now upon the market.

"T.S." (Bucks.) *asks for criticism of his set.*

The arrangements suggested are very practical, and quite suitable for the purpose which you intend to use them for. We suggest you use a series or parallel switch in the aerial circuit for joining the aerial condenser and aerial tuning inductance in series or parallel for short and long wavelengths respectively. The suggested alterations shown in sketch 2 are quite suitable, but the high tension voltage should normally exceed 30 volts. It is usual to use about 60 volts when 6 volts is applied to the filament circuit for use on the valves through a filament resistance.

"CONTACT" (London, E.18) *asks* (1) *For a diagram of a six-valve set comprising 3 H.F., 1 detector, and 2 L.F. valves, with provision for plug-in transformers and resistance capacity coupling.* (2) *Whether a potentiometer is useful.* (3) *Whether a three-coil holder could be used alternatively with a two-coil tuner.* (4) *Whether it is better to gradually increase the H.T. volts instead of applying the full voltage suddenly to the apparatus.*

(1) and (2) See Fig. 4. The potentiometer is used to control the grid potential of the H.F. valves and is very useful. (3) The three-coil holder and the two-coil tuner can be used as required. It is doubtful however whether much benefit will be derived through this additional complication. (4) It would be better to do so if it could be arranged.

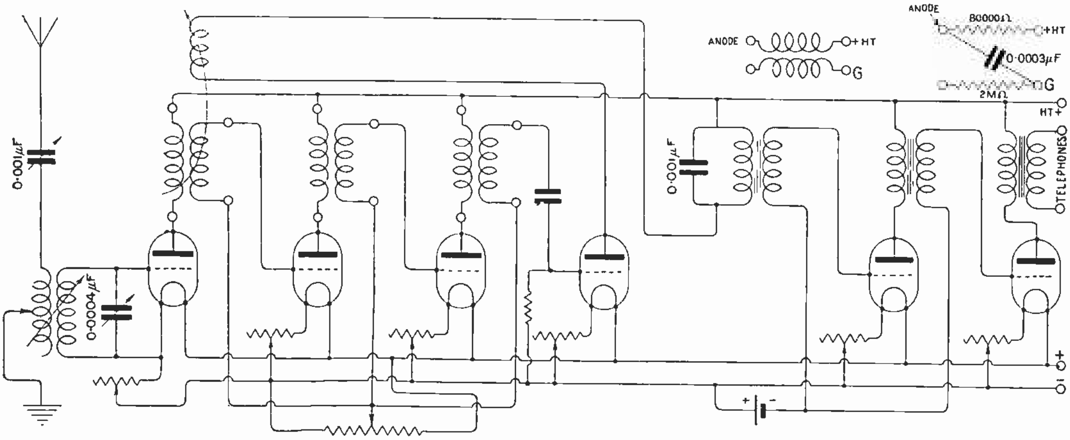


Fig. 4.

"E.S." (London, S.W.4) *asks* (1) *Whether diagram submitted is correct.* (2) *What is meant by "stand-by" and "tune switch."*

(1) The arrangement is not quite correct. The correct connections were given in a recent issue in reply to a correspondent. (2) A stand-by and tune switch is a double-pole throw over switch used to connect the aerial or the closed circuit to the grid and filament of the first valve. See Fig. 5.

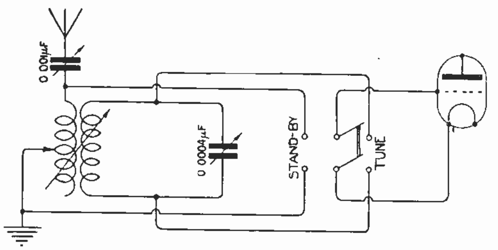


Fig. 5.

"E.C." (Penistone).—The diagram submitted is quite correct, with the exception that the reaction coil should be coupled with the tuned anode coil. The method is simply to wind the reaction coil on a suitable former and fix it so that its coupling with the anode coil may be varied. A two-coil holder is sometimes used for the purpose, and sometimes a sliding coil is used. It is not good practice to join the condenser and inductance in parallel when receiving on short wavelengths. Should trouble due to interference be experienced at any time, it will be necessary to use a secondary circuit coupled to the aerial circuit. This is done by many users.

"J.W." (Glasgow).—The reaction coil which is coupled with the high frequency transformer or tuned anode may have a fixed value consisting of about 100 turns of No. 38 S.S.C. wire, in a former with a mean diameter of 2″. This winding does not need to be tuned, but it may be necessary when long wavelengths are being received to add a little more inductance in this circuit. This inductance may take the form of a tube 2″ in diameter and 6″ long, wound full of No. 38 S.S.C. wire, with eight tappings. This coil should not couple with any other coil. It will be unnecessary for you to take steps to renew your licence. The Post Office will communicate with you shortly after the date on which your licence expires, and simply ask for a renewal of the fee.

"H.G." (S.W. 19) *submits particulars of his receiver and asks for advice.*

Coil A could consist of a winding of No. 30 D.C.C. wire on a former 4″ diameter and 8″ long, with 10 tappings. We think you will find it advisable to put 6 tappings in the reaction coil. In the diagram submitted no tuning condenser is shown in the secondary circuit. This should have a value of 0·0005 mfds., as you probably know.

"J.D." (Swansea).—The aerial which you have at the present time is quite suitable for use, but it would be better, if it were possible, to use a small aerial (say 60′ long and 30′ high) for the short wavelengths, and for the longer wavelengths the use of a larger aerial consisting of two wires each 60′ long and spaced 7′. However, quite good results are obtainable with only one aerial of medium size such as the one you describe.

"H.B." (Yorks) *asks* (1) *Whether a certain set would be permitted by the Post Office for use on broadcast wavelengths.* (2) *Would the apparatus, joined as in the sketch submitted, cause interference with other stations.* (3) *Is a person allowed to construct his existing apparatus to comply with the new broadcast regulations, or is he compelled to purchase a new set from a broadcasting company.* (4) *For a diagram of a four-valve circuit,*

(1) The circuit Fig. 2, page 880, September 30th issue, may be used provided you hold an experimenter's licence, and it will be for you to take care that oscillations are not set up on the aerial circuit over the broadcasting wavelengths while broadcasting is in progress. (2) The circuit submitted cannot cause energy to be set up in the aerial circuit, and will therefore be quite suitable for use. (3) A person wishing to use home-made gear is regarded by the Post Office as an experimenter, although if the aim of the individual is not to have any serious interest in the technicalities of the science, he is required by the Post Office to purchase made-up apparatus, owing to his non-acquaintance with the subject, in order that he may not cause serious interference by the use of an incorrectly designed receiver. The position of the experimenter has been clearly defined in recent issues. (4) See Fig. 6.

"A.C." (Southport).—We consider three 30-volt carbon filament lamps would burn out if connected to charge your accumulator, and it would be better for you to use four 50 candle-power carbon lamps in parallel and join them in series with your accumulator. Carhon lamps are used because they pass far more current for a given candle-power than metal filament lamps, and furthermore, are considerably cheaper. The lamps should be those normally used on a 220-volt circuit, and we should point out that the accumulator should be placed on a stand when charging, so that currents cannot leak to earth. As considerable heat will be generated by the lamps, it is better to make up a small framework with the lamps mounted. If you desire to charge the accumulators at a slower rate, a lamp may be easily taken out. Charging the accumulators at a slow rate does not do any harm, but on the contrary, considerably benefits them. The charging should be carried out in a regular manner.

"J.H." (W.C.1) *submits particulars of his unit system and asks* (1) *Whether it is suitable, and values of components.* (2) *Whether the A.T.I. is suitable, and if tappings are necessary.* (3) *Whether the windings of the anode and reaction coils are correct.*

(1) The tuning condenser, C_1, should have a

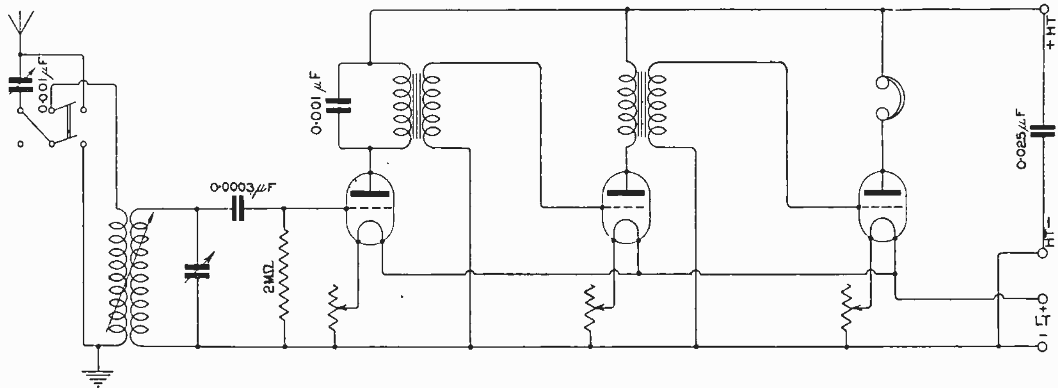


Fig. 6.

maximum value of 0·001 mfds., and C_2, 0·0003 mfds. (2) We suggest you do not dispense with the tapped aerial coil, as better results will be obtainable with its use. (3) The anode windings are correct, and we suggest you adhere to the present arrangement, since it is efficient and easy to operate.

"C.M." (Lancs.).—We have examined the circuit submitted, and we think you had better try the tuning condenser in series with the tuning inductance when receiving short wavelengths, say of 600 metres. The remainder of the diagram appears to be correct. We cannot however help you much, as you have not given us particulars of the coils and condensers used in the circuit. The aerial tuning condenser should have a value of 0·001 mfd., and the closed circuit condenser 0·0005 mfds. The reaction condenser may have a value of 0·0002 mfd. The grid leak should have a value of 0·0003 mfds., and the leak resistance 2 megohms. If the condenser bridging the telephones and negative H.T. battery is of large value, we suggest you will have the connection so that only the battery is bridged by it. It would be better, we think, if you removed the switches from the circuit and rewired the set without them, until you find where the fault lies. We assume, of course, that the plug-in high frequency transformer tunes to the same wavelength as the aerial circuit.

"A.A.P." (Herts.) *asks which is better, to use high resistance apparatus directly in the anode circuit, or to use a transformer and low resistance apparatus.*

It is without doubt better to employ a telephone transformer and low resistance telephones or loud speaker than to connect high resistance apparatus directly in the anode circuit of the valve. High resistance apparatus is of course wound with very fine wire ; the winding is therefore delicate, and is very liable to be damaged by the continuous application of the anode voltage. The transformer, on the other hand, is easily insulated, and is able to withstand the anode voltage. In addition, capacity effect, due to changing the capacity of the telephones and leads, is absent.

"MEMBER" (South Shields) *asks* (1) *Why his set will not oscillate on wavelengths below* 600 *metres.* (2) *For suggestions.* (3) *An opinion on the set.*

(1) and (2) The reaction coil is not large enough to set up oscillation on low wavelengths. We suggest you add a few more turns, although we do not see why you do not couple the reaction coil with the tuned anode coil and so minimise radiation. The A.T.C. and A.T.I. should be in series when receiving short wavelengths, and you might incorporate a switch for this purpose. (3) The circuit is quite a standard one, but would be better with the modification suggested above. In addition we think you should connect the grid leak to +ve L.T. instead of −ve L.T.

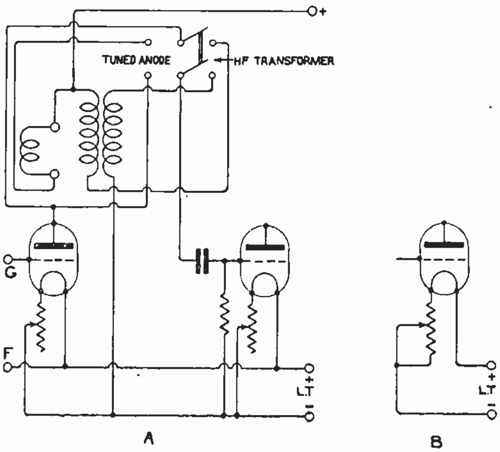


Fig. 7.

"F.B." (Southport).—The circuit may be arranged as indicated in Fig. 7 (A). The correct method of connecting the filament resistance is indicated in Fig. 7 (B). The resistance is connected in the L.T. negative lead, and it is an advantage, especially when using valves which take a heavy current, to connect the resistance and sliding contact together as shown. In this way, if the resistance occasionally breaks contract, the valve will still remain alight, as when a large current is being taken. As in the case of transmitting valves, the drop in the lead is considerable, and the reduction in this drop of potential due to one valve having its current supply suddenly taken off, results in a large increase in current through remaining valves. The alterations necessary to the amplifier referred to are outlined at the bottom of page 609, August 12th issue.

"V.G.C." (N.W.3.) *asks* (1) *The dimensions of a frame aerial for receiving over a wavelength range of* 300-1,000 *metres.* (2) *Whether* PCGG *may be received using this aerial and a four-valve set.* (3) *Whether a microphone amplifier may be used to operate a loud speaker.*

(1) A suitable frame would be 4′ 6″ square with 15 turns of No. 18 copper wire spaced ¼″. Five tappings should be taken to a switch. (2) We think with careful adjustments you will receive PCGG transmissions. (3) Yes, but a little experimental work will be necessary.

"HECTOR DEEN" (Surrey) *asks* (1) *The formula for calculating the inductance of a lattice coil.* (2) *How the turns are counted.* (3) *Whether empire cloth may be used to separate coils.* (4) *Whether* 18 *S.W.G. copper wire is as suitable for wiring as* 18 *S.W.G. tinned copper wire.*

(1) The formula for calculating the inductance of lattice coils is

$$L\,\text{mhy} = \frac{1}{1{,}000} \times \frac{4\pi^2 a^2 N^2}{b + c + R} \times F_1 \times F_2$$

a = mean radius of the winding—
b = axial length of the winding
c = thickness of winding
R = outer radius
N = total number of turns

$$F_1 = \frac{10b + 12c + 2R}{10b + 10c + 1{\cdot}4R}$$

$$\text{and } F_2 = 0{\cdot}5 \log_{10}\left(100 + \frac{14R}{2b + 3c}\right)$$

in cms.

(2) One turn is completed when the wire has travelled from the starting point back again to a point over the starting point. (3) Empire cloth is suitable for the purpose. (4) There is no great objection to the use of bare copper wire in place of the tinned copper wire.

"L.V." (S.W.) *asks for criticism of his set, diagram of which is submitted.*

We suggest you join the tuning condenser (maximum value 0·001 mfds.) in series with the aerial when receiving on short wavelengths. The coil may be a winding of No. 22 D.C.C. wire on a former 4″ diameter and 6″ long, with 12 tappings. The reaction coil could be a winding of No. 28 D.C.C. on a former 3″ diameter and 4″ long with 3 tappings. The circuit arrangement is correct, although you would probably find it advantageous to use a secondary circuit.

"RADIOMAD" (Salisbury) *asks* (1) *What results to expect when using a three-valve amplifier.* (2) *Whether an earth lead* 12′ *long will reduce the signal strength.* (3) *Whether the telephone leads may be increased to* 20′ *without bad results.* (4) *Suitable values of condensers for use in a three-valve set.*

(1) We cannot say, since the results depend so greatly upon the skill of the user, his location with respect to the transmitting stations, etc. Large amplification should of course be obtained. (2) The earth lead will not reduce signal strength to any great extent, although if you can reduce the length it will be better. (3) The leads may be lengthened, and probably no falling off in signal strength will result, provided a telephone transformer is used. (4) The values are given in many recent issues.

"F.W." (Oxford).—We suggest you do not construct the set referred to. For short wave work your coils are far too large, and the resistance capacity method of H.F. amplification is not suitable. The aerial coil may consist of a winding of No. 22 D.C.C. on a former 4″ diameter and 6″ long, and the secondary, a winding of No. 26 D.C.C. on a former 3″ diameter and 7″ long. We suggest you employ one of the many simple circuits which have been given in replies to other correspondents recently; for example, Fig. 4, page 288, November 25th issue; Fig. 3, page 251, November 18th issue; Fig. 7, page 217, November 11th issue.

"J.E.M." (Kent) *asks* (1) *For a diagram of the Armstrong super heterodyne circuit.* (2) *For suitabl valves.* (3) *Whether this is a good circuit for long distance reception.*

(1) and (2) The diagram submitted is correct and is reproduced in Fig. 8. The tuner is of the normal type with the addition of a small coupling coil A, which could consist of 15 turns of No. 2 D.C.C. wound on a former 3″ diameter. A heterodyne wavemetre may be coupled to this coil by including in the wavemetre anode circuit a small coil (B.) Probably 10 turns of No. 26 D.C.C. wound on a former 2″ in diameter would be suitable. Wavemeter construction has been dealt with in recent issues, it being understood that a wavemeter is referred to here as a suitable oscillator. The addition of coil B will slightly change the calibration of the wavemeter. (3) This circuit is quite a good one, and good results are possible, especially when receiving the longer wave signals. When receiving the shorter wavelengths, difficulty is sometimes experienced due to slight wavelength changes, when the signals vary greatly in strength.

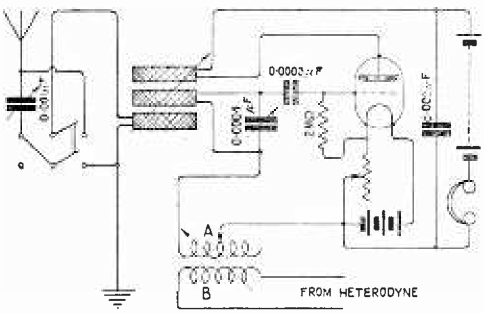


Fig. 8.

"D.S.K.R." (Glam.).—We think the trouble is due to a high resistance disconnection in the telephone circuit. You should test for this. If you join another pair of telephones in parallel you will be able to tell immediately which pair is faulty, or you could try short-circuiting each ear-piece separately while listening to signals with the other.

"DON BEER" (Southall).—The construction of dead-end switches has not been dealt with recently. A good form is indicated in Fig. 9.

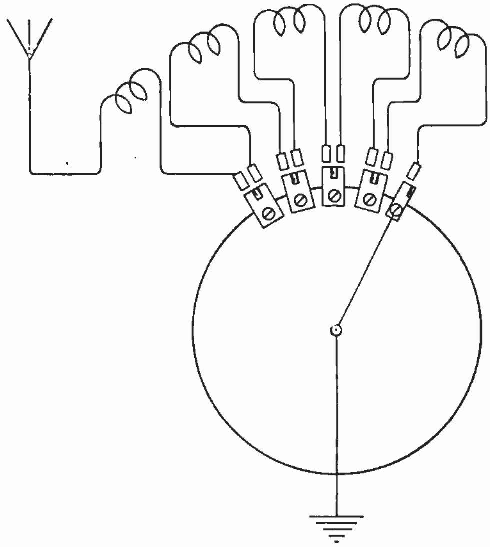


Fig. 9.

The rotor is of ebonite upon which a number of brass segments are fastened. The stator consists of a number of smaller segments properly spaced, and the rotor is mounted so that successive segments are bridged as more inductance is required.

"H.W.F." (Bristol) *has a transformer which, after fifteen minutes of load, is so hot that it cannot be handled.*

The only cure is to rewind the transformer, and we suggest you rewind the primary winding with 1,000 turns of No. 32 D.S.C. wire, and the secondary with 100 turns of No. 16 D.C.C. The core should be built up to a diameter of 1½″. An alternative arrangement would be to connect a choke consisting of 1,000 turns of No. 36 D.C.C. wire on a former 4″ long and ⅝″ in diameter, but in this case the secondary voltage would be considerably reduced. The whole trouble is due to lack of sufficient primary turns, or alternatively, too small a cross section of iron core.

SHARE MARKET REPORT

Prices as we go to press on January 5th, are :—

Marconi Ordinary	£2	6	6
,, Preference	2	0	0
,, Debenture	102	15	0
,, Inter. Marine ..	1	5	6
,, Canadian		11	6

Radio Corporation of America :—

Ordinary	16	3
Preference	13	4

THE
WIRELESS WORLD
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No. 179 [No. 16. Vol. XI.] JANUARY 20TH, 1923. WEEKLY

Valve Current from A.C. Mains

NOTES ON THE DERIVATION OF CURRENT FOR PLATE AND FILAMENT IN RECEIVING CIRCUITS.

By L. F. Fogarty, A.M.I.E.E.

GREAT increase in the number of receiving stations, and the advantage which would result from the suppression of accumulator batteries has directed the attention of many experimenters to endeavour to utilise the current from the public main, both for filament and plate circuits of receiving apparatus.

Early in 1919, M. Vallette, of Messrs. Ducretet, had developed and had in regular use an arrangement which furnished direct current to the plate circuit, operating from the mains at 100 volts alternating, and several three-valve H.F. amplifiers were constructed on this system.

This combination consisted of a small transformer T (Fig. 1), and one valve A. The transformer was equipped with two secondaries, S_1 and S_2, the first, S_1, furnishing a high voltage alternating current of which one phase was rectified by an ordinary three-electrode valve connected in the customary manner, and whose filament was supplied by energy taken from the additional low voltage secondary S_2. The choking coils L and the condensers C, when suitably chosen, form an energy storage system which ensures that the voltage available at the points M and N was continuous despite its pulsating nature at the points M_1N_1. This was the first satisfactory attempt to use alternating current for this purpose within the knowledge of the writer.

The same year Mr. Barthelemy took out a patent on behalf of the Société Indépendante de T.S.F. for an arrangement using alternating currents for filament heating, and having the object of overcoming the humming noises usually associated with any attempt to utilise this current in wireless work.

To reduce to a minimum the noises produced by the nature of the supply, it was proposed to bring what is usually known as the common or neutral point to a position electrically equidistant between the ends of the filament, as for example in the diagram Fig. 2, illustrating the so-called potentiometer method.

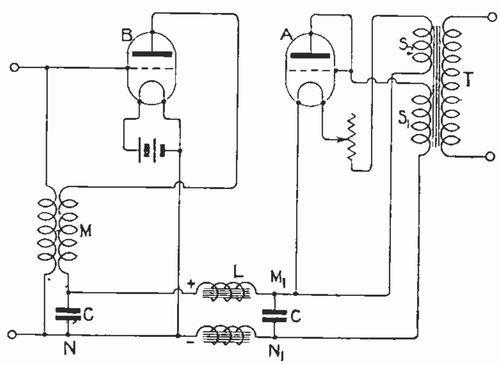


Fig. 1. Transformer with two secondaries, one of which supplies alternating current suitable for the filament heating of a rectifier valve, whilst the other provides current at a voltage, which after rectification provides H.T. for use with a simple receiver.

Immediately following this, M. Moye disclosed his ingenious solution of the problem which comprised a high frequency amplifier supplied entirely from alternating current (plate circuit supplied with H.T. rectified A.C. analogous to M. Vallette's method), and in which a galena crystal rectified the high frequency amplified currents.

The foregoing methods have been fully described by Dr. P. Corret in the course of a highly interesting article appearing in No. 15 of *T.S.F. Moderne*, and many French amateur experimenters using the information there made known have succeeded in producing very convenient and moderately efficient three to five stage amplifiers. It was found that in general these were more noisy than those whose energy was drawn from accumulators and dry cells.

The difficulties encountered in using amplifiers supplied from A.C. arise mainly from the fact that any attempt to make even moderate use of reaction for amplification will immediately set up self oscillations, and in addition the following inconveniences were experienced :—

1. A slow waxing and waning of strength in the received signals.
2. A humming sound at the supply frequency, which increases rapidly as the reaction is brought into use, and which becomes gravely inconvenient before the coupling of the reaction coil has become sufficiently close to give maximum amplification. It was therefore necessary to work far from the point of maximum amplification to obtain freedom from distortion and parasitic noises.

Experts were convinced that a more perfect solution of the problem could be found, and in fact the Société Ducretet, after a long period of study and experiment on a single valve receiver, was able to elucidate several obscure matters and published several alternative diagrams of suitable circuits. It appears that the central feature for success is the use of a valve having special patented characteristics.

They set up a single valve receiver in accordance with Fig. 3, comprising a tuned grid circuit, with a reaction coil B, a telephone in the plate circuit, and further arranged for the plate to be supplied from a true source of direct current such as dry cells, and the filament with alternating current by means of a transformer shunted by a resistance enabling access to be gained to the middle point of the filament potential.

Having set up and put into operation this arrangement a periodic humming noise of A.C. even with very loose coupling of the reaction circuit was still experienced, but on the other hand, and using the circuit shown, it is easy to see that this noise cannot be due to any L.F. inductive effects, and the conclusion therefore is that the noises heard in the telephone *are due to harmonic variation in the temperature of the filament during a complete A.C. cycle.*

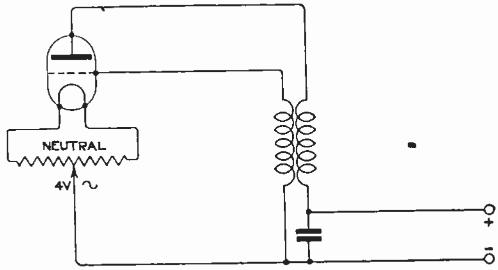


Fig. 2. Method of providing a neutral point by means of a potentiometer.

If we now slowly bring into use the reactance coil B, we shall cause a roaring noise to be heard in the telephones, which will increase rapidly with the degree of coupling. This noise has its origin in the aforesaid temperature variation of the valve filament, as the varying plate current due to this cause is being amplified in the usual manner.

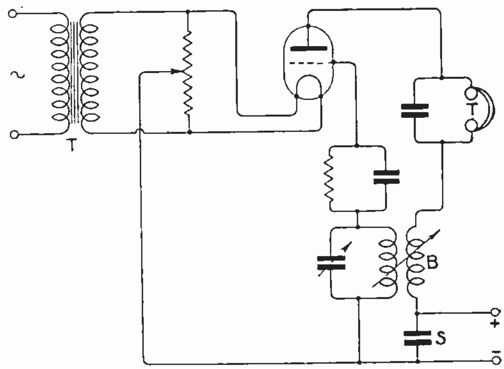


Fig. 3. A test circuit which demonstrates that the humming heard when heating a valve filament from an A.C. source, is due to variation in the temperature of the filament during the A.C. cycle.

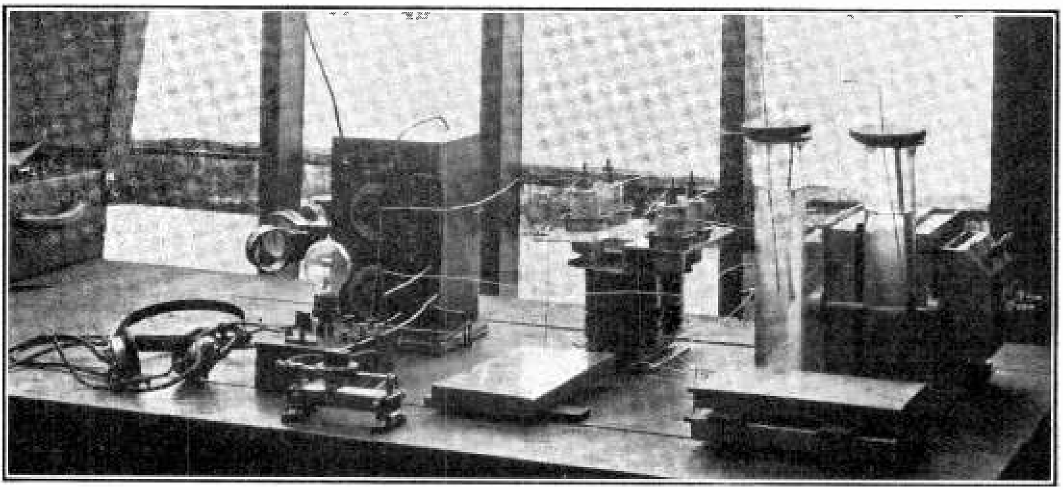
It is well known that the temperature of the filament controls to a considerable extent the conditions under which a valve will oscillate, and it is easy to imagine circumstances such that the valve only oscillates when the filament of the valve is at its maximum temperature, *i.e.*, when the voltage of the transformer T (Fig. 3) is at peak value, and equally that the valve stops oscillating when the filament temperature falls. Under the foregoing circumstances there will be produced in the circuits "chopped" trains of continuous waves of group frequency, not necessarily equal to that of the main alternating current supply to the filament.

The foregoing explains the distortion and variation in strength of signals received on these sets. For the degree of amplification obtained with a reaction coil varies very rapidly when nearing the point of oscillation, the temperature of the filament being constant; but if this latter varies and is sometimes high enough to oscillate, and at others too low, there will be set up periodic variation in the value of the amplified current produced of a frequency akin to that of the associated A.C. supply. This tends to explain the partial failure of M. Moye's ingenious method of rectifying the plate circuit current by a galena crystal.

The cause of the noise having been thus determined, it was easy to suggest various possible solutions, and trials were made with valves fitted with several filaments, each simultaneously heated by alternating currents differing in phase, special attention being given to a valve with two filaments supplied from two phase A.C. and another having a single filament heated with high frequency currents.

Ultimately the firm of Ducretet adopted a method which, whilst not necessarily the most perfect, was certainly the most practical, and took the form of a valve with a heavy filament of considerable heat storage capacity, and requiring 3 amperes at 2 volts. Such a filament is of great strength and durability as compared with the standard type, and a valve as described was covered by a French provisional patent No. 162570.

One of these special valves incorporated into the circuit shown in Fig. 3 resulted in an almost perfect avoidance of noise, for although a very slight humming persists it is negligible as compared with other noises, such as jamming, heterodyning, etc., and serves to show that variation of filament temperature still exists, but highly diminished in magnitude, for broadcast concert music can be excellently received, pure in tone, and with reaction amplification close to the point of oscillation.



Receiving apparatus making use of alternating current for heating the valve filament. The step-down transformer is in the centre, whilst on the right is an electrolytic rectifier arranged for supplying the H.T.

Where alternating current is available, the slight increase in energy consumption from 3 to 6 watts is of no importance as will readily be seen, for the current in the one case is taken from accumulators, and in the other from a public supply main.

Energy from the main will cost from 4d. to 6d. per 1,000 ampere hours, while from accumulators of the portable type the same energy would cost at least as many shillings. Therefore in addition to cheaper running costs we are enabled to dispense with the troublesome accumulator battery, and the bother of conveying same to the charging station at regular intervals.

From the experiments outlined above, experience has been gained and incorporated into a set shown in diagram Fig. 4. This receiver is entirely supplied with alternating

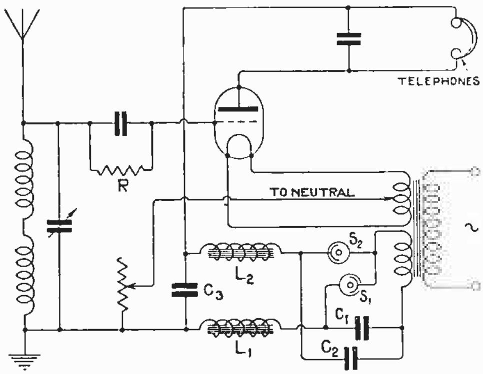


Fig. 4. Simple receiving circuit, deriving H.T. and L.T. from an alternating source.

current, but is arranged so that the usual high tension battery and accumulators may be substituted if and when desired.

The transformer was fitted into a separate box, and wound to provide 100 v. rectified continuous current to the plate, and 2 volts to the filament circuit of the valve. The main feature of the transformer box is the two minute sealed electrolytic cells, for rectifying the plate circuit supply.

Experience over some weeks has shown that the small rectifier cells have proved satisfactory in normal work, and in addition the cells are easily made, and can be replaced in a few seconds.

A considerable number of receivers of this kind are in use in France, and the Eiffel Tower telephony transmissions are regularly received even in the southern confines of that country.

Additional to the foregoing, it may be of interest to indicate an example of a two-valve amplifier operating on alternating current.

Suppose for example it is desired to amplify signals received on the crystal detector D, on Fig. 5. We can utilise for the first stage two valves V_1 and V_2, having equal characteristics, and a transformer T_1, with two secondaries S_1 and S_2 connected to the grids G_1 and G_2, in such a way that an oscillation in V_1 whilst making the grid G_1 positive, simultaneously makes grid G_2 negative. From this it follows that there will be an increase in the plate current of V_1, and a diminution of plate current in V_2.

Now, if we pass these two plate currents into the two primaries P_2 and P_3 of the transformer T_2, in such a way that the resultant oscillation transfered to secondary S_2 is the sum of the two oscillations, *i.e.*, that the flux produced by each D.C. plate current is in opposition, and that the two secondaries are alike, we can readily see that any disturbance of an alternating nature will produce equal and opposite effects, and the resultant flux will be zero. Therefore there will be no parasitic currents in the secondary S_2, but only those oscillations which it is desired to amplify.

The secondary S_2 may be connected to a further stage comprising a duplication of the above, but in such case the combined effect of the four valves would be equal to three only connected in the usual manner, and which is ordinarily considered as about the

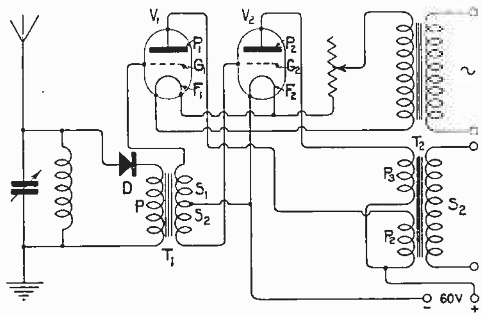


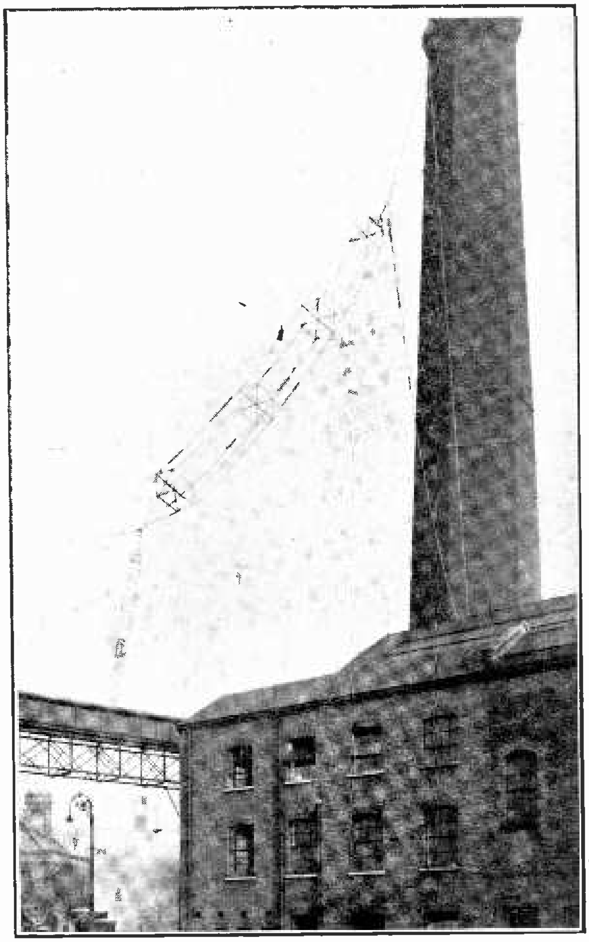
Fig. 5. Crystal and two magnifying valves employing A.C. for filament heating.

limiting number of stages for low frequency amplification.

These notes have been prepared from a considerable series of experiments, on the lines indicated by many writers in the French technical press, and are contributed in the hope of stimulating keen amateurs in this country to continue these, as good and efficient receiving apparatus operated direct from the public supply will represent a considerable advance in the practical application of radio science.

The Erection of 5WS—The Radio Society's Special Station at Wandsworth.

By E. COURSEY, B.Sc.



The aerial attached to the chimney stack at the Wandsworth Generating Station. Part of the earthing system is attached to the iron framework seen on the left.

AS all readers of this journal are probably aware, the Transatlantic Radio Tests took place during the last month of 1922. In 1921 tests of the same nature were made from America, when signals were received by several amateurs on this side of the water, but this time tests were conducted in both directions. It could, of course, hardly be expected that the amateur stations complying with the ordinary Post Office regulations would be able to reach through to America from Great Britain, but for the period of the tests, viz., December 22nd to 31st, several special licenses were issued permitting the holders to use increased power, and to erect larger aerials. Amongst those so favoured was the Radio Society of Great Britain, which was represented by a specially appointed sub-committee, including Messrs. G. G. Blake, P. R. Coursey, N. Hamilton, N. Lee and C. F. Phillips, and these members were later joined by Mr. M. Child. Having no club rooms or regular transmitting station of any kind the first matter to be considered was a suitable location for the special station to which the call letters 5 WS were to be assigned. Several proposals were tentatively examined, but all proved impracticable, until Mr. Blake approached the Engineer of the Generating Station at Richmond, with a view to the possible use of a site at their station. Some such situation was desirable, since the provision of a suitable power supply was essential. While the Richmond engineers were themselves unable to help, they suggested that application should be made to the County of London Electric Supply Company. Mr. Bacon, the Chief Engineer, was therefore approached, and proved very sympathetic. Through his kindness the matter was put before the directors of the company and their consent to the use of a site quickly obtained. Permission was given for the use of a chimney stack of their Wandsworth Generating Station, to support the aerial. Mr. Bacon was also good enough to put the Committee in touch with the Metropolitan Water Board, who own property adjoining the generating station, a very conveniently situated small brick building belonging to the Board being discovered empty near the foot of the chimney. This building had been disused for some time, and although somewhat small, proved very suitable for the purpose of a transmitting station. The Metropolitan Water Board readily allowed its use by the Radio Society for the purpose of housing the apparatus, and as it was situated but a few yards from the base of the chimney stack of the generating station, and separated from it only by a narrow lane known as the Causeway, the erection of an almost vertical aerial was comparatively easy.

The next step was to obtain transmitting apparatus, and this might have proved a serious stumbling-block but for the generosity of manufacturers in lending parts. As the power licensed to American amateurs does not exceed 1 kilowatt, and as the special station put up in America during the tests in December, 1921, to send signals to Mr. Godley, used approximately this amount of power, it was desired to install an equipment of about the same output. To deal with this amount of energy large transmitting valves were necessary, and the M.O. Valve Company, Hammersmith, kindly consented to loan to the Society two T4. A power valves and two U2 rectifying valves, the presence of an A.C. supply rendering the use of rectifying valves preferable to the installation of a special H.T. D.C. generator.

Although as mentioned above, an A.C. supply of 220 volts, 50 cycles, was available from the generating station, the task of securing step-up transformers suitable for this supply did not prove easy, and a solution was eventually found in the use of a motor-driven generator delivering current at 350 cycles to two separate step-up transformers so that double-wave rectification could be employed. The step-up transformers for this frequency were each of $1\frac{1}{2}$ kilowatt output and were loaned by Messrs. R. M. Radio, Ltd. This firm also lent a 350 cycle rotary converter suitable for feeding the transformers. This machine, while primarily designed for a D.C. supply at 100 volts, was not directly suitable for use on the supply available and was therefore fitted with a pulley in lieu of the customary rotary spark (the machine being one of a type normally used for ships' spark radio installations) and was belt-driven from an induction motor run off the 50 cycle A.C. supply. This latter machine, together with its starter, switches and fuses for the circuit associated with it, was loaned by the Dubilier Condenser Company, Ltd.

Various inductances for use in the aerial and other circuits associated with the transmitting apparatus were loaned by the Radio Communication Company, Ltd., Leslie McMichael, Ltd., and Dubilier Condenser Company, Ltd. This last firm also supplied a number of condensers for use with the rectifying valves for smoothing out the rectified currents for the grid circuits of the oscillator valves and for the oscillation and aerial circuits, several of these being specially made up for the purpose.

Low tension supply for lighting the valve filaments was obtained partly from special transformers loaned by Mr. L. F. Fogarty, of the Zenith Manufacturing Company, Ltd., Willesden (who also supplied four adjustable filament resistances for the valves), and partly from an 18-volt accumulator battery, loaned by Messrs. Leslie McMichael, Ltd. Grid leak resistances of assorted values suitable for use with the oscillating valves were loaned by Messrs. Gambrell Brothers, Ltd. and by the Zenith Manufacturing Company, Ltd. Wire for the aerial was supplied by Leslie McMichael, Ltd., and the transmitting key and receiving set by Mr. M. Child.

Apart from the fitting of the pulley block at the top of the chimney stack and the fitting of a suitable halyard thereto, which was carried out by Messrs. Beaumont and Son, a firm of steeplejacks, the labour entailed in the erection of the station was entirely voluntary.

The aerial was a six-wire cage, having an overall length, including the lead-in wires, of approximately 160 feet. It was constructed by Messrs. Child, Manning and Hathaway, members of the Radio Society of Great Britain, E. Pickering, assistant to Mr. G. G. Blake, E. Trehearne, lent from the staff of the Dubilier Condenser Co., a rigger from the staff of Messrs. Burndept, Ltd., and a representative from Leslie McMichael, Ltd., who shared the labour on different days. The weather was fine during the erection of the aerial, but later turned very wet and stormy, and grave fears were entertained that the shrinkage of the ropes supporting the aerial might cause a catastrophe. Fortune favoured 5 WS, however, and even the terrific winds which blew from time to time during the tests left the aerial unharmed.

The apparatus was collected in the research laboratories of the Dubilier Condenser Co., Hammersmith, and on Saturday, December 16th, only five days before the tests were to begin, the assembling of the various parts was commenced. This part of the work was carried out by Messrs. Blake, Coursey and Trehearne during Saturday, Sunday and Monday, during which time a rough wooden framework was made to support the valves, filament resistances and transformers, with a switch controlling the latter. Difficulties in the insulation from earth of the filament circuits of the rectifying valves necessitated the temporary use of an accumulator battery supported on a wooden framework separated from the floor by four stoneware pots. After these arrangements had been made considerable time was devoted to adjusting the constants of the circuits so as to obtain as large an oscillatory current as possible at a wavelength approximating to 200 metres in a dummy aerial circuit, having a resistance of 5 to 6 ohms.

The apparatus was transported to the Wandsworth station by means of a motor van lent by Dubilier Condenser Co. on the afternoon of Tuesday, December 19th, and the evening was spent there by Messrs. Blake, Child, Coursey and Trehearne in getting the motors running, and so on. Late that night (or early next morning) the aerial circuit was joined up and some current obtained in that circuit. The current was not very large, but it was left to a subsequent time to increase it by readjustment of the various parts, the workers by this time feeling that they deserved a rest for what remained of the night.

No work was done at the station on Wednesday, December 20th, as there was a meeting of the Radio Society, but as the first transmissions were to take place at 2.45-3 a.m. on Friday morning, the 22nd, it was essential that all final arrangements should be made on Thursday evening. Accordingly the same four enthusiasts, together with Major Hamilton, assembled once more at Wandsworth on Thursday and after much persuasion the aerial current was increased to 3 amperes, which was thought sufficiently satisfactory for a start. During the period of the tests, however, various modifications and improvements were made from time to time with the result that the maximum current obtained was 4.3 amperes, representing nearly three-quarters of a kilowatt of high frequency energy in the aerial.

The British transmissions were arranged to take place between midnight and 3 a.m., and 3 a.m. and 6 a.m., on alternate nights. Owing to the extreme lateness of the times, it was, of course, necessary for the operators to be taken to the station by car, and Messrs. Klein, McMichael and Woodhams very kindly lent cars on different nights for this purpose. As the apparatus was put together rather roughly, owing to the shortage of time, it was necessary for one of the four who had been responsible for its arrangement to be present each night, in order to see that all was in order. They therefore took it in turns to attend, and on some nights were accompanied by Messrs. Maitland and White, members of the Radio Society, who were anxious to have a share in trying to "raise" America. On one or two occasions the key of the hut was not forthcoming at the proper moment, but fortunately such a trivial matter was not allowed to stand in the way of progress, as the intrepid scientists gained an entrance through a very small window. This minor discomfort, however, was eliminated on Christmas night. Through the kindness of the caretaker of the premises, a fire was laid each day in the cabin, so that those in charge each night were able to keep themselves warm.

The weather throughout the tests was very rough and wet, and fears were entertained for the safety of the aerial. Fortunately, however, no accidents occurred, and all the scheduled transmissions were duly accomplished. On the nights before and including Christmas, additional transmissions were made from **5 WS** during the times allocated to **2 ON**, which station was not used on those nights, owing to the absence of Major Parker. The Marconigram from Mr. Schnell the Traffic Manager of the American Radio Relay League, was anxiously awaited each day by the Committee, but sad to relate, the first two or three reports were most discouraging. However, the signals from **5 WS** were reported as received on the other side of the Atlantic on the mornings of the 24th, 25th and 26th.

As a matter of interest, it may be stated that the aerial energy from **5 WS** was greater than that put out by **1 BCG**, the special station erected in America, during the 1921 tests, which was received by so many listeners over here. Although, on the whole, the results of reception on the American side are rather disappointing, yet it is gratifying to know that the station was received. A more detailed account of the number of Americans who heard **5 WS**, with a description of the apparatus, etc., used, will be given when it has been received from America.

Electrons, Electric Waves and Wireless Telephony—XVI.

By Dr. J. A. FLEMING, F.R.S.

The articles appearing under the above title are a reproduction with some additions of the Christmas Lectures on Electric Waves and Wireless Telephony given by Dr. J. A. Fleming, F.R.S., at the Royal Institution, London, in December and January, 1921-1922. The Wireless Press, Ltd., has been able to secure the serial rights of publication, and any subsequent re-publication. The articles are therefore copyright, and rights of publication and reproduction are strictly reserved.

VII.—THE PRINCIPLES OF WIRELESS TELEPHONY.

1.—Production of Continuous Electric Waves.

It is now possible to gather up the threads of all previous explanations and utilise them is making an exposition of the principles and mode of operation of the wireless telephone, which is certainly one of the most wonderful of all the achievements of technical science.

To conduct wireless telephony as contrasted with telephony with line wires, we have to replace the line wire by some agency which will enable us to transmit energy and yet permit us to employ the usual type of microphone transmitter and magneto-receiver used in ordinary telephony with wires at the sending and receiving stations. It has been found that we can do this by substituting for the connecting wire a stream of undamped or continuous high frequency electro magnetic waves. We must, then, first explain how these waves are created.

There is only one method practically employed at present in small plants, or those of moderate size, and that is by means of the thermionic valve. We have already explained that an incandescent tungsten filament in vacuo emits a torrent of electrons, and that these in the three-electrode valve make their way through the apertures of the surrounding grid and fall upon an anode or collecting plate. To make them do this the anode must be kept at a high positive potential so as to attract to it the negative electrons. This is done by means of a battery, dynamo, or other source of direct electromotive force. The anode must be connected to the filament by an external circuit which includes the above-mentioned source of electromotive force, but also a coil of wire called the plate circuit coil. This plate circuit coil has also its terminals connected to a condenser of a certain capacity, so that the coil and condenser, taken together, provide a circuit in which electric oscillations can take place with a certain natural frequency determined by the capacity of the condenser and the inductance of the coil in accordance with rules already given.

If, then, the grid is connected to the filament through another circuit which also includes a coil of wire, and if this last coil, called the grid circuit coil, is placed near to the plate circuit coil and in a certain position, any change in the current in the plate circuit coil will create an induced electromotive force in the grid circuit coil, and this in turn will alter the grid potential and charge the grid either negatively, that is put more electrons into it, or positively, that is take free electrons from it. When the grid is made negative it will reduce the electron stream flowing from the filament to the plate, and reduce the current in the external plate circuit or coil. By a proper mode of connection it is possible to make the changes of grid electrification of such sign and nature as to sustain the fluctuations of the plate current, which, in turn, by the mutual inductive action of the plate and grid coils, create the appropriate variations of grid potential.

The grid and plate coils are then said to be coupled for production of oscillations. The plate current then consists of a steady direct current, on which is superimposed an alternating current, or the plate current fluctuates in strength. The power required to produce these oscillations comes from the battery in the plate circuit, but the power is transformed from direct current (D.C.) power to alternating current (A.C.) power.

The action of the thermionic valve in this respect has been compared with a steam engine. The steady pressure of the steam is applied to push forward the piston, but to make the piston oscillate or move backwards and forwards alternately, the steam must be admitted to the cylinder by means of the slide valve, first on one side of the piston and then on the other. To make the engine self-acting we have to connect the slide valve by some mechanism with the piston so that motions of the piston move the slide valve in the proper manner to maintain the oscillations of the piston. The steam may be compared with the electrons emitted by the filament; the grid is analogous to the slide valve, and the external plate current to the motions of the piston.

The above analogy is, however, very imperfect, and a much better one is as follows: If we connect together in series a Bell magneto telephone, a carbon granule microphone transmitter, and a couple of cells of a battery, a current will flow through the carbon and through the coils of the telephone. If we hold the diaphragms of the transmitter and receiver near together the receiver will emit a shrill musical note, and continue to emit it as long as the two instruments are close together.

The reason is as follows. Small noises in the room set the diaphragm of the transmitter in vibration. This causes compression of the carbon granules, and in turn varies the current, and this makes the receiver emit a sound. This sound actuates the transmitter, and this again reacts on the receiver. Hence continuous sound waves are emitted by the system, and the power to produce them is drawn from the battery.

Just as this coupled receiver and transmitter generate low frequency oscillations of electric current in their circuit, so the coupled thermionic valve circuits react on each other and create high or low frequency electric oscillations in the plate circuit according to the capacity and inductance in the circuit. To radiate electromagnetic waves we have to utilise these oscillations to produce similar oscillations in an *aerial wire*, or radiative circuit. The simplest method, then, of producing undamped or continuous waves (C.W.) by a thermionic valve is by an arrangement as follows:—

Let V (see Fig. 86) be the valve of which P is the plate or anode cylinder, G the grid, and F the filament. Let B_1 be the battery which provides current for incandescing the filament, and r the regulating resistance. Let the grid be connected with the filament through a coil of wire L_2, called the grid coil, and let the plate P be connected with the filament through another coil L_1 and a key K and high voltage battery B_2 giving a voltage of 200 to 400 volts or more. The negative terminal of B_2 must be in connection with the filament. This battery B_2 must be shunted by a condenser C_2. The coil L_1 is also shunted by a condenser C_1. If the degree of coupling or closeness of the coils L_1, L_2 is adjusted, and the direction of their mutual inductance correct, then, as already explained, continuous oscillations will be set up in the circuit of L_1 which are superimposed upon the steady or direct current produced by the battery B_2. The frequency (n) of these oscillations will be determined by the capacity of the condenser C_1 and the inductance of the coil L_1 in such fashion that—

$$n = \frac{5033}{\sqrt{C_1 L_1}}$$

The capacity C_1 must be measured in microfarads or fractions of a microfarad, and L_1 must be measured in millihenrys, or fractions of a millihenry, and the square root of the numerical product of C_1 and L_1 divided into the number 5033.

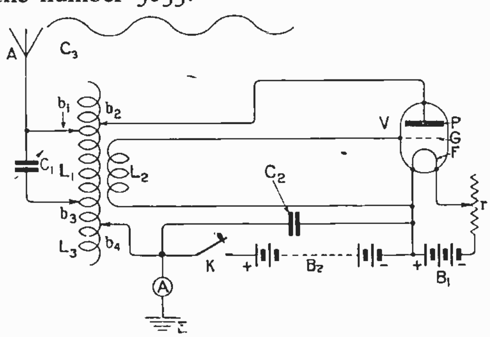
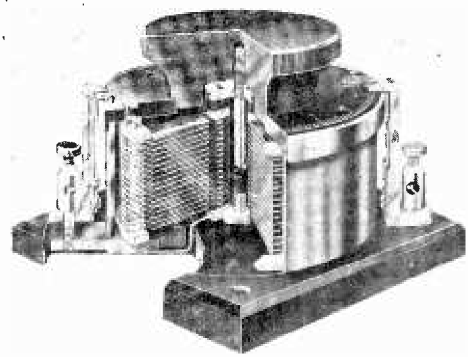


Fig. 86. Arrangement of Circuits for producing continuous electric waves (C.W.) by a thermionic valve.

The condenser C_1 is connected to the coil L_1 by sliding contacts b_1, b_3 so that the inductance L_1 can be varied. Also the condenser C_1 is an adjustable capacity indicated symbolically by the arrow crossing two parallel black lines.

In actual practice the coil L_1 is made by winding enamelled copper wire in close turns on an ebonite or fibre tube about 4 or 6 ins. in diameter. The enamel is then scraped or rubbed off a narrow strip parallel to the length of the cylinder, and enables rubbing contacts of brass to be slid along a bar and so make contacts at places b_1, b_2, b_3, b_4, as desired with the copper wire. The condenser C_1 is made of a number of semi-circular plates of aluminium spaced a little way apart, which are attached to an axis. These plates are so fixed that they can be turned to sandwich in, more or less, between a number of fixed semi-circular plates. The fixed and movable plates are the two plates of the condenser, and by rotating the movable plates so as to bring them more or less in between the fixed plates, the capacity of the condenser is varied (see Fig. 87).



By Courtesy of Marconi's Wireless Telegraph Co., Ltd

Fig. 87. An air condenser of variable capacity formed with a set of fixed semi-circular metal plates and similar movable plates, which latter can be brought more or less into proximity to the former by rotating the ebonite head of the axis carrying the movable plates. N.B.—Part of the condenser in this illustration is shown cut away so as to enable the structure to be seen and understood.

2. Radiation of Continuous Waves.

We have next to make provision for using these oscillations to create continuous electric waves. We have seen that when high frequency oscillations are set up in a straight rod or wire with metal plates at the end, called a Hertzian oscillator, the result is to radiate electromagnetic waves which we have explained to be vibrations propagated along the electrolines proceeding from the free electrons in the wire, the rapid to and fro movements of which are the electric oscillations in that wire.

This radiation is effected by connecting to the contact b_1 an aerial wire A, which consists of two or more copper wires which rise vertically into the air a certain height, and then run horizontally a certain distance, and are insulated at the far or free end (see Fig. 86). At the same time we connect another point b_4 on the inductance coil L_1 through a current-reading instrument A, called a hot wire ammeter, to a plate E sunk in the earth, or it may be the water-pipes of a building.

The aerial A has a certain electrical capacity with respect to the earth, and may be regarded, therefore, as another condenser joined across a section of the coil L_1 between the points b_1 and b_4. By suitably choosing the points of contact b_3 and b_4, we can tune together the oscillatory circuits composed respectively of the condenser of capacity C_1 and the section L_1 of the inductance coil, and also the capacity C_3 of the aerial and the section $L_1 + L_3$ of the inductance coil by making the adjustments so that the product C_1L_1 is equal to the product $C_3 (L_1 + L_1)$.

If, then, we close the key K, the battery B_2 will send a stream of electrons from the filament of the valve to the plate, and they will find their way back through the coil L_1. If the grid then becomes slightly negative the electron stream from the battery will be reduced, and by the inductive action of the coils L_1 and L_2 this reduction of plate current can be made to give the grid a slight positive charge, and this then increases the electron stream. Accordingly fluctuations are set up in the plate current. The object of the condenser C_2 shunted across the high voltage battery is to provide a path for the high frequency oscillations thus created in the plate circuit. The varying potential of the terminals of the condenser C_1 then sets up sympathetic oscillations in the aerial wire, and this results in electromagnetic waves being radiated from it in an uninterrupted stream. The ammeter A placed just above the earth plate E then indicates a steady high frequency current, which is called the aerial current.

In the actual apparatus the two coils L_1 and L_2 are wound on ebonite tubes or in flat spirals, and so arranged that they can be brought near to or separated from each other to vary the mutual inductance. This coupling must exceed a certain value if the oscillations are to be created by the thermionic valve and electric waves radiated from the aerial. We can determine the frequency of the oscillations when we know the wavelength required or used from the simple relation—

frequency × *wavelength* = *velocity of wave*.

The velocity of electromagnetic waves through air is nearly 300,000 kilometres per second. Hence, to produce a wave of 300 metres wavelength requires oscillations at the rate of one million per second in the aerial. The standard wavelengths for amateur wireless telephony and for "broadcasting" lie between 350 and 425 metres. Hence a 400 metres wave requires

750,000 oscillations per second in the aerial. Let us then suppose that we have set up at some place, an aerial and continuous wave (C.W.) generating valve plant, as above described. We can suppose it set in operation and to radiate continuous waves say of 400 metres wavelength. These waves are called the *carrier waves.*

Next, suppose we have at some other place a receiving station at which there is an aerial properly tuned to the wavelength of the wave sent out by the generating station, and that this receiving aerial is coupled to another closed oscillatory circuit comprising an inductance coil and a condenser with the capacity adjusted to tune it to the aerial circuit (see Fig. 88).

The waves from the transmitting station would strike the aerial of the receiving station and would set up in it feeble electric oscillations of the same frequency. These would generate other similar oscillations in the associated closed condenser circuit. The terminals of this last condenser would then alternate in potential alternately being positive and negative.

Suppose, next, that we connect to these condenser terminals to the plate of a two-electrode rectifying valve in series with a telephone, as in Fig. 88.

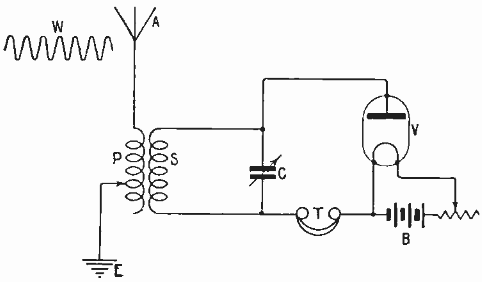


Fig. 88. Simple form of receiving circuit for Wireless Telephony. A is the aerial, P the aerial tuning coil, C is the tuning condenser and V a Fleming rectifying valve, T is the telephone. W represents the arriving carrier waves.

The valve when its filament is incandescent would permit negative electricity or electrons to pass from the filament to the plate inside the bulb, but not in the opposite direction. Hence, the telephone coils would be traversed by a steady unidirectional or direct current.

This kind of current produces no effect on the telephone except to create a slight " tick " or sound at the moment the steady current begins or ends. Suppose then that we insert in the external grid circuit of the valve in the transmitting apparatus the secondary circuit of a small telephone induction coil I (see Fig. 89), and in the primary circuit of the coil a carbon microphone M and battery B_3. If we speak to this microphone mouthpiece the result will be to create in the grid circuit a fluctuating electromotive force, which will have the wave form of the speech sound, and will have a low frequency or *audio-frequency* as it is called, because it falls within the limits of the frequencies used in audible speech.

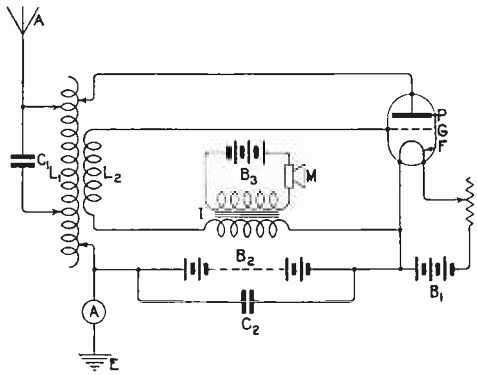


Fig. 89. Circuits of a simple form of wireless telephone transmitter showing the speaking microphone M coupled inductively through an induction coil I to the grid circuit L_2 of the thermionic valve.

The effect of this will be to increase or diminish the amplitude of the carrier waves radiated. In other words, the speech made to the carbon microphone M will modulate the amplitude or height of the carrier waves exactly in accordance with the frequency and wave form of the aerial vibrations made by the voice of the speaker.

Let us then consider what the effect of this will be on the receiving apparatus just described. Any increase or decrease in the amplitude of the carrier waves will increase or decrease in the same proportion the direct or rectified current which flows through the magneto telephone in series with the rectifying valve. Hence, if speech is made to the microphone transmitter inserted in the grid circuit of the transmitting valve, the current in the sending aerial, and the amplitude of the carrier waves and therefore the current through the Bell telephone in the receiving current, will vary or change in nearly the same manner as the changes of air pressure made by the voice of the speaker near the microphone.

(To be continued)

Note on Electro-Magnetic Screening.

By R. A. WATSON WATT, B.Sc., F.Inst.P. and J. F. HERD, Member I.R.E.

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IT is widely recognised, in a general way, that some part of the energy picked up by a radiotelegraphic receiver may enter the system otherwise than by the antenna, and that, notably in a receiver consisting of a frame antenna and a multistage amplifier, the amount of energy picked up by the amplifier and its accessories may be far from negligible. There does not however appear to be much published data from which the magnitude of such effects may be inferred. The results of some experiments, incidental to other work, may accordingly be of interest.

The Radio Research Board's Station at Aldershot, which is concerned with the investigation of atmospherics, is situated within a wavelength of another station handling high speed C.W. traffic on a power which, at the time of the experiments, was about 1½ kW. This station provided an admirable test for interference prevention. The general nature of the phenomenon in question was well shown by the following experiment, doubtless frequently carried out elsewhere.

The signals from the adjacent transmitting station were found to be nearly as strong on the amplifier system disconnected and with its input terminals short-circuited as on the normal arrangement, slightly detuned from the 1,650-metre wave, and with a "rejector" circuit in the grid lead. The frame was therefore detuned completely and the tests continued with the first grid terminal short-circuited to its filament terminal. The signals were still audible with the last two stages (L.F.) of amplification alone operative in the disconnected amplifier.

The amplifier, still short-circuited, was now placed, with its batteries, in a sheet-iron case at ground level. Signals were now inaudible so long as the telephone headgear was at the level of the amplifier, but the raising of the operator's head, with headgear in position, half a metre above the amplifier served to bring up readable signals. (It should be noted that throughout all the work to be described there was no heterodyne or autodyne oscillator, the signals in question being keying impulses and generator noise treated as "spark.") Signal strength increased rapidly as the observer raised his head still further, and very loud signals resulted from the observer standing on a stool, so that the telephones were some 2.2 metres above ground. A still further increase of signal strength was obtained if the observer stretched out his arms crosswise.

It appeared therefore, that a very important supply of energy was reaching the input end of the amplifier by stray capacities or other means from the "capacity aerial" formed by the output apparatus.

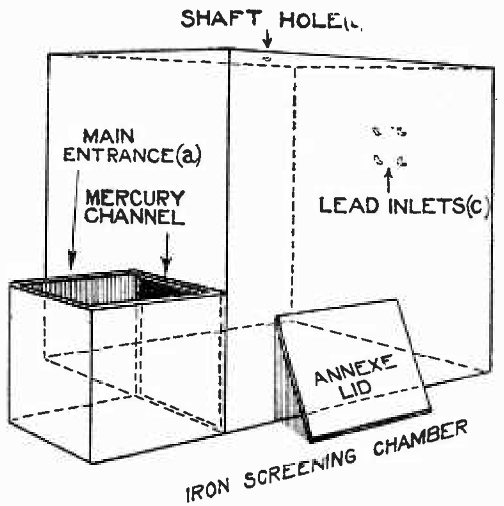


Fig. 1. The Screening Chamber.

It was accordingly decided to screen the whole of the apparatus, with the exception of the frame aerial, and to provide for carrying the screening to the extreme of practicability. The form of screening chamber adopted is shown in Fig. 1, and consists of a shell of sheet iron 0.063 cms. thick, with all joints between sheets turned outwards and autogenously welded by the oxy-acetylene process. The only breaks in the shell are (a) the main entrance for apparatus and observer; (b) 1½-in. hole in roof to admit driving shaft of a recorder; (c) four ½-in. holes to admit leads.

The main entrance (a) is provided in the form of a one-metre cube annexe welded to the main chamber, with a channel 1.25 cms. wide by 2.5 cms. deep round the top. Into this fits the flange of a lid of the same thickness of iron sheet, and the joint can be sealed by mercury in the channel.

The shaft hole (b) is similarly sealed by an annular channel of mercury, in which rotates a flanged cup carried on the driving shaft. Insulated leads passing through holes (c) are run through U tubes of iron welded into the shell, and also containing mercury.

The arrangement thus provides an almost continuous shell of iron, free from vertical orifices, and with several vertical channel walls subtending an angle of several degrees below all horizontal orifices. It might accordingly have been expected, a priori, that the filling of the seals with mercury would be an almost unnecessary refinement, as indeed proved to be the case.

The effectiveness of the screening was tested by observations on the local transmitter and on the Eiffel Tower signals. A frame antenna measuring 1.2 m. × 0.75 m. was tuned by an ebonite variable condenser, and directly coupled to an amplifier with five H.F. stages of amplification, resistance-capacity coupled, rectifier, and one L.F. stage, transformer coupled, with iron-screened transformer. Negative potential was applied to the last grid until signals were reduced to inaudibility or unreadability, and the voltage required accepted as a measure of the signal strength.

With whole apparatus in the open, 46 volts negative had to be applied to the seventh grid to reduce signals from either Aldershot or Eiffel Tower to practical inaudibility.

With the frame antenna in the open, but the amplifier and its accessories and all save a few centimetres of lead inside the screen, the voltages required to reduce signals to virtual inaudibility were 36-38 in the case of Aldershot, 34-36 for Paris.

With the frame inside the screening chamber but projecting halfway into the annexe, as in A, Fig 2, the lid being left off, Aldershot's signals were not noticeably altered, while Paris was now inaudible with about 30 volts negative. The frame remaining at A, the lid was closed but not mercury sealed. Paris was now completely inaudible without the application of negative potential, while Aldershot could be reduced to complete inaudibility by 6 to 8 volts.

Withdrawing the frame to position B, entirely within the main portion of the screening chamber, the lid being closed but unsealed, resulted in the complete elimination of signals from either source. Opening the lid by some 10 cms. gave signals from Aldershot which could be neutralised by 6 volts.

The amplification was now increased by the introduction of a further L.F. stage. This brought signals in the open to such a strength that they could not be neutralised by 100 volts negative on the eighth grid. With the lid of the annexe open, the frame was now placed in the positions C, D, E and F, Fig. 3, and observations made on Aldershot signals. The signal strengths were :—at C 12 volts, at D 30 volts, at E 10 volts, and at F 36 volts.

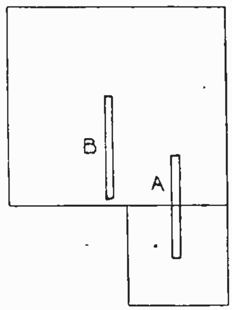


Fig. 2.

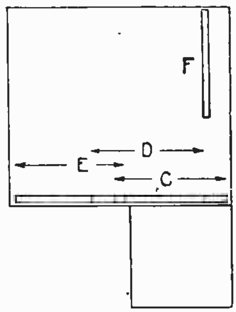


Fig. 3.

It will be noted that these results form a very pretty demonstration of the action of a frame antenna. Essentially the frame consists of two vertical antennæ, the two vertical sides of the frame, coupled in opposition. In position C both sides were insufficiently screened, and moderate signals resulted.

In position D however, one side was as favourably placed for reception as before, while the second was more effectively screened. Thus the opposition was between a well-screened and a badly-screened antenna; the difference was not now, as in the normal case, merely due to the phase difference between the two opposed potential differences, but between two potential differences of very different magnitudes. Thus, although the two potential differences were less in the D position than at C, their difference, which determines the signal strength, was much greater, giving a 30 volt signal. At position E the screening had again approached equality for the two sides, and the signals fell to 10 volts.

Reverting to the principal experiment, it will be seen that an output signal voltage of 46 volts in the open fell to 36 volts when the amplifier gear was screened, and that practically complete screening was attained without mercury sealing.

Thus it may fairly be concluded that some 20 per cent. of the output voltage, or nearly 40 per cent. of the output energy was due to direct reception on the amplifier, its batteries, leads, and telephones. In considering this somewhat startling value, it must not be forgotten that it was attained under conditions which were not particularly favourable to direct reception by the gear.

The high frequency stages of the amplifier were resistance capacity coupled, the coupling resistances being of carbonised cellulose, so that there were very few possible linkages of the signal lines of force through inductive loops in the amplifier, such as might account for direct reception on a transformer-coupled amplifier. In the L.F. stages the transformers were cased in stout iron screens, cases and cores being connected to the common low potential terminal of the amplifier, so that again the design minimised direct reception. The amplifier was mounted on a table, some half-metre above ground, the accumulator H.T. and L.T. batteries being on the ground. The long lead (about 4 metres) of twisted lighting flex connecting the frame to the amplifier lay on the ground, while the amplifier was outside the screen, so that the diminution of signal strength on moving the amplifier into the screen is not to be accounted for by leakage through the earth capacity of this lead.

It must then be concluded that in all frame antenna work, especially for direction finding, very special care must be taken to ensure that the amplifier gear itself does not behave as a remarkably effective antenna. While circumstances and experimental conditions would not often justify a large screen such as that here described, a sheet-iron case to enclose the amplifier gear need not be bulky or costly and is most desirable.

The Exhibition of the Physical Society of London.

The annual exhibition of the Physical Society of London and the Optical Society, held at the Imperial College of Science and Technology, South Kensington, on January 3rd and 4th, presented a selection of apparatus of particular interest to those interested in radiotelegraphy and telephony, and in electrical matters generally.

The fine show of apparatus manufactured by the Cambridge and Paul Instrument Co., Ltd., included the Moullin voltmeter, designed to supply the need of a high frequency current instrument for low voltages which does not cause appreciable alteration in the constants of the circuit; the Eccles valve-maintained tuning fork for generating voltages and currents having amplitude and frequency suitable for use in measurements of the magnifying powers of amplifiers; and a reed hummer designed to produce oscillations of audio-frequency used in bridge-testing, the model shown being that approved and adopted by the British Post Office for telephonic measurements.

The products of the Concordia Electric Wire Co., Ltd., were represented by a selection of wires used for all electrical purposes and for wireless sets and aerials. The Dubilier condenser Company (1921), Ltd., exhibited several new types of condensers both for wireless and power line protection; and the Dubilier insulator specially designed for continuous wave wireless. Regarding the latter the manufacturers claim that it is unbreakable both mechanically and electrically.

The Edison Swan Electric Co., Ltd., had a collection of lamps manufactured by them including Neon lamps and W.T. valves. The firm of Adam Hilger, Ltd., of Camden Road, London, N.W., had assembled various types of optical and physical apparatus, among which their optical sonometer is of special interest, applicable as it is to the study of wave forms in connection with wireless telephony. The optical sonometer records the pressure variation caused by sound waves, and the instrument is so designed that the sound waves are received by a horn attached to a diaphragm, the inner face of which is platinised. Light from a suitable source is brought to a focus on the diaphragm, and the beam then brought to an intense point image upon a revolving drum provided with photographic paper. In this way a continuous record of the deflection of the diaphragm is obtained.

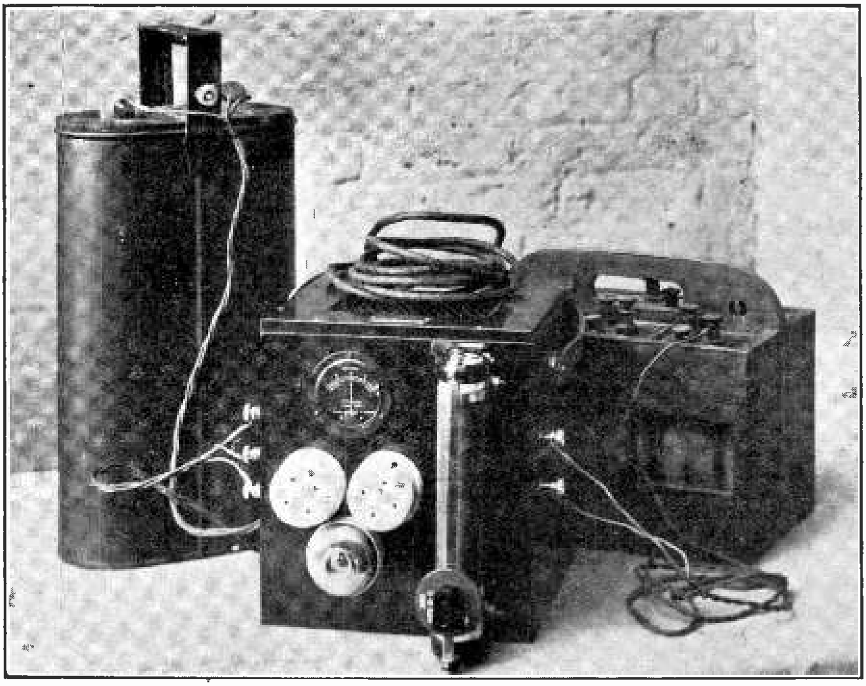
The numerous electrical exhibits of Messrs. Elliott Brothers (London), Ltd., mainly measuring and testing instruments, included their direct reading potentiometer in which a special feature is the high insulation obtained by the enclosure of all current-carrying parts.

Everett, Edgcumbe & Co., Ltd., of Hendon, provided a comprehensive display of electrical measuring and controlling instruments ranging from a 2-in. "Dwarf" pattern, specially adapted to wireless requirements, to a 200,000 volt voltmeter.

Evershed & Vignoles, Ltd., presented a series of insulation testing instruments. Gambrell Bros., Ltd., of Merton Road, London, S.W., exhibited models of their inductances, tuners, amplifiers and various components for experimental work. Igranic Electric Co., Ltd., of Bedford, were represented by exhibits of their inductance coils. Nalder Bros. & Thompson, Ltd., of Dalston, London, provided a selection of measuring and testing apparatus manufactured by them.

Among the apparatus shown by Negretti and Zambra, a useful little instrument for providing a forecast of the weather claimed attention. The weather forecaster may be had in a convenient form which has the size and appearance of a watch. Of the other portable forms, one is for use in conjunction with a barometer, whilst the other combines both barometer and forecaster in an instrument about 10 ins. in diameter. Among their other electrical exhibits, H. W. Sullivan, Ltd., provided a display of radio-telephony transmitters and receiving sets, and also their standard wavemeter (40 to 25,000 metres). The Zenith Manufacturing Company, of Willesden Green, London, exhibited resistances, rheostats, etc., and in particular their "Acdic" electrolytic rectifier which was shown under working conditions. This rectifier, it is claimed, possesses important advantages, being self-starting and entirely automatic in operation.

The Mullard Radio Valve Co., Ltd., of Balham, London, S.W., in addition to various accessories for wireless experimental work, including valve sockets, resistances, condensers and telephones, displayed a selection of transmitting and receiving valves.



Zenith Manufacturing Co. Electric Rectifier for charging accumulators from D.C. supply.

Wireless Club Reports

NOTE.—Under this heading the Editor will be pleased to give publication to reports of the meetings of Wireless Clubs and Societies. Such reports should be submitted without covering letter and worded as concisely as possible, the Editor reserving the right to edit and curtail the reports if necessary. **The Editor will be pleased to consider for publication papers read before Societies. An Asterisk denotes affiliation with the Radio Society of Great Britain.**

Correspondence with Clubs should be addressed to the Secretaries direct in every case unless otherwise stated.

Cambridge University Wireless Society.*

Hon. Secretary, Mr. J. B. Hickman, 4, Rose Crescent, Cambridge.

On November 6th a paper was read to the Society by Flight Lieut. de Burgh, R.F.A., who dealt with the various methods of radio-goniometry. He described the loop, Bellini Tosi and the unilateral systems of direction finding, and also gave an account of directional work in connection with aircraft. The meeting closed with a discussion and a very hearty vote of thanks was passed to the lecturer.

On November 13th, Lieut. G. W. N. Cobbold, M.A., of the Signals Experimental Establishment, Woolwich, lectured to the Society. His paper was a description of a method of measurement of the constants of an aerial, *i.e.*, capacity, inductance and resistance. At the conclusion of the lecture this apparatus was shown working, and the constants of the small laboratory aerial were found.

On November 20th, Mr. T. Hollingworth, M.A., Peterhouse, of the National Physical Laboratory, Teddington, gave a most interesting lecture. The substance of his discourse was "The Application of Theory to Radio Practice." To some his remarks seemed rather pesimistic. He pointed out that although the pure mathematics and what it showed was always right, yet there were limits to the function of the mathematician. There were constants that were not constant, and other factors that might be put down and solved in a differential equation, yet actually in practice the result might be very far removed from what the theory would indicate. Pure mathematics gave the law, but the quantitative result could often not be obtained with any degree of accuracy. So the practical working had to be associated carefully with what the theory would show. The theoretical side must always be borne in mind, but its limitations must be intelligently noted, or there would be serious discrepancy.

The Thames Valley Radio and Physical Association.*

Hon. Secretary, Mr. Eric A. Rogers, 17. Leinster Avenue, East Sheen, S.W.14.

A meeting was held at the headquarters of the Association on January 4th, 1923, with Mr. C. Appleton-Smith in the chair. The minutes of the previous meeting being confirmed, the Chairman called upon Mr. Jocelyne to give his lecture on "Induction." With a series of experiments and liberal blackboard sketches, the lecture proved both interesting and instructive. At the end of the lecture questions were answered by Mr. Jocelyne, and a vote of thanks was accorded him for his work.

The Chairman then read out the list of dates on which the Technical Committee is to give Radio concerts to local hospitals, and the members were also informed of the lectures arranged for January and February. On this occasion ten new members were passed for membership, and 28 members and eight visitors were present.

On January 18th, Mr. Dowse will lecture on "Sound," and an exhibition of members' sets will be held on January 25th, 1923.

Leeds and District Amateur Wireless Society.*

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

A general meeting was held at the Grammar School on January 5th, Mr. W. G. Marshall being in the chair. The minutes of the previous meeting having been accepted and other business discharged, the Chairman called upon Mr. T. Brown Thomson to lecture upon the "Transmission of Photographs by Wireless."

The lecturer sketched the methods that have been used since 1847, paying particular attention to the efforts of Knudsen in 1908. Mr. Thomson expressed his belief that it would soon be possible to transmit an ordinary negative without the use of special plates, and advocated the use of undamped waves for such a transmission. Various methods of transmission using spark, arc, or valve were briefly considered, and arrangement of receiving apparatus examined.

A valuable discussion arose after the conclusion of the lecturer's remarks, there being some very original but quite practical remarks put forward. Synchronisation again received close discussion. The problems of atmospherical disturbances and harmonics of GBL were touched upon, but soon abandoned as they tended to dishearten the meeting.

Mr. Thomson was heartily thanked for his paper, and the meeting closed after Mr. J. O'Donohoe had been elected Chairman for the next meeting.

Stoke-on-Trent Wireless and Experimental Society.*

Hon. Secretary, Mr. F. T. Jones, 360, Cobridge Road, Hanley.

A meeting of the Society was held at the Y.M.C.A., Hanley, on Thursday, January 4th, under the Chairmanship of Mr. Bew. After the ordinary business of the meeting was concluded a lecture was delivered by Mr. R. W. Steel, on "Sources of Electric Current." In the opening portion of his address he explained the nature of electricity by means of the Electron theory, and then proceeded to describe the various methods of producing electricity, classifying them under four main headings: Frictional, Chemical, Thermal and Dynamical.

A series of lectures has been arranged to take place on alternate Thursdays, the next of which will be given on Thursday, January 18th, by Mr. L. F. Fogarty (Treasurer, Radio Society of Great Britain), on "Rectifiers."

Wandsworth Wireless Society.*

Hon. Secretary, Mr. F. V. Copperwheat, Wandsworth Technical Institute, High Street, Wandsworth, S.W.18.

By the courtesy of Capt. E. S. Davis, members of the above Society were afforded an interesting evening on Wednesday, December 20th, at "The Pavilion," Marble Arch, better known probably as **2 BZ.**

On arrival, the party were admitted to the private theatre and several films of an educational character were shown, these being interspersed with broadcast music. During the changing of one of the films the opportunity was taken of recording wireless telephony and music on a dictaphone.

The announcement that loud speakers could be made out of tooth powder tins caused no small comment, but upon producing the instrument so named, and subjecting it to severe working conditions, those present had to admit that this was possible, at least as far as **2 XL** was concerned.

The workshop was a source of envy to most of the visitors, as were some of the pieces of both amateur and professional apparatus displayed.

After partaking of refreshments kindly provided by their host, the party proceeded to inspect the Power House, with its generators, main distribution panels, air compressors and battery rooms. Altogether a more enjoyable evening would have been almost impossible, thanks to Capt. E. S. Davis, the organiser, Goldwyn Bray and Gaumont, Ltd., and The Marconi Wireless Telegraph Company, who kindly lent the films.

The Society has now commenced its new session and intending members should apply to the Secretary.

The North Lincs. Wireless Society.*

Hon. Secretary, Mr. N. Harrison, 323, Cleethorpes Road, Grimsby.

The Society held its first annual social gathering at the Japanese Café on January 3rd. There was a record attendance, about seventy sitting down to supper. Proceedings opened with a whist drive, followed by songs by Mr. Bentinck, and an excellent forty-five minutes magical entertainment.

Supper was followed by the presentation of prizes which in the ladies' case took the form of handkerchiefs, and in the gentleman's a wireless set. The President, Mr. E. H. Dutton, gave a short address outlining the growth and objects of the Society.

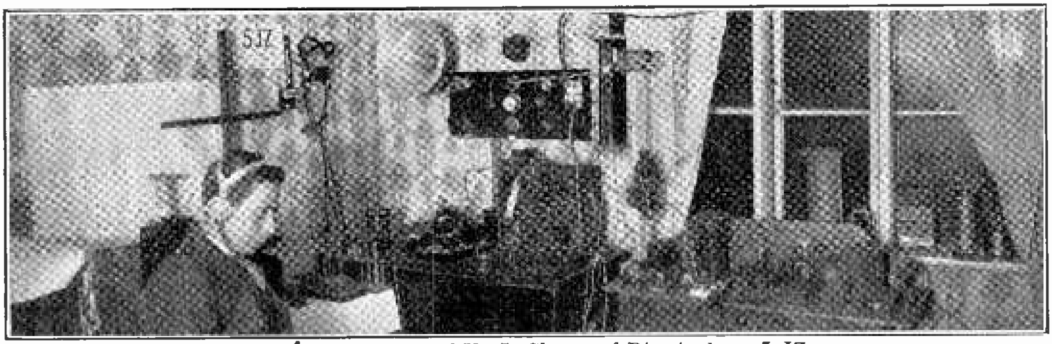
Oldham Amateur Radio Society.*

Hon. Secretary, Mr. W. Schofield, 92, Sharples Halt Street, Oldham.

The above Club has now been formed, and the following officers elected :—Chairman, Mr. J. Everett; Hon. Treasurer, Mr. H. Hinchcliffe; Instrument Steward, Mr. W. J. Potts; Librarian, Mr. J. O. Gardiner; Committee, Messrs. H. Humphrey, C. Mills and R. Grimshaw.

At the last meeting the Chairman, Mr. Everett, started a morse class which will be carried on during the first half-hour of each meeting. On the same occasion Mr. Humphrey gave a very clear and interesting explanation of electrical signs used in wireless circuits. At this meeting it was decided to begin upon the construction of a four-valve set.

The weekly meetings of the Society are held on Fridays at 8.30 p.m. At the next meeting to be held on Friday, January 12th, 1923, Mr. Everett will give a paper on "Aerial Construction," and on Friday, January 19th, Mr. Potts will lecture on "Electrical Units."



The amateur station of H. J. Cheney of Birmingham, **5 JZ.**

Southend and District Radio Society.*

Hon. Secretary, Mr. A. L. Whur, 4, Wimborne Road, Southend-on-Sea.

At the general meeting held at headquarters, 76, Queen's Road, Southend-on-Sea, Mr. H. Jagged gave a very interesting lecture on various small pieces of apparatus used in connection with wireless matters. The advantages and disadvantages of various kinds of coils and coil holders used for Wireless reception were discussed by the lecturer, who showed by means of drawings convenient methods of mounting coils and making plug-in H.F. transformers, resistances, tuned anode coils etc.

The Chairman, Mr. D. L. Plaistow, then spoke about a new permanent radio detector known as the Phonephane, and said that he hoped to have one shortly for experimental purposes and to be able to give a short lecture on it at a later date.

The Secretary would be pleased to hear from anyone in the district who is desirous of joining the Society.

Cowes District Radio and Research Society.*

Hon. Secretary, Mr. L. Ingram, 1, Mill Hill Road, Cowes. I.W.

At the headquarters on Wednesday, December 6th, two papers, one entitled "Some Scientific Aspects of Wireless," and the other "Freak Transmissions," were read by Mr. Ellis, the Vice-Chairman.

The Wembley Wireless Society.*

Hon. Secretary, Mr. W. R. Mickelwright, A.M.I.E.E., 10, Westbury Avenue, Alperton, Wembley, Middlesex.

On November 25th, about 30 members had the pleasure of visiting Northolt Transmitting Station by kind permission of Mr. Brown of the G.P.O.

The party were met by Mr. Evans and Mr. Wilson, who conducted the members over the station where the plant and apparatus was explained in detail. Great interest was displayed in the generating plant, switchboards, arc transmitters, valves, and receiving apparatus, and also the three 450 ft. masts and fan-shaped aerial.

Before leaving the President gave a brief address of thanks to the hosts for the cordial reception which they had so kindly given to the members of the Society.

Lectures have recently been given by Mr. H. W. Gregory on "The Inductive Effect of Iron," by Mr. B. J. Axten on "The Valve," by Mr. W. E. Wallis on "Notes on Circuits," and by Mr. H. W. Comben on "Inductance and Capacity."

The Society has now erected a new aerial mast, the better aerial enabling lecturers to demonstrate the merits of various apparatus, such as tuners, condensers, etc.

The social evening on December 8th, arranged by Messrs. Hawking and Lewis, with a committee, was a great success, over 100 members and friends being present. The Society's membership continues to increase, and the meetings become more interesting and instructive each week, as additions are made to the Society's apparatus and equipment.

On December 14th, Mr. B. J. Axten gave a lecture and demonstration on "The Oscillating Valve." Anti-radiation circuits were described, and the steps necessary to prevent radiation were demonstrated.

Mr. W. A. Robinson has presented the Society with a detector panel, and it is proposed to add stages of amplification to this, so that a loud speaker will always be available at the Thursday evening meetings.

It is thought that if other Societies would give beginners instruction on the correct use of their sets the interference caused by local amateurs would soon be eliminated.

Battersea and District Radio Society.

Hon. Secretary, Mr. F. J. Lisney, 66, Newland Terrace, Queen's Road, S.W. 8.

The first annual meeting of the Society was held at the headquarters, "The Invitation," Cairn's Road, S.W.11., on December 28th.

It was decided to hold two meetings a week, commencing on January 1st: Mondays, from 7.30 p.m., buzzer and experiments; Thursdays, 7 p.m. buzzer, 8 p.m. lectures and demonstrations.

An aerial has been erected, and the experimental three-valve panel is in hand. This panel will be drilled by Mr. Howling, and assembled on Thursday evenings, members making and winding coils where possible. The wiring will be of such a nature as to facilitate easy connections of any circuit or apparatus to be tested.

Subscriptions have now been fixed at 10s. per annum for seniors, and 5s. per annum for juniors (under 18), payable quarterly in advance; all new members to pay in addition an entrance fee of 1s.

Mr. Howling has promised to continue his weekly lectures and to supply apparatus until the experimental panel is finished. These lectures are particularly interesting to those building new sets, as all values and dimensions are plainly set out. Anyone willing to give a lecture or demonstration is asked to communicate with the Hon. Secretary.

All amateurs in the district are cordially invited to join the Society, and are assured of a continuance of instructive and entertaining meetings, full particulars of which can be obtained from the Secretary.

Norwich and District Radio Society.

Hon. Secretary, Mr. H. A. Greenfield, 160, Queen's Road, Norwich.

The inaugural meeting of this Society was held at the Y.M.C.A., St. Giles', Norwich, recently. and thirty-one members were enrolled. The Chairman, Capt. H. J. B. Hampson, in his opening remarks, said that in consequence of the strides that had been made in the science in radio, both during and since the war, many societies had sprung up, and although the number of those interesting themselves in the subject in Norwich was now considerable, there was as yet no radio society. In this Norwich was, he said, behind many less important provincial centres, and it was to remedy this that the meeting had been called.

The Chairman went on to outline the possible scope of a local society, and among other things mentioned lectures both of an elementary and more advanced nature in order to assist all to learn more concerning this subject.

Passing to the interference caused by the unskilled use of reaction, Captain Hampson said he thought that a society could do much to remove this nuisance by helping the inexperienced to acquire the knowledge necessary to handle their sets without causing disturbance to others.

Regarding affiliation to the Radio Society of Great Britain, the Chairman said that although this was in his opinion a very desirable thing, and one to be put into execution as soon as possible, he felt that the Society ought, perhaps, to become established before incurring the expense of this.

Mention was made of a Society mart at which members could exchange apparatus among themselves, of field days during the summer months and of the appeal recently broadcast from Marconi House by Captain Ivan Fraser of St. Dunstan's on behalf of the blind wireless amateur.

In conclusion the Chairman suggested that the annual subscription should be 10s. 6d., with a reduced subscription for schoolboys. The meeting then proceeded to the election of officers, with the result that Captain H. J. B. Hampson was elected President, and Mr. H. A. Greenfield Hon. Secretary and Treasurer, while the Committee was formed of the following gentlemen:—Messrs. K. H. A. Newhouse, J. G. Hayward, W. G. Hurrell, G. A. Rudd, A. P. Cooper, C. H. Moore and J. E. Nickson.

The Society had been fortunate in acquiring the use of a room at the Y.M.C.A. for weekly meetings as the result of the kind consideration accorded to them by the Y.M.C.A. Secretary, Mr. O. L. Whitmee. Meetings will be held weekly on Fridays at 8 p.m., to which all who are desirous of joining the Society are cordially invited.

Leeds Y.M.C.A. Wireless Society.

Hon. Secretary, Mr. N. Whiteley, Wireless Section Y.M.C.A., Albion Place, Leeds.

A meeting was held on January 1st to discuss the rules of the Society and other business. It was decided to accept the room offered by Mr. Mills, which will be used as an experimental room and workshop, and it is hoped, providing the necessary grant is forthcoming, to install a four-valve receiving set. The set will be constructed and made by members themselves, and will provide a good opportunity for beginners to gain some practical experience.

A Technical Advisory Committee has been elected, consisting of Messrs. Whiteley, Parker and Boocock, who will also be responsible for the scheme in detail. Mr. G. Boocock was elected Chairman for the ensuing month.

British Wireless Relay League.

READERS will remember that in the issue of *The Wireless World and Radio Review* for August 26th, 1922, page 697, an announcement appeared regarding the formation, under the auspices of the Manchester Wireless Society, of a British Wireless Relay League which had the approval of the Postmaster-General.

The success of the Transatlantic Tests held this year, which, in America were organised by the American Radio Relay League, has naturally given a stimulus to the similar enterprise in this country, and consequently the following letter, which has been forwarded to the Secretaries of the wireless societies throughout Great Britain, will be of particular interest.

15/1/23.

Dear Sir,—A meeting of the above League, which has the approval of the Postmaster-General, was held in Manchester on Thursday, January 11th, and it was decided to circularise the wireless societies of Great Britain with a view to obtaining their co-operation in the management and control of the League. In view of the recent enormous success of the Transatlantic Tests, it is desirable that every effort should be made to maintain the enthusiasm which has been shown in America, France, Holland and other countries, and, in the opinion of the promoters, this can only be done by enrolling all wireless experimenters in Great Britain. Mr. Pocock, Editor of *The Wireless World and Radio Review*, has been elected Hon. Secretary, and it was unanimously decided to adopt the *Wireless World and Radio Review* as the official organ of the League. A request has been forwarded to the Radio Society of Great Britain asking that the matter of the League be included on the Agenda at the Annual Conference to be held in London on January 24th, when a suitable membership has been attained. The question of districts will be discussed, and suggestions from all those interested will be appreciated. Amended rules are attached herewith.

Yours faithfully,

H. Green.

President.

It will be seen that the proposal is to bring up the question of a British League before the Annual Conference, which takes place on January 24th, and in order to ensure the success of the League, the heartiest co-operation of all societies and individual amateurs is necessary. The organisation and management of such a League is no longer a matter which can be directed by one Society alone, but this work must be undertaken by the co-operation of all the societies through some such means as the Conference of Wireless Societies, which it is now understood are to be held at more frequent intervals than annually as in the past.

The present officers of the League are:—*President*, Harold Green, A.M.I.E.E., A.M.I.M.inE.; *Traffic Manager*, Y. W. P. Evans; *Hon. Treasurer*, W. H. Lamb; *Hon. Secretary*, Hughs S. Pocock, The Offices of *The Wireless World and Radio Review*, 12-13, Henrietta Street, W.C.2.

The Tungar Rectifier

By A. RUSHTON, M.Sc., A.M.I.E.E.

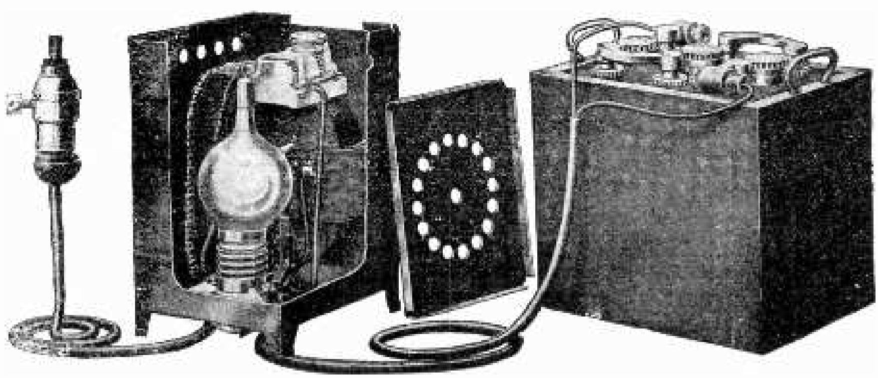
THE present article deals with the results and oscillograms obtained in an experiment performed on a B.T.H. Tungar rectifier used for charging secondary batteries. The Tungar rectifier is a self-contained device for changing alternating to direct current and transforming it down to the required voltage. Its chief parts comprise a bulb, or two-electrode valve (which performs the rectification), a transformer, a reactance in the larger sizes, a D.C. fuse plug and a bayonet adapter to fit the standard lampholder.

The bulb or valve is filled with argon and has two electrodes, a low voltage tungsten filament (the cathode) and a graphite electrode (the anode). The current can only flow through the valve from anode to cathode, that is, from the graphite electrode to the tungsten filament. Thus the valve acts as a rectifier and if supplied from an alternating current source, one half-wave is completely suppressed and a pulsating unidirectional current results. This valve action also has the important advantage of preventing the batteries from discharging back through the rectifier in the event of the alternating current supply being cut off for any reason.

The Tungar rectifier on which the present experiments were carried out was of the home garage type, 5 to 3 amperes, 7.5 to 15 volts D.C., the auto-transformer having primary tappings for 105, 115 and 125 volts at 60 cycles.

A diagram of connections is shown in Fig. 1.

The rectifier is suitable for charging 3 or 6 cells, according to the position of the D.C. fuse, for which two sockets are provided just under the cover. The charging current depends entirely upon the number of cells and the condition of charge. A 3-cell battery will take approximately 5 amperes, a 6 cell battery 3 amperes, and a 9 cell battery 1.5 amperes. Therefore, to use the rectifier, it is only necessary to connect the D.C. leads to the battery, taking care of polarity; insert the adapter in a convenient lampholder and turn on the switch.



By Courtesy of the British Thomson-Houston Co., Ltd.

Schematic view of the Tungar apparatus connected up to AC Supply and arranged to deliver accumulator charging current.

Tests were made at 60 and 83 cycles per second, the latter being the frequency on which the rectifier was to be used; the supply voltage being 105 volts in each case. The A.C. input was measured by means of ammeter, voltmeter and wattmeter. The rectifier was used to charge six accumulators, the direct current being measured by two ammeters, a moving-coil and a moving-iron, and the voltage by a moving-coil and a moving-iron voltmeter. The moving-coil instruments, of course, measure the true average value of the current and voltage, while the moving-irou instruments (the readings of which depend upon the square of the current through them)

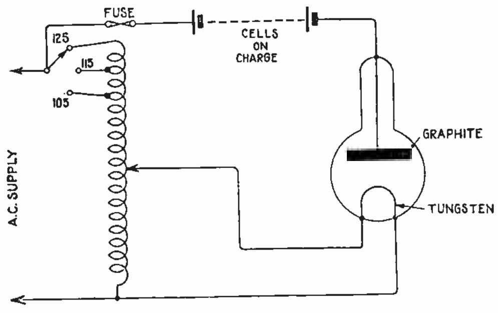


Fig. 1.

measure the equivalent or root mean square (R.M.S.) values.

the period, the negative half-wave being suppressed during the other half period. In Figs. 4 and 5 the positive half-wave of current occupies less than half the period, the charging

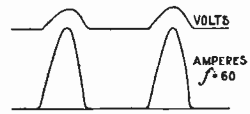


Fig. 4.

current being zero for more than half the time. This is caused by the back E.M.F. of the battery which prevents current flowing when the forward E.M.F. from the rectifier is less than the back E.M.F. of the battery. The effect of this and more particularly the

TABLE 1.

Alternating.					Direct.				Oscillogram.
Frequency	Volts.	Amps.	Watts.	Power Factor	Average Volts.	R.M.S. Volts.	Average Amps.	R.M.S. Amps.	
60	105	0·58	55	0·90	11·7	18·8	—	—	Fig. 2
60	105	2·04	127	0·59	14·3	14·4	2·45	4·12	„ 3
83	105	0·56	55	0·93	11·0	18·4	—	—	„ 4
83	105	1·53	105	0·65	14·3	14·4	1·75	3·0	„ 5

N.B.—The tests on 83 cycles were made after those on 60 cycles.

Readings were also taken with the D.C. side of the rectifier open-circuited

The results obtained are given in Table 1.

By means of the Duddell high-frequency oscillograph, oscillograms were taken of the

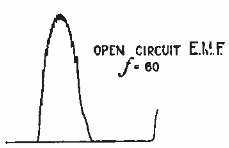


Fig. 2.

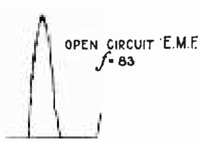


Fig. 3.

current and voltage supplied to the battery and of the voltage of the rectifier on open-circuit. These are shown in Figs. 2, 3, 4, and 5. In Figs. 2 and 3 (open circuit) the positive half-wave of voltage occupies half

suppression of the negative half-wave is to make the average current small compared with the maximum; thus in Figs. 4 and 5, the maximum is about 4 times the average

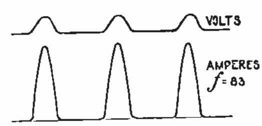


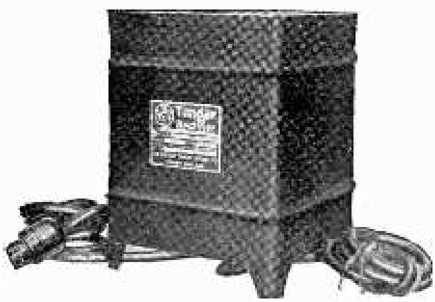
Fig. 5

current. The ripples which occur in the wave of open-circuit E.M.F. disappear as soon as a small current (0.2 amperes) is taken out of the rectifier. The ratio of the equivalent or R.M.S. value to average value is known as the form-factor of the wave, while the ratio of maximum to R.M.S. value is known as the crest factor. These values have been calculated and are entered in Table 2.

TABLE 2.

Oscillogram.	Frequency	Input Watts.	Output Watts.	Efficiency Per cent.	D.C. Volts.			D.C. Amperes.		
					Maxm.	Form factor	Crest factor	Maxm.	Form factor	Crest factor
Fig. 2	60	55	—	—	40·8	1·6	2·17	—	—	—
„ 3	60	127	39	30·7	16·8	1·0	1·17	9·35	1·68	2·27
„ 4	83	55	—	—	40·2	1·67	2·18	—	—	—
„ 5	83	105	30	28·6	16·3	1·0	1·13	7·35	1·71	2·45

The capacity of a battery depends upon the quantity of electricity stored, that is, upon $\int i\,d\,t$ where i is the current at any instant. If the current supplied to the battery is a varying one, as it is in this case, then the quantity stored equals $I_{av}\,t$, where I_{av} is the average value of the current during the time t. This is, of course, measured on a moving-coil instrument, and if a moving-iron instrument



By Courtesy of the British Thomson-Houston Co., Ltd.

The Tungar Battery Charger designed to give an output of about 2 amperes.

is used (as is often the case because of cheapness) quite an erroneous idea of the quantity supplied during the charge will be obtained.

In order to calculate the efficiency of the rectifier, it is necessary to know input and output in the same units. The power on both sides is not constant but pulsates about a certain mean value. The average input is measured on the wattmeter, the average output being found as the average height of the product of the current and voltage waves, that is $\int_0^t i\,e\,d\,t$ From this the efficiency has been calculated. the results being given in Table 2.

As regards efficiency, the Tungar rectifier does not show up so well as, say, the mercury vapour rectifier, but it is cheaper in first cost. It is much more efficient than the method of charging cells off the 100 or 200 volt D.C. lighting mains, unless charging is only carried out when lighting is required.

When the supply is alternating current the Tungar rectifier should be most useful for charging small cells employed in wireless and other work.

The great points in favour of the Tungar rectifier are its simplicity and compactness. There is very little to go wrong and it can be left unattended for almost any period.

The above experiments were performed in the Electrical Engineering Department of the City and Guilds (Engineering) College, S.W.7, under the direction of Professor T. Mather, F.R.S., to whom the writer's thanks are due.

THE RADIO SOCIETY OF GREAT BRITAIN

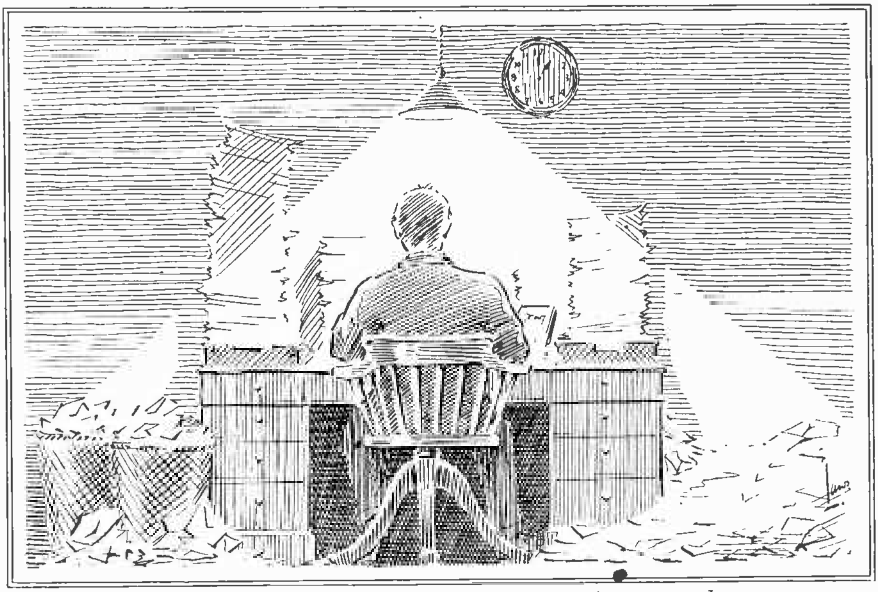
PRESIDENTIAL ADDRESS & ANNUAL CONFERENCE

On January 24th, at the Institution of Electrical Engineers, London, at 2.30 p.m.

The Transatlantic Tests

NOW that the Transatlantic Tests are over, a great keenness to know the results is bound to exist among all those who participated in and watched the progress of these experiments.

Owing to the enormous amount of work, however, which has fallen upon Mr. Philip R. Coursey, the organiser of the tests, we must exercise our patience, as the task with which he is confronted is a formidable one.



Any night since the Transatlantic Tests. Sorting out results.

The number of letters to be dealt with and the information contained therein to be extracted, is very great. He is devoting all his efforts to the completion of his report for publication at an early date, and it is hoped before very long to give full details of the results achieved. It is understood that the tabulated results up to the present have reached 106 pages of manuscript.

In the meantime it is interesting to read the following extracts from a letter which he has received from Mr. K. B. Warner, Secretary of the American Radio Relay League, who was responsible for making the necessary arrangements on the American side.

December 21st, 1922.

" . . . . Mr. Schnell has handed " me yours of November 29 . . . . . and it is " my pleasure to acknowledge.

" It has been so entirely awe inspiring to " receive the daily reports from your good " self and Dr. Corret that we are unable to " think intelligently about the matter at this " early date. Our expectations have been " so completely surpassed and the success " of your listeners has been so great that all " of our standards are swept away. We can " only say that to British and French amateur " radio is due the very highest commenda- " tion, and we offer our sincere congratulations.

" I suppose this will be the last eastbound " transmission test—your fellows have done " the thing so conclusively that there will be " no thrill in further attempts. Doubtless, " however, many of them will request " American stations to send at another time " for them to listen to, and I wish that you " would be at particular pains, if possible, " to point out that the transmission during " these tests has not represented any particular " departure from our routine amount of " transmitting, and that on any night in good " weather, particularly Saturday night, regard- " less of whether there are special tests or " not, the amateur air in the United States " is just as occupied as it has been during these " transatlantic tests. Your men should be " able to listen in at any time of any night " and hear American amateurs working DX. " . . . .

"I wonder if you can imagine how interested "we are in the apparatus used by your amateurs "in the marvellous reception. Your results "proved that you have found the right com- "bination, and it is undoubtedly of an order "superior to what American amateur radio "is using. . . . .

"With renewed congratulations and ap- "preciation of your great help in our behalf, "I am . . . .

"K. B. WARNER."

With reference to the suggestion in this letter that tests may now take place at any time regardless of specially organised arrangements, it should be noted that experimenters in this country have been hearing American amateur stations at other times than during the test periods. The remark with regard to the efficiency of British receiving apparatus are of interest.

With regard to the success of the transmissions from this side of the Atlantic already reported briefly in this Journal it is understood that full details have already been mailed, and will be available for publication in the next issue.

Notes.

A Lecture by Sir Oliver Lodge.

Sir Oliver Lodge will give a Silvanus Thompson Memorial Lecture at the Technical College, Leonard Street, E.C.2, on January 26th, at 7.30 p.m., on "The Basis of Wireless Communication." There will be interesting demonstrations in the laboratories and many pictures and instruments will be on view.

An Association of Radio Manufacturers.

An Association which already includes many of the principal British manufacturers of wireless apparatus has been formed for the purpose of taking up questions of common interest to the trade upon which united action may on occasion be desirable. The avowed objects of the Association, which is known as the National Association of Radio Manufacturers, are to straighten out the somewhat chaotic conditions at present obtaining in this new industry, but without exercising control as a "ring," and to establish fair and equitable conditions of trading. All manufacturers qualified for membership of the British Broadcasting Association are eligible for membership of the National Association of Radio Manufacturers.

Special Speech Transmission from America.

The Wireless World and Radio Review has been informed by Mr. W. J. Crampton that a special message to British Amateurs will be transmitted next Saturday night from America by Mr. Henry Edmunds, a well-known pioneer in electrical engineering, who is at present on a visit to America.

Mr. Crampton wrote to Mr. Edmunds to the effect that it would be of special interest if he could arrange to speak by wireless telephone from one of the American broadcasting stations, in view of the great interest which British amateurs are taking in the transmissions of WJZ and others. In reply the following message has been received :—

> "Through Courtesy American Telephone & next Saturday 9-10 p.m., American time speech 10 minutes from New York WEAS 400 metres from Henry Edmunds to Wireless Amateurs of England."

It is understood that the transmissions will be of 10 minutes duration ; from 9 to 9.10 and 10 to 10.10 p.m. American time, or 2 to 2.10 and 3 to 3.10 a.m. Sunday, British time.

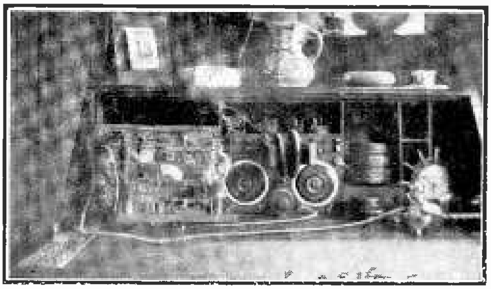
Any reports of the reception of this message will be cabled to America on Monday the 22nd inst., so that anyone receiving the message is requested to forward his report at once ; either to this office, or to Mr. W. J. Crampton direct at 73, Queen Victoria St., E.C.4.

Offices of the British Broadcasting Company.

The offices of the above Company are now located in Magnet House, Kingsway, London.

Broadcasting in Norway.

A comprehensive scheme for the development of wireless broadcasting in Norway is under consideration, and it is reported that the companies concerned propose to popularise the movement by providing receiving apparatus for hire by subscribers at an annual fee. Application has been made for leave to build a large radio-telephone station in Christiania in order to broadcast press exchange news and weather forecasts over the whole of Southern Norway.



The receiving station of Mr. A. N. Jackson Ley at Nottingham, which is ingeniously contained in a writing-desk.

Wireless Installations in France.

The French Under-Secretary for Posts and Telegraphs recently stated that about fifty thousand private wireless installations were in use in France.

Wireless Reception in a Motor-Car in Motion.

Some experiments made a short time ago by the Daimler Company in conjunction with Marconi's, showed that broadcast transmissions could be heard quite distinctly in a motor-car travelling at 20 miles an hour, the actual speed, of course, making no difference. The equipment was all contained in a neat case close to the near side arm rest, no aerials being visible.

Opera Broadcast.

The broadcasting of the actual performance of Grand Opera, an experiment hitherto unattempted, was accomplished with remarkable success on Monday, January 8th, and the nights following, when parts of the production at Covent Garden Opera House, of Mozart's "Magic Flute," and other operas, were transmitted from **2 LO**, the London broadcasting station.

This innovation was brought about by arrangement between the British Broadcasting Company and the British National Opera Company, with the assistance of the Covent Garden electrical engineer, Mr. W. J. Crampton, and the engineering staff of the General Post Office. Transmission from the theatre was effected by microphones placed midway between the stage and the auditorium, and connected by a specially installed underground cable to Marconi House, whence the music was broadcast. Reports of the reception of the operas have been entirely satisfactory, and testimony as to the purity and volume of the music has been forthcoming from many parts of the country. Contrary to expectation, the vocalists were heard more distinctly than the orchestra, although the presence of the instruments, even during solo passages, could always be detected. As was to be expected, the strength of the voices depended, to some extent, on the position of the singers in relation to the microphones, and the imaginative listener could thus locate the whereabouts of each performer.

Owing to the placing of the microphones it was possible to detect very clearly the usual sounds proceeding from the auditorium, the buzz of conversation, and the hand-clapping of applause being remarkably distinct. This enterprising series of experiments concluded with the close of the opera season, but in consequence of widespread public appreciation, it is hoped to carry out similar transmissions in the near future.

The Model Engineer Exhibition.

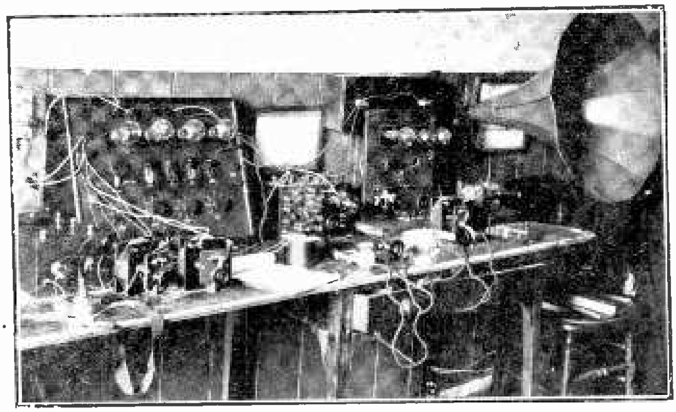
Among many other interesting features on view at the Model Engineer Exhibition recently held at the Royal Horticultural Hall, Westminster, was a display of wireless apparatus, and at frequent intervals during each day demonstrations were given. Exhibits of wireless apparatus and accessories for experimental work were shown by the following firms :—J. B. Bower & Co., Ltd., of Wimbledon ; Wainwright Manufacturing Company, Ltd. ; F. Yates & Sons, Ltd. ; Grafton Electrical Company ; A. W. Gamage, Ltd. ; Peto Scott Co. ; G. Z. Auckland & Son ; Bowyer, Lowe Co., Ltd. ; Leslie McMichael, Ltd. ; M. W. Woods ; Economic Electric, Ltd.

Proposed Wireless Societies.

It is proposed to form a wireless society in Pirbright and district. Mr. W. Day of the Gardens, Pirbright, Surrey, who has kindly consented to act as Secretary *pro tem*, will be pleased to hear from those interested. A radio society is also to be formed in Doncaster and district and all interested are invited to communicate with Mr. Ernest F. Brett, 51, Highfield Road, Doncaster.

Senator Marconi on the Transatlantic Experiments.

The recent successful experiments in Transatlantic wireless telegraphy, carried out by members of the Radio Society of Great Britain, were warmly commended by Senator Marconi in an interview with *The Times*. Referring to the suggestion, however, that in view of the short wavelength employed in the experiments (200 metres and a maximum power of one kilowatt and a half) the existing high power stations for long-distance communication were therefore unnecessary, Senator Marconi disagreed. These high power stations, he explained, using wavelengths up to 30,000 metres and power up to 350 kilowatts, were not unnecessary, because experience had shown that with shorter wavelengths and lower power a eliable service under certain atmospheric conditions could not be maintained. The experiments made by the Radio Society, he pointed out, were carried out in the winter months and in the early morning hours, when wireless transatlantic signalling was least difficult, though there was no satisfactory explanation for the phenomenon.



The amateur receiving station of Mr. B. H. Read of Brundall, Norwich.

Progress of the British Empire Exhibition.

In order to house the large number of exhibits of mechanical and electrical equipment and apparatus which has already been entered for the British Empire Exhibition, it has been found necessary to extend the Machinery Hall by the addition of about 70,000 square feet. The mechanical exhibits are being organised by the British Engineers' Association, and electrical exhibits by the British Electrical and Allied Manufacturers' Association.

2 LO Received at Coventry on Crystal Sets.

It is reported that members of the Coventry and District Wireless Association have been receiving from the London broadcasting station (**2 LO**) on simple receiving sets, in spite of the fact that these are usually considered to have a range of only 25 to 30 miles.

Calendar of Current Events

Friday, January 19th.

LEEDS AND DISTRICT AMATEUR WIRELESS SOCIETY.
Lecture on "The Armstrong Super-Regenerative Receiver," by Mr. H. F. Fardley, M.I.R.E.

SHEFFIELD AND DISTRICT WIRELESS SOCIETY.
At 7.30 p.m. At the Dept. of Applied Science, St. George's Square. Lecture on "Practical Construction of Wireless Apparatus," by Mr. Brookes.

THE RADIO SOCIETY OF HIGHGATE.
At 7.45 p.m. At the 1919 Club, South Grove. Sale of apparatus.

OLDHAM AMATEUR RADIO SOCIETY.
At 8.30 p.m. "Electrical Units," by Mr. Potts.

Saturday, January 20th.

LAMBETH FIELD CLUB AND MORLEY COLLEGE SCIENTIFIC SOCIETY.
At 7.30 p.m. Lecture on "Epochs in the Development of Wireless," by Mr. J. J. Denton, A.M.I.E.E.

Sunday, January 21st.

At 3.5 p.m. *Daily Mail* Concert from **PCGG**, The Hague, on 1,050 metres.

Monday, January 22nd.

9.20 to 10.20 p.m. Dutch Concert **PCGG**, The Hague, on 1,050 metres.

IPSWICH AND DISTRICT WIRELESS SOCIETY.
At 8 p.m. At 55, Fonnereau Road. Lecture by Mr. S. Cork.

PUDSEY AND DISTRICT RADIO SOCIETY.
At the Mechanics' Institute. Ordinary meeting.

Tuesday, January 23rd.

Transmission of Telephony at 8 p.m. on 400 metres, by **2 MT**, Writtle.

Wednesday, January 24th.

ROYAL SOCIETY OF ARTS.
At 8 p.m. At John Street, Adelphi, W.C. Lecture on "The New Methods of Crystal Analysis and their Bearing on Pure and Applied Science." By Sir W. H. Bragg, F.R.S.

HALIFAX WIRELESS CLUB AND RADIO SCIENTIFIC SOCIETY.
Lecture on "Short Wave Transmission and Reception," by Mr. P. Denison.

EDINBURGH AND DISTRICT RADIO SOCIETY.
At R.S.S.A. Hall. Lecture by J. G. W. Thompson.

MALVERN WIRELESS SOCIETY.
Lecture on "Telephones and Loud Speakers."

Thursday, January 25th.

ILFORD AND DISTRICT RADIO SOCIETY.
Lecture on "Wireless Waves and Harmonics."

LUTON WIRELESS SOCIETY.
At 8 p.m. At Hitchin Road Boys' School. Exhibit and Demonstration, by A. J. Wells.

DEWSBURY AND DISTRICT WIRELESS SOCIETY.
Lecture by Mr. Whiteley (Bradford).

HACKNEY AND DISTRICT RADIO SOCIETY
At the Y.M.C.A., Mare Street, E.8. Informal meeting.

At 9.20 to 10.20 p.m. Dutch Concert from **PCGG**, The Hague, on 1,050 metres.

Friday, January 26th.

RADIO SOCIETY OF HIGHGATE.
At 7.45 p.m. at the 1919 Club, South Grove. Lecture on "Direction Finding," by Mr. Wise.

MANCHESTER WIRELESS SOCIETY.
Discussion.

LEEDS AND DISTRICT AMATEUR WIRELESS SOCIETY.
Instructional Meeting. Lecture on "Construction of Inter-Valve Transformers," by S. Kniveton.

SHEFFIELD AND DISTRICT WIRELESS SOCIETY.
At 7.30 p.m. At the Dept. of Applied Science, St. George's Square. Practical Demonstration.

Correspondence

To the Editor of THE WIRELESS WORLD AND RADIO REVIEW.

SIR,—Referring to the subject of The Armstrong Super-Regenerative Receiver, I find that the circuit recently given by Mr. Harris works very well, but I would suggest the following modifications :—

(1) The American broadcasting band of wavelengths is slightly under ours, and if the dimensions given by Mr. Harris are followed the condenser should be placed in shunt with the tuning coil instead of in series with the loop.

(2) The intermediate tappings are not required, as I find the minimum W.L. of coil as given about 340 metres.

(3) Vernier adjustments to the variable condensers are a big help, and on the oscillating valve rheostat an immense advantage.

(4) The inductance windings should be in the same direction as the variometer coils.

(5) Although some American writers state C.W. signals cannot be received well, I find no difficulty in their reception, in fact Morse signals were the first heard on this remarkable and tricky circuit.

E. R. W. FIELD.

To the Editor of THE WIRELESS WORLD AND RADIO REVIEW.

SIR,—I think your readers will be interested to learn that I have received a communication from Messrs. Reid, Sharman & Co., Solicitors to Captain Bolitho, informing me that Captain Bolitho is the inventor of the Super-Regenerative Circuit, and that the instrument built by me and described in *The Wireless World and Radio Review* of October 21st last, is covered by Captain Bolitho's patent, 156330.

PERCY W. HARRIS.

January 5th, 1923.

BROADCASTING STATIONS.

Regular evening programmes, details of which appear in the daily press, are now conducted from the following stations of the British Broadcasting Company :—

London	2 LO	369	metres.
Birmingham	5 IT	420	,,
Manchester	2 ZY	385	,,
Newcastle	5 NO	400	,,

Questions and Answers

NOTE.—This section of the magazine is placed at the disposal of all readers who wish to receive advice and information on matters pertaining to both the technical and non-technical sides of wireless work. Readers should comply with the following rules :—(1) Each questions should be numbered and written on a separate sheet on one side of the paper, and addressed "Question and Answers," Editor, THE WIRELESS WORLD AND RADIO REVIEW, 12/13, *Henrietta Street, London, W.C.2. Queries should be clear and concise. (2) Before sending in their questions readers are advised to search recent numbers to see whether the same queries have not been dealt with before. (3) Each communication sent in to be accompanied by the "Questions and Answers" coupon to be found in the advertisement columns of the issue current at the time of forwarding the questions. (4) The name and address of the querist, which is for reference and not for publication, to appear at the top of every sheet or sheets, and unless typewritten, this should be in block capitals. Queries will be answered under the initials and town of the correspondent, or, if so desired, under a "nom de plume." (5) In view of the fact that a large proportion of the circuits and apparatus described in these answers are covered by patents, readers are advised, before making use of them, to satisfy themselves that they would not be infringing patents.* (6) **Where a reply through the post is required every question sent in must be accompanied by a postal order for the amount of 1s., or 3s. 6d. for a maximum of four questions.** (7) *Four questions is the maximum which may be sent in at one time.*

"REDESIGNER" (Kent) *wishes to convert his set from one H.F., one detector, one L.F., to one detector, two L.F., and asks for diagram.*

We suggest you adhere to the old arrangement as we do not think the addition of one note-magnifying valve will compensate for the loss of one high frequency connected valve; but without knowledge of the three-valve circuit which you use, we cannot help you much, nor say why the results are unsatisfactory, but the arrangement of the detector and two-note magnifier set will be only limited by the tuning range of the aerial circuit. See Fig. 1.

"T.C.O." (Southport) *asks whether it is an advantage to use different anode potentials for valves which are used to function in different ways.*

The proposed method of applying the high tension voltage is correct. As a rule you will find that 70 volts are required on the low frequency valves, rather less on the detector valve, and some adjustment is required to obtain the best potential for the high frequency valves. These remarks assume the use of "R" type valves. The adjustment of H.T. potential is just as important as the adjustment of filament current.

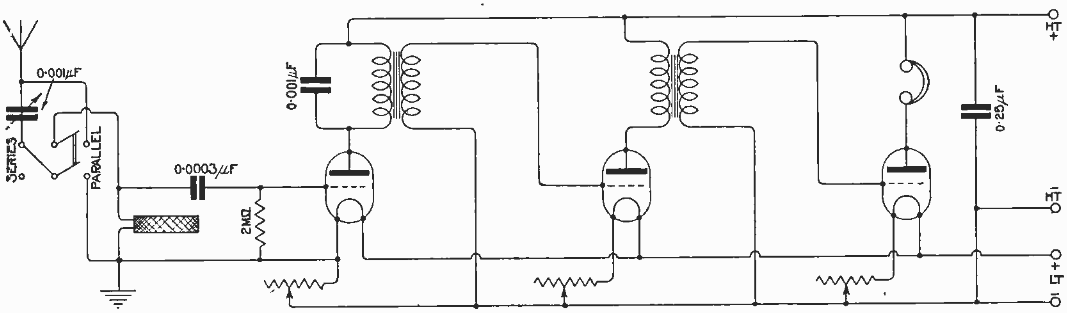


Fig. 1.

"R.H." (Herts.) *asks* (1) *For a diagram of a crystal valve circuit using a loose coupler.* (2) *For the values of various condensers.* (3) *For the position of the telephone transformer and particulars for making same.* (4) *Where to obtain constructional details of honeycomb, basket and slab coils.*

(1) We suggest you look through this section in recent issues when you will find a number of circuits using a crystal and a valve, and you will be able to choose one which meets your requirements. (2) The values of condensers are given in all recent issues. (3) The primary winding of the telephone transformer may consist of 3 ozs. of No. 44 S.S.C., and the secondary, 3 ozs. of No. 34 S.S.C. (4) The construction of coils is fully dealt with in Mr. Coursey's book entitled "Radio Experimenter's Handbook," price 3s. 6d., obtainable from the publishers, 13, Henrietta Street, W.C.2.

"RADIO KLOOFNEK" (Capetown) *has a single-valve set, and asks* (1) *Whether it is detrimental to the working of the set to run various leads from the instruments through a wooden table.* (2) *Whether it is possible to insert a microphone in the aerial circuit and transmit speech for a short distance.*

(1) The circuit is working very satisfactorily, and provided care is taken to properly insulate the leads, and their length is kept reasonably short, we do not think any loss of signal strength will occur through wiring the set on a wooden table. (2) We suggest you increase the filament heating battery to 6 volts, and the anode voltage to 70 volts. It would then be possible with a microphone inserted in the earth lead to transmit telephony for a short distance, provided the coupling between the grid and plate circuits is made very close.

"B.D." (Southsea) *asks* (1) *For a diagram of a five-valve receiver for use on wavelengths up to 2,500 metres.* (2) *How could an external heterodyne be coupled with the receiver.* (3) *Would the arrangement operate a loud speaker.* (4) *How to make a H.F. intervalve transformer for receiving up to 2,500 metres.*

(1) See Fig. 2. A switch is connected in the aerial circuit to join the A.T.C. and A.T.I. in series or parallel for short or long wave reception, and a "tune-stand-by" switch is provided which will be found useful when tuning in. (2) A small coil consisting of a few turns is coupled to the anode coil in the second anode circuit; only a small coupling is required. The generator may be an ordinary heterodyne wavemeter with the coil connected in the anode circuit. When receiving short wavelengths you may find it an advantage to couple the first anode coil with the closed circuit coil. If the circuit oscillates rather easily, the connections to the filaments (A) should be changed from $-^{ve}$ to $+^{ve}$. (3) You will be able to operate a loud speaker from this receiver. (4) H.F. transformers were described in the issues of September 2nd and 16th. The circuit given uses the tuned anode method of coupling as generally good results are easier to obtain, both from the operating and constructional points of view.

"H.E.C." (Surrey) *submits a sample of wire and asks* (1) *Its size.* (2) *If it is suitable for intervalve transformer construction.* (3) *Whether it may be used to wind a telephone receiver.*

(1) The wire is No. 34 S.W.G., S.S.C. (2) The wire is rather heavy for this purpose. We suggest you use 3 ozs. of No. 44 S.S.C. for the primary, and 3 ozs. of No. 46 S.S.C. for the secondary. The telephone transformer may consist of a winding of 3 ozs. of No. 44 S.S.C. for the primary, and 3 ozs. of No. 34 S.S.C. for the secondary. (3) The telephones may be wound with No. 34 S.S.C. wire. The bobbins should be filled.

"J.P." (Preston).—We suggest you employ a three-valve receiver, using one H.F., one detector, and one L.F. connected valves. We cannot name any particular manufacturer, but the firm you mention manufacture a unit system from which you could build up a three-valve set. However, the better plan is to consult the advertisements in this journal, and write for the catalogues issued by the manufacturers concerned and make a choice. Some firms have a good reputation for their products, and these are generally the most expensive. To purchase cheap apparatus is a false economy. The aerial is very satisfactory.

"A.J." (Middlesex).—We consider the result you have obtained to be quite satisfactory. To obtain greater signal strength, we suggest you add one note magnifying valve, and if you wish to receive broadcasting from the broadcasting stations situated in the North of England or Scotland, we suggest you add one high frequency valve connected as indicated in the issue of September 2nd, page 717. The trouble which you experience is due to the series parallel switch, and is simply a matter of tuning. You do not give any particulars of your coil, so we are unable to definitely say whether this is the case. The series parallel switch is connected correctly. We cannot give a definite reason why the "R" valve works best with only 27 volts on the plate, but we consider it is probably due to the use of too low a filament voltage. Four volts are required as a rule across the valve filament, which means that a six-volt accumulator is required if you use a filament resistance.

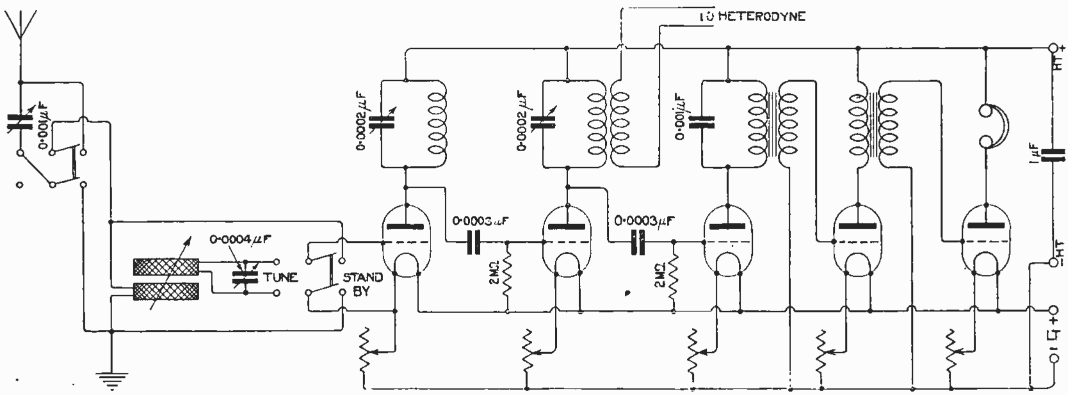


Fig. 2.

"HIGH FREQUENCY" (Birmingham) *asks* (1) *Whether the circuit submitted is suitable for the reception of broadcast transmission.* (2) *The dimensions of the reaction coil.* (3) *Are the values of components as given in an issue of this journal correct.* (4) *Windings of honeycomb coils to cover all wavelengths.*

(1) The circuit is quite suitable, except that the secondary circuit is not tuned with a variable condenser, which is probably a slip. (2) The reaction coil should consist of about 100 turns of No. 38 S.S.C., wound on a former with a diameter of 2″. When receiving long wave signals extra coils may be added in series with the reaction circuit. The reaction coil coupling should be variable. (3) The values given are correct. (4) You should wind about 12 coils, with turns from 40 to 2,500. For short wavelength work use coils with 40, 60, 95 and 130 turns. The formers may be 2″ diameter and 2″ wide.

"**A.B.**" **(Plymouth)** *asks for a diagram of a receiver which will operate a loud speaker when connected with a frame aerial.*

We suggest you use a receiver comprising two H.F., one detector, and two L.F. valves. The H.F. valves may be coupled by means of a tuned anode coil and a grid condenser and leak (fig. 3). The anode coil suggested is quite suitable. We suggest you employ a three-coil holder with a complete set of coils. The H.T. supply for the anodes of the valves should be adjustable; in general, valves which function as H.F. amplifiers do not require the same potential as those which function as an L.F. amplifier. For this purpose tapping leads are indicated. Suitable values of components are indicated, and it would be as well to purchase first-class apparatus. To purchase cheap, or apparatus made by a firm without a great deal of wireless experience, is a false economy. A switch is shown for connecting the A.T.C. and A.T.I. in series or parallel, for short or long waves respectively, and another has the purpose of connecting either the aerial or closed circuit to the first valve. When tuning in, it is better to connect the aerial circuit to the valve, and after signals are heard, to change over to the closed circuit.

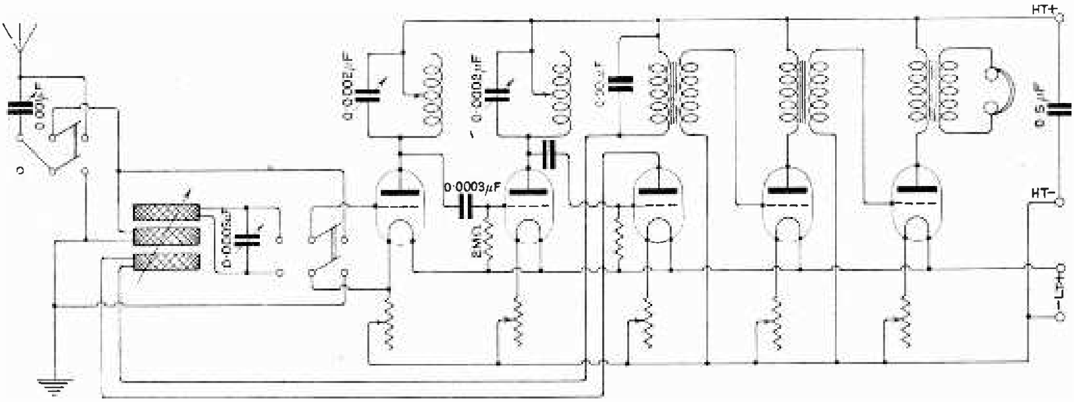


Fig. 3.

"**C.F.I.**" **(Hunts.)**.—The aerial tuning inductance may consist of a winding of No. 28 D.C.C. wire, 5″ in diameter and 8″ long, and 16 tappings may be taken at equal intervals. The secondary circuit, which we assume will be tuned with a 0·0005 condenser, may consist of a winding 4″ in diameter and 10″ long, wound full of No. 32 D.C.C. Ten tappings should be taken from this winding at equal distances. Before winding, the former should be thoroughly dried, and after the winding is wound on the former, the whole should be dried out, and only a little insulating material, such as a good shellac, applied to prevent the absorption of moisture during use.

"**T.S.F.**" **(Hants.)** *asks* (1) *For the issue in which appears the diagram of a receiver suitable for receiving short and long wave telegraphy and telephony.* (2) *Whether a licence is necessary before he can use a receiving set.*

(1) The diagram given on page 316 of December 2nd issue will meet your requirements. The tuning inductance may consist of a winding 5″ in diameter and 8″ long, with 18 tappings. When receiving short wavelengths the high frequency intervalve transformer is used, and the reaction coil may be coupled to the secondary of this transformer. When receiving longer wavelengths, the reaction coil should be coupled with the aerial tuning inductance. The construction of intervalve transformers has been described in the issues of September 2nd and 16th. The anode resistance should have a value of the order of 80,000 ohms. (2) It is necessary to hold a licence before you conduct experiments with wireless reception, and you should apply to the Secretary, the Post Office, London.

"**WORRIED**" **(Yeovil)** *asks* (1) *Who is* **2 FQ**. (2) *Why his receiver, particulars of which are submitted, is noisy.* (3) *The name of the station which is transmitting speech daily on* 3,600 *metres.* (4) *What is the cause of the variation in atmospheric strength between the day and the night reception.*

(1) **2 FQ** is the call sign of Messrs. Burndept, Ltd., experimental station, Blackheath, London. A full list of the call signs of experimental and amateur transmitting stations may be obtained (price 6d.) from the Mail Order Dept., The Wireless Press, Ltd., 12 & 13, Henrietta Street, Strand, London, W.C.2. (2) We suggest you fit a filament resistance to control the filament current of each valve, and increase the L.T. voltage to 6 volts. As your H.T. battery has had considerable use, we think the trouble is due to cells becoming worn out; otherwise the circuit is correct. (3) We have no information of this station, although we believe a number of German stations are conducting telephony transmissions on a wavelength of 3,600 metres daily. (4) The whole question of atmospherics is very involved, and we cannot usefully discuss the question briefly, but we would refer you to any standard text-book on the subject.

"HOPEFUL" (Birmingham) *wishes to convert his one-valve receiver into a two-valve receiver, and asks* (1) *For a circuit showing one H.F. and one detector valve.* (2) *For particulars of windings of the coils.* (3) *Whether to tune the reaction coil.* (4) *Whether he may expect considerably better results from two valves.*

(1) See Fig. 4. Suitable values are marked in. (2) The aerial coil may consist of a winding 4″ in diameter and 8″ long, wound full of No. 22 D.C.C. The anode coil may consist of a winding 3″ in diameter and 8″ long, wound full of No. 28 D.C.C. (3) In this event the tuned anode coil acts as a reaction coil. (4) We think you will obtain much louder signals from this two-valve combination. We have made it as simple as possible and in such a manner that very few new components will be required.

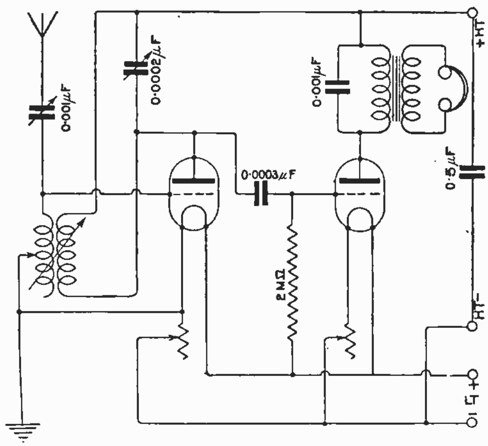


Fig. 4.

"G.F." (Bermondsey) *asks for the connections of a valve detector to replace the crystal detector in his present set.*

See Fig. 5, page 76, October 14th issue. We suggest, however, that you use the single valve as a high frequency amplifier, and still make use of the crystal detector for rectification, and we would refer you to Fig. 2 on page 183, November 4th issue. The anode is tuned by means of a coil and tuning condenser. This method will give far better results than would be obtained from the use of the detector valve by itself.

"C.R." (Weybridge) *submits particulars of his receiver and asks* (1) *The correct method of joining a L.F. transformer.* (2) *For criticism of his receiver.*

(1) The correct method of joining a L.F. transformer is indicated in Figs. 3 and 4, page 215, November 11th issue. (2) The wiring diagram submitted is correct, with the exception of a condenser across the primary winding of the L.F. transformer. In addition, we think you should use higher anode volts, and very likely your valves are not satisfactory. Generally very superior results are obtained when "R" type valves are used. In this case it is better to use an anode potential of about 60 volts with a 6-volt battery connected across the filament in series with the filament resistance. The resistance should be about 7 ohms, and should be sufficient to reduce the filament current, so that there is no danger of the valves burning out. You will notice that we have connected the filament resistances in the negative lead, and the grid leak is connected directly between the grid and negative of the filament battery.

"R.G." (Som.) *refers to Fig. 5, page 216, and asks* (1) *For particulars of the anode tuning coils.* (2) *How to use a three-coil holder with this circuit.*

(1) The first three valves have each a tuned anode coil in the anode circuits, and each coil and condenser should be as alike as possible. Plug-in coils may be used, or tapped cylindrical coils are useful. The coil which is shown coupled to the anode coil of the first valve is the reaction coil, as may be seen from following out the diagram carefully. Coupling the reaction coil in this manner prevents the possibility of energy oscillations being set up in the aerial circuit. The anode coil should be made a little larger than the closed circuit coil. (2) The reaction coil may be plugged in the spare coil to either of the three coil holders, in which case care must be taken to prevent oscillating energy being set up in the aerial circuit. The position of the reaction coil in the diagram referred to is simply moved. The wiring remains the same. Alternatively you could cut out the reaction coil and couple the first tuned anode coil with the closed circuit coil.

"R.W." (Dundee) *asks* (1) *for a two-valve circuit, 1 H.F. and 1 detector, with a switch to disconnect one valve.* (2) *Whether a plate 5′ × 2′ 6″ is suitable for use as an earth.*

(1) See Fig. 5. The tuned anode method of H.F. coupling is used. (2) This should provide a good earth.

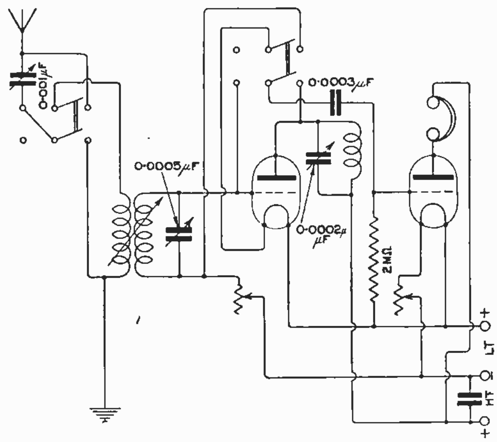


Fig. 5.

"A.G." (Salisbury).—The circuits referred to are good circuits for experimental purposes, but we think you would obtain greater selectivity and amplification by adopting an H.F. intervalve transformer cônnected in the usual manner. The transformer windings should be determined by experiment to give the greatest step-up in voltage, and as each winding is tuned with a variable condenser, the windings should be loosely coupled in order that tuning one circuit will not greatly change the tuning of the coupled circuits. For this purpose the transformer may consist of a cylinder 3½" diameter with a tapped winding. The secondary should be constructed so that it may slide into or out of the primary winding. The winding should be spaced, to reduce self capacity. Using the normal method of connection, the H.T. battery may be common to each anode circuit, although each circuit will require a different H.T. voltage. The circuits sketched are normal circuits, with the addition of variable coupling, the provision of which enables very selective tuning, and high amplification. Suitable valves are indicated. We think it is not advisable to use a common H.T. battery with the type of circuit submitted.

"L.J.V." (Devon) *asks (1) For data to enable him to construct a current limiter or barreter. (2) The explanation of a peculiarity experienced when using a crystal rectifier. (3) Whether it is correct to be guided by filament current or the voltage applied to the filaments.*

(1) We can give you very little data concerning the construction of the current limiter. The wire is of iron or special iron alloy, and is sealed into a tube which contains hydrogen to prevent the wire burning. The exact composition of the wire, and the pressure of hydrogen in the tube is probably only known to the manufacturers, and very little information is available for publication. (2) Without a knowledge of the circuit and disposition of the components of your receiver, we cannot state why the effects are noticed. We think you may be sure the crystal does not provide the explanation. (3) The emission from a given filament depends upon its temperature, which is determined by the heating current. During the life of the valve, the filament becomes thinner, and to maintain the emission, or what is the same thing, to maintain the heating current at its previous value, a higher voltage is required. Sending the same current through the valve in this manner to keep up the emission gives the filament a higher temperature, and its life is greatly reduced. The output of the valve may be maintained by increasing the filament voltage as the filament becomes old, but if long life of the valve is desired, the applied potential should be held constant, and the output be allowed to fall off. When using valves for reception, it is usual to be guided by the requirements of the circuit, irrespective of whether this results in the valve current being varied.

"EASTERN" (Norfolk) *asks (1) Whether diagram submitted is correct and suitable. (2) May reaction be obtained by using a two-coil holder, one coil being a reaction coil and the other forming a tuned anode coil of the first valve. (3) Whether an amplifier in his possession is suitable for use with the circuit in (1) above. (4) Whether proposed arrangement for long wave reception is suitable.*

(1) and (2) The diagram submitted is correct, but you will notice notification which appeared in the issue of November 18th. When tuned stand-by connections are provided, the reaction coil should be coupled with the aerial coil. It is better however to couple the reaction coil and anode coil together. Reaction effects are easily obtained, and the Post Office approve of this method of using reaction. (3) The amplifier in your possession may be used in conjunction with the tuner, in place of the telephones of the tuner. The input circuits of the amplifier should be connected, provided the H.T.— is connected to the same side of the filament battery in each case: common H.T. and L.T. batteries may be used. (4) The grid condenser may with advantage be given a little larger capacity than when receiving on long wavelengths, and we suggest you try 0·0004 or 0·0005 mfds. The by-pass condensers may have the same value as for short wave reception. The grid leak will probably not require changing, although it is sometimes better to connect a little higher leak resistance, and we suggest 2 megohms.

"HETERODYNE" (South Wales).—We do not think you will obtain any increase in output from your generator by joining the valves in parallel We suggest you increase the anode and filament voltage and tighten the coupling between the grid and plate circuit coils. However, the method of joining valves in parallel indicated by your sketch is correct.

"R.A." (Sussex) *asks for a practical test to determine whether the set is oscillating.*

A practical test of oscillation is to touch the grid condenser of the first valve while listening with the receivers. If the circuit is oscillating, a loud pop will be heard in the receivers when the connection is touched, and when the finger is removed. To stop the oscillations, the filament circuit and H.T. potential should be adjusted, and if the circuit persistently oscillates, the reaction coil should be reversed. It will also be better to connect the grid leak to the +ve L.T.

"E.C.H." (Doncaster) *is situated near a large 50 cycle power transformer and has difficulty in receiving signals due to the hum.*

It is a difficult matter to prevent hum when one is situated so closely to a large A.C. power unit. We find that the arrangement which is very effective in one case is useless in another case. However, we think you could make up a rough frame aerial and try the result. The hum which is heard in the telephones before the aerial is connected generally is not heard when signals are received. We suggest a frame aerial because the hum is often picked up by the earth lead having a small P.D. set up across it, and the removal of the outside aerial reduces the chances of inductive effects. Using H.F. valves in place of L.F. valves is generally a very effective method of reducing hum. Iron core transformers themselves pick up a considerable amount of L.F. energy due to the magnetic field set up by the transmission lines. As a final precaution, the set may be completely screened with tin foil, or a tin box, and the telephone and battery leads wrapped round with wire and earthed.

"G.R.W." (Watford) *proposes to construct a three-valve receiver to operate a loud speaker and asks the best arrangement to adopt, with diagram.*

The diagram (Fig. 1) on page 249, November 18th issue, shows the connections of one H.F., one detector and one L.F. coupled valves, and may be thoroughly recommended. The H.F. coupling makes use of a tuned anode, and grid condenser and leak. The anode coil and reaction coil may be mounted on a two-coil holder in a similar manner to the aerial and closed circuits. If the circuit tends to be unstable, you would find it helpful to connect the closed circuit between the grid and + L.T. and the leak resistance + L.T. If you are not accustomed to tuning, we suggest you connect a switch to connect the aerial circuit or the closed circuit to the input of the first valve. Then with the switch in the "stand-by" or aerial position, signals are tuned in. If the switch is now thrown over to the "tune" or closed circuit position, it is quite easy to alter to tune the secondary circuit to the aerial circuit.

"W.S.B." (Newport Pagnell) *sends us a sketch of his aerial and turns, and asks (1) Whether aerial arrangement is suitable. (2) How to add a H.F. connected valve to his crystal set. (3) How to connect the H.F. transformer tappings.*

(1) The proposed arrangement is quite suitable, and we consider you possess a good aerial. (2) and

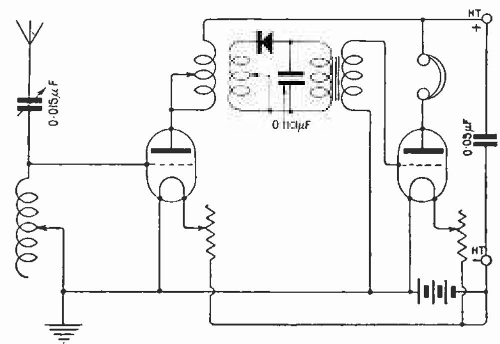


Fig. 6

(3) As you propose to purchase a tapped H.F. transformer, the manufacturer will supply you with a diagram showing how to connect it up. See Fig. 6.

"E.T." (Middlesex).—A broadcast licence is granted only to those persons who purchase apparatus bearing the stamp "B.B.C." The apparatus which bears this stamp has been passed by the Post Office, and is such that energy cannot be set oscillating in the aerial circuit. Persons who construct their own apparatus are not granted a broadcast licence, but an experimenter's licence, if it is considered that their qualifications are such that harmful effects will not result through the use of apparatus.

"E.C." (S.W.16).—(1) Celluloid labels may be fastened to ebonite with Prout's elastic glue. (2) There is no successful solvent of ebonite, but the surface of ebonite may be softened with carbon disulphide.

"K.H.F." (India) *submits a diagram and asks for criticism.*

The proposed arrangement is quite suitable provided single valves are used. It is not necessary neither is it of much assistance, to connect receiving valves in parallel for H.F. amplification.

"W.L.B." (Fulham).—See Fig. 7. Suitable values are marked in.

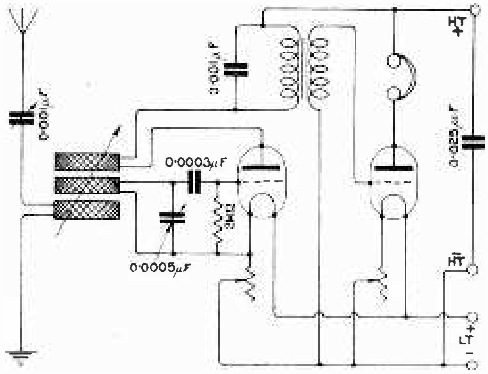


Fig. 7.

"E.B." (Medstead) *asks (1) For criticism of his receiver, particulars of which are submitted. (2) Whether we consider any alteration is necessary. (3) What stations he should receive.*

(1) and (2) The diagram submitted is quite suitable, although when receiving short wavelengths we suggest you connect the tuning condenser in series with the A.T.I. Without a knowledge of the size of your inductance coil, we cannot estimate the wavelength range of the set. The value of resistance given does not help us much, as the inductance coil does not possess resistance in any useful sense. (3) We think you will be able to hear the broadcast transmissions, and also the transmissions of local amateurs. You may, in addition, receive the transmissions from higher power long wave stations.

"H.K." (Gorleston-on-Sea).—(1) The set to which you refer will time from 250 to 650 metres. (2) No doubt the method of connecting the valves is patented, but you may test such circuits in your experimental work. (3) The H.T. battery may be 60 volts and the L.T. 6 volts. (4) We suggest you secure a bound volume of this journal for the half-year ending 30th September, 1922.

"C.G.B." (Wimbledon Park) *submits a diagram of connections and asks (1) For criticism of the proposed arrangement. (2) For particulars of a suitable reaction coil which is to be 4½" in diameter to couple into a tuned anode coil. (3) The approximate capacity of the aerial in microfarads. (4) What is the approximate relationship between the dimensions of the tuned anode coil and the reaction coil for short wave work.*

(1) The proposed arrangement is very suitable indeed, and is a standard circuit. (2) The reaction coil marked "R" in the diagram submitted may consist of 50 turns of No. 34 D.C.C. wound on a 4½" diameter former. Three tappings should be taken. (3) The approximate capacity of the aerial is 0·00025 mfds. (4) To obtain the correct reaction effects the dimensions of the reaction coil depend largely upon the tuning adjustments and upon the wiring of the receiver. In general the reaction coil will require approximately the same inductance as the tuned anode coil.

"W.P.A." (Congleton) *asks* (1) *For criticism of his set.* (2) *For diagram of one-valve set.* (3) *Does the set comply with P.O. regulations.* (4) *For design of a three-valve set.*

(1) The diagram submitted shows no grid leak or aerial tuning condenser, otherwise it is correct. We suggest you use "R" type valves, 6 volts L.T. and 70 volts H.T. It is better to tune the aerial circuit with a condenser of 0·001 maximum capacity, that is, with a condenser made up of about 61 plates. A vernier three-plate condenser may be connected across it for fine tuning. The closed circuit tuning condenser and the inductance are quite suitable. (2) See Fig. 8. The figure indicates the method of connecting up one H.F. valve with one detector valve. The anode of the H.F. valve contains a coil and condenser which together tune to the wavelength of the signal. Suitable values are indicated. (3) The arrangement is permitted by the Post Office. (4) See figure. This circuit is Fig. 8 with a note magnifier added. From these two figures you will be able to add H.F. or L.F. connected valves as desired.

"W.E.N." (Lincoln) *asks* (1) *How to prevent the noise which he hears in the receivers while receiving or when the aerial and earth are disconnected.* (2) *How many turns of No. 30 should be wound on a 2½" former to provide reaction between wavelengths of 200 to 1,000 metres. The reaction coil is to be coupled to the H.F. transformer.* (3) *Is he correct in assuming that if a circuit is using 10 amps. at 60 volts, the watts absorbed in the circuit amount to 600.*

(1) We gather from your remarks that the trouble is due to induction from neighbouring mains. Provided the noise does not exist when the signals are being received, we think you have nothing to worry about. It is a difficult matter to remove the noise. We suggest that if possible you use a counterpoise in place of the earth connection, and also try screening the telephone leads by wrapping them round with soft iron wire connecting them with earth. (2) A suitable reaction coil would consist of 100 turns of No. 30 S.S.C. wound on a 2½" former. We suggest you provide three tappings, as the amount of reaction required depends largely upon the wiring of your receiver. (3) The power absorbed by a direct current circuit in watts is equal to the voltage drop across the circuit, times the current flowing in the circuit, therefore the example quoted above is correct.

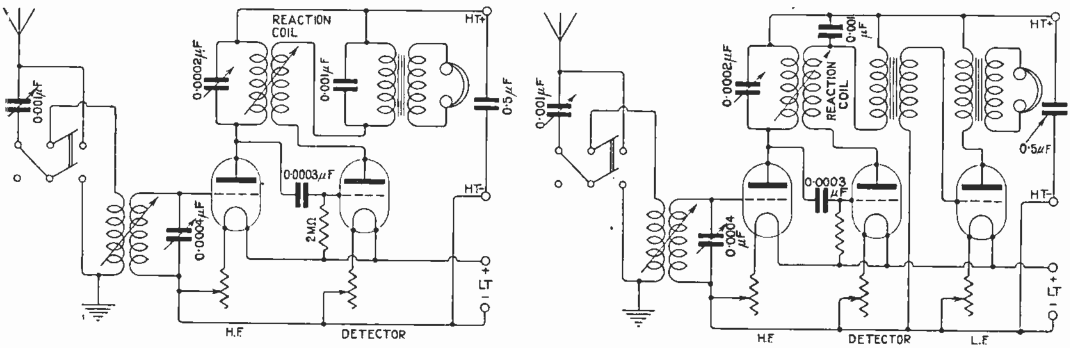


Fig. 8.

"H.D.K." (Clapham) *asks* (1) *For the gauges of the samples of wire submitted.* (2) *Are any of the wires submitted of use in building a telephone transformer. Is the iron wire suitable for the core of a transformer.* (3) *For particulars to enable him to construct a telephone transformer.* (4) *Is there any good book published dealing with the construction of telephone transformers.*

(1) Particulars of the samples of wire submitted are as follows:—(*a*) 34 D.S.C. copper; (*b*) 38 S.S.C. copper; (*c*) 39 S.S.C. copper; (*d*) 37 S.S.C. copper; (*e*) 21 enamelled copper; (*f*) 18 bare copper; (*g*) Gauge 22 iron wire. (2) and (3) We suggest that for the primary winding of the telephone transformer you use No. 39 S.S.C. copper wire and for the secondary No. 34 S.S.C. wire. The core may be built up of the No. 22 iron wire. We suggest you build a core ½" in diameter and 4" long. The primary winding should be wound on first, and may consist of 4 ozs. of No. 39 S.S.C. wire. The secondary may consist of 2½ ozs. of No. 34. The high resistance telephones may be connected in series with the telephone transformer primary, and a third winding on the transformer is not recommended. (4) We do not know of a suitable publication to which you may be referred.

"AMATEUR ELECTRIC" (Cheshire) *submits a diagram of the connections of his receiver and asks* (1) *Whether the connections are correct.* (2) *The correct method of connecting L.F. valves.* (3) *How to add a H.F. panel, using the H.F. transformer method of amplification.*

(1) The connections of the unit system are not quite correct. We suggest you add a closed circuit, and a grid leak and condenser. Presumably the latter was omitted from the sketch in error. (2) Calling the beginning of the primary and secondary windings IP and IS respectively, when the two windings are wound in the same direction, IP is connected with + H.T. and IS with the grid. OP and OS are connected with plate and filament respectively. (3) See Fig. 5, page 113, October 21st issue.

"H.A." (Lancs.) *asks* (1) *Which of two aerials will be better for short wavelength reception.* (2) *Whether the four-valve receiver described in the* *issues of July 15th, July 22nd and August 12th is suitable for the reception of broadcast transmissions.*

We suggest you use the single wire aerial which is 80′ long and 20′ high. (2) The receiver referred to is quite suitable, provided the reaction coil is coupled with the anode coil as shown in the issue of November 25th.

"G.F." (Ealing) *asks (1) Whether he may expect to satisfactorily operate a loud speaker from a two valve receiver—one detector and one low frequency. (2) Whether the arrangement, one H.F. valve, one crystal detector and one L.F. valve will provide sufficient signal strength to operate the loud speaker.*

(1) You will not be able to successfully operate the loud speaker from a two-valve receiver. (2) This arrangement will probably not provide sufficient signal strength for your purpose. We suggest you employ one H.F., one detector and two L.F. connected valves as given in Fig. 4, page 386, December 16th issue.

"L.J.N.K." (Rugby) *submits a diagram of connections and asks (1) Whether a receiver connected up in the manner indicated is liable to radiate energy. (2) Is it advisable to provide a reaction coil with inductive value similar to the tuning coil. (3) What power will operate a Weston relay. (4) Is the above relay suitable for operating a Syphon recorder.*

(1) The arrangement proposed will not radiate energy under ordinary circumstances, and may therefore be recommended. (2) The size of the reaction coil depends largely upon the construction of the receiver, and we suggest the reaction coil be provided with tappings. (3) The Weston relay will operate with a current of 0·2 milliamperes. (4) The Weston relay is suitable for slow speed recording purposes.

"H.B.F." (Liverpool) *submits a diagram of connections for our criticism.*

The proposed arrangement is fairly suitable. We suggest you connect a switch in the aerial circuit for connecting the condenser in series with the aerial tuning inductance when receiving short wavelengths. A vernier condenser is very useful in the aerial circuit. The grid condenser should have a value of 0·0003 mfds., and the grid-leak 2 megohms. A condenser of 1 mfd. should be connected across the H.T. battery. If the set tends to oscillate, the connections of the secondary of the H.F. transformers should be made between the grid and the + L.T.

"E.McK." (Glasgow) *submits a diagram of the receiver he proposes to build and asks (1) Should the H.F. transformer be mounted in such a manner that the reaction coil may be moved over it. (2) Is it necessary to tune the reaction coil. (3) Are the condensers having values 0·0005 mfds. and 0·001 mfds. suitable. (4) Will the receiver function efficiently on all wavelengths provided the tuning is properly carried out.*

(1) The reaction coil should be mounted so that it may swing near the H.F. transformer. We would refer you to the articles on "Experimental Station Design" in the issues of September 2nd and September 16th. (2) It is not necessary to tune the reaction coil, although in some cases it is helpful. We suggest you provide a tuning condenser of 0·0003 mfds. for this purpose. (3) The capacity of the variable condensers suggested is quite suitable. (4) The receiver should function efficiently providing the tuning is properly carried out.

"A.O.G." (Cornwall) *refers to the Armstrong super-regenerative circuit, and asks several questions.*

We are afraid you do not understand the principles underlying the operation of the Armstrong super-regenerative receiver. It is not possible to construct such a receiver having a maximum wavelength of 8,000 metres. In the suggested diagram there are a large number of errors, and in addition you propose to use it in conjunction with an ordinary open aerial. We suggest you abandon the idea of constructing this receiver; in any case it should not be used except with a loop aerial having 2′ sides.

"D.R.M." (Gt. Missenden) *asks (1) Whether we can refer him to a practical treatise on the design and construction of wireless receivers. (2) Whether it is possible to attend a college and take a complete course in radio engineering.*

(1) We are afraid we cannot recommend a book to meet your exact requirements, but you will be able to gain a great deal of information from the study of the standard wireless works. We suggest you consult the catalogue of books issued by The Wireless Press, Ltd., and make a choice yourself, as you will be able to judge matters, such as the price, better yourself. (2) It is quite possible to attend a college to take a complete course in radio engineering, and we suggest you communicate with the college nearest your home.

"J.W.C." (Wigan) *has a three-valve set, and is using "R" type valves. He asks whether the lists of components submitted is suitable.*

The dimensions and values of the components are quite suitable for your purpose. We cannot say what stations you will hear, but you may be sure you will hear the broadcasting stations, and of course those high-power stations to which you tune.

"J.S.F." (Herne Hill) *asks whether a capacity earth would be better in his circumstances than an earth connection.*

We consider you will obtain better results when an earth capacity is connected in place of the earth connection. The counterpoise may consist of three wires spaced 6′ apart run on insulators mounted on wooden posts 6′ high. The length of the counterpoise should be about 50 per cent. in excess of that of the aerial wires. The counterpoise should, of course, be well insulated from the earth.

SHARE MARKET REPORT

Prices as we go to press on January 13th, are:—

Marconi Ordinary	.. ..	£2 6 0
,, Preference	.. ..	2 0 0
,, Debentures	.. ..	103 10 0
,, Inter. Marine	.. ..	1 5 6
,, Canadian	.. ..	11 6

Radio Corporation of America:—

Ordinary	.. .. ..	16 6
Preference	.. .. ..	13 6

THE WIRELESS WORLD AND RADIO REVIEW

THE OFFICIAL ORGAN OF THE RADIO SOCIETY OF GREAT BRITAIN

No. 180 [No. 17 VOL. XI.] JANUARY 27TH, 1923. WEEKLY

Frame Aerials in Radio Reception

A CONSIDERATION OF SOME OF THEIR PROPERTIES, WITH DATA FOR CONSTRUCTION.

BECAUSE the frame or loop aerial is a rather poor collector of energy from electro-magnetic waves as compared with the ordinary elevated type of aerial, its use has been very restricted until the advent of the thermionic valve and its development as an amplifier. Now, however, the frame aerial finds favour in many applications and may be equally as good for radio reception as elevated aerials, provided that additional amplification is available, whilst in addition, the frame aerial has many important advantages over other types.

One of the special advantages of the frame aerial is its directional properties. For the benefit of those not familiar with the theory of directional reception with frame aerials it may be mentioned that reception is strongest when the frame is in the same plane as the direction of the station being received, and that if the frame is rotated through 90° it will be noticed that the strength of the incoming signal is at a minimum since the frame is least sensitive in this position. A further movement through 90°, or 180° from the original position, brings back the strength again to maximum, since the frame is again in the plane of the direction of the station being received.

On account of these directional properties it is possible to use a frame aerial as a means of reducing or entirely eliminating interference from transmitting stations not in the same plane as the station which it is desired to receive. Thus, for instance, if a receiving station is in the vicinity of a powerful transmitter which normally causes interference, it may be possible, by employing a frame aerial, to eliminate this interference where reception of stations in a direction at right angles to the interfering station is concerned.

Similarly the frame aerial is now extensively used in the reception of commercial transatlantic signals, partly on account of the directional properties assisting in eliminating interference from other high power stations but largely because, as compared with elevated aerials, the frame aerial is less sensitive to atmospheric interference, which is one of the most serious problems of long distance commercial working.

Fig. 1 shows a photograph of a frame aerial of portable type with the tuning condenser mounted on the base.

In designing a frame aerial for amateur and experimental purposes some consideration should be given to the type of circuit to be employed with it. Theoretically it is desirable that the whole of the inductance of the tuning circuit should be included in the frame itself, in order that the maximum voltage may be obtained across the variable condenser in parallel with the frame aerial inductance, which is provided for tuning. This condenser should have a maximum value preferably not exceeding 0·001 mfds.

One of the most important papers on the subject of frame aerials and frame aerial design has been published in the *Journal of the Franklin Institute* and is due to A. S. Blatterman. In this paper, in considering the design of frame aerials, attention is especially drawn to the following points :—

(1) Best size of loop and number of turns for given wavelength.

(2) Effect of spacing the turns.

(3) Size and kind of wire.

(4) Insulation and its effect.

(5) Suitable value of the tuning condenser.

(6) Effect of proximity of the frame to walls, etc.

(7) Effect of dead-end turns in the frame inductance.

Brief conclusions are given below to consideration of these points :—

(1) Blatterman has shown that there is a best size of loop and number of turns for reception on a definite wavelength, and that for short wavelengths large frames of few turns are most suitable and smaller frames with a large number of turns for larger waves, whilst for the very long wavelengths it again becomes desirable to increase the size of the frame and reduce the number of turns.

(2) The spacing of the turns has been shown to be a matter of considerable importance. If the turns are wound close together the inductance value is increased but at the same time the resistance goes up. The most suitable spacing is where the resistance is kept as low as possible without a loss in the inductance value.

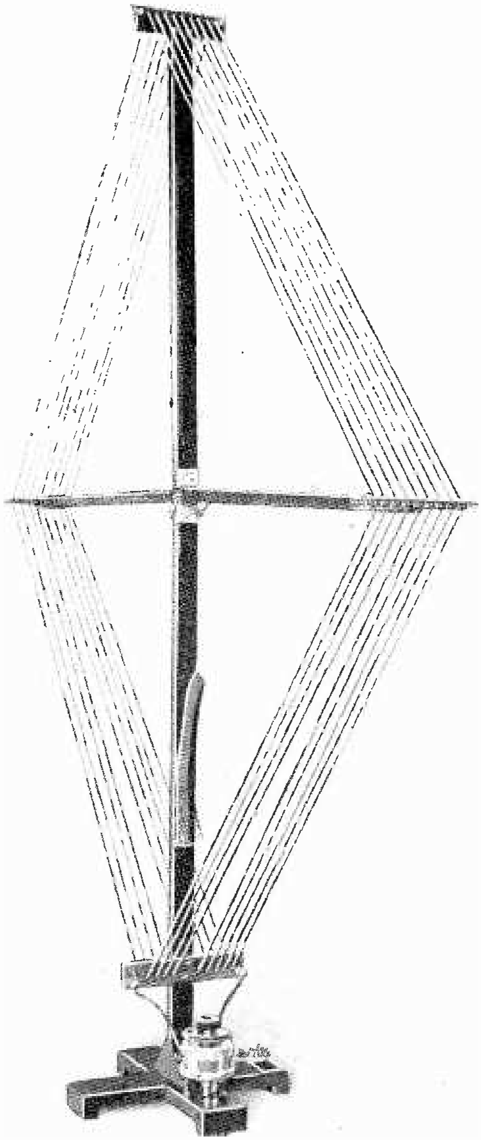


Fig. 1. A portable frame aerial with the tuning condenser mounted on the base.

(3) The size of the wire used does not, of course, have any effect on the wavelength range and the important point in choosing the wire is that it should have a low resistance. Wire of Nos. 22 to 14 gauge is suitable, whilst standard electric lighting flex is especially efficient and has the advantage that it is convenient to wind and being well insulated, the turns can be arranged to touch if desired.

(4) If the frame is closely wound then it is essential that the wire should be insulated, but with suitable spacing, bare wire may be employed.

(5) The tuning condenser used in conjunction with frame aerials should preferably not exceed a maximum value of 0·001 mfds.

(6) In use, a frame aerial should be kept at some distance from the walls of buildings, since proximity to such masses raises the effective resistance of the frame.

(7) It is preferable not to tap out the turns of a frame aerial inductance, since this method introduces dead-end turns on some adjustments. It is therefore better if possible to design the frame so that it covers the required range of wavelength without tappings.

The mechanical construction of a frame to carry the wires for a frame aerial is a matter which leaves much scope for individual ingenuity. There are several points to be remembered in designing the frame. The limitations of size, depending on the space available for installing it, is an important factor and it must be remembered that sufficient space must be allowed to permit the free rotation of the frame without fouling other apparatus, etc. It must be easy to rotate the frame, which should be held in rigidly secured bearings in order that it shall not be capable of swinging or swaying, as otherwise the strength of signals would be continually varying.

In making use of reaction with a frame aerial, different methods of procedure are available. A part of the inductance may be distinct from the frame and the reaction coil of the plate circuit coupled to it, or the reaction coil may form part of the frame itself. In this case it is best to arrange a second frame either hinged to the side of the main frame or pivoted within it. Figs. 2 and 3 are suggestions for the design of frame, to either of which reaction frames may be added. In Fig. 3 a suggestion is made for ebonite slots to receive the wire with which the frame is wound, and in this case bare wire, either stranded or of substantial diameter, may be used in place of insulated wire, since the slotted ebonite carriers will serve to separate the turns. In Fig. 3 the frame is wound as a helix, whilst in Fig. 2 the winding would take the more usual form of a solenoid. In Fig. 3 the method of rotating the frame would be by mounting it on a rod, for which purpose a guiding bracket and an upper bearing are provided, as shown. The frame shown in Fig. 2 is not arranged to rotate freely but would be required to be moved round to stand in the desired position.

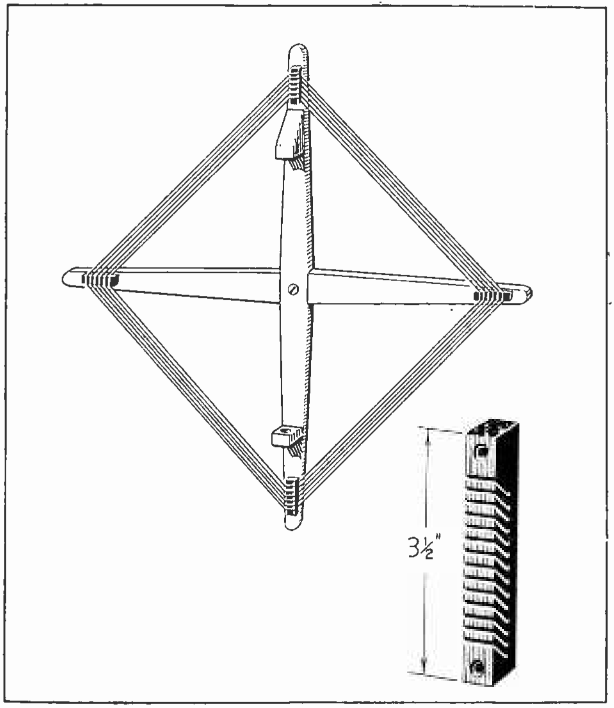


Fig 3. A design to carry bare wire spaced. This frame is rotatable.

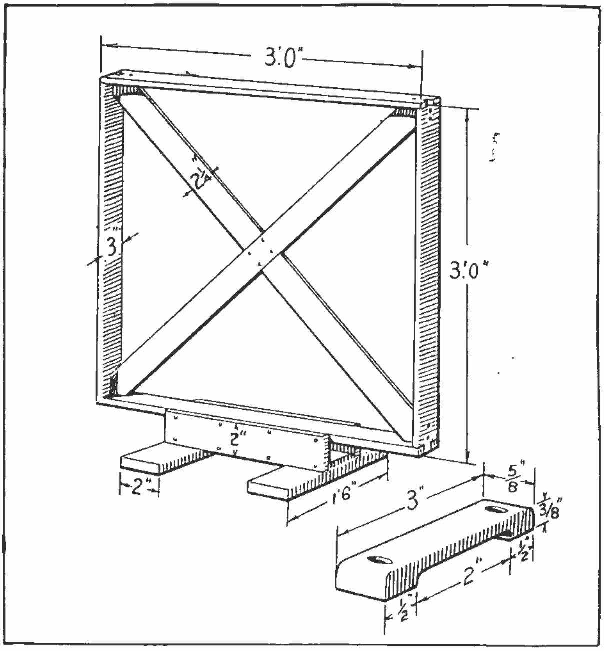


Fig. 2. A portable frame aerial showing details for construction.

A good deal of data regarding the number of turns required for different wavelength ranges has been published. The chart, Fig. 4, published in the *Journal of the Franklin Institute*, gives data on the best dimensions and number of turns for wavelengths up to 10,000 metres. Suppose that it is desired to design a frame for reception on 2,500 metres. From the chart we find the following as possible combinations :—

Size of Frame.	Turns.	Spacing.
4 feet	50	$\frac{1}{4}$ inch
6 feet	40	$\frac{7}{16}$ inch
10 feet	23	$\frac{3}{4}$ inch

If now we refer to the curves on the upper half of the chart we can find the "reception factor" which indicates which of these combinations is the most efficient on this wavelength :—

Size of Frame.	Reception Factor.
4 feet	6,400
6 feet	9,300
10 feet	8,600

From this it will be seen that the highest reception factor is with the 6-ft. frame and therefore this is the most suitable for use on 2,500 metres with the spacing given.

An interesting fact in connection with the design of loop aerials for definite wavelengths is that, where the same length of wire is used the inductance will give the same

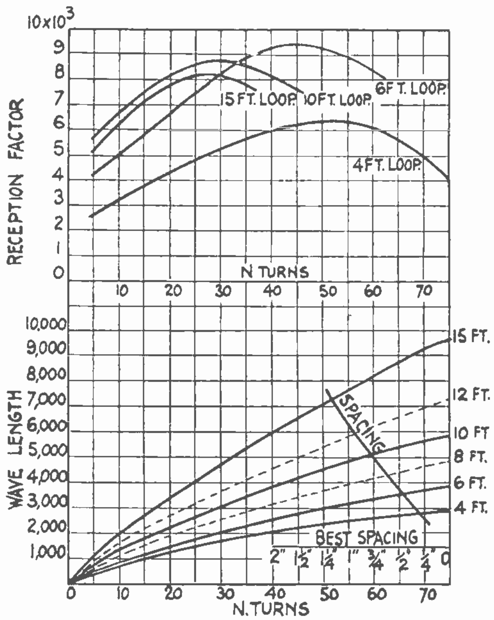


Fig. 4.

fundamental wavelength, irrespective of the size of frame, if suitable spacing is arranged. In illustration of this the following table is given, which appeared in a Radio pamphlet published by the U.S. Signal Corps.

Length of Side (feet).	Turns.	Spacing (inches)	Inductance (mhys)	Capacity (mfds)	Fundamental Wave-length (metres)
8	3	$\frac{1}{2}$	96	75	160
6	4	$\frac{1}{4}$	124	66	170
4	6	$\frac{1}{4}$	154	55	174
3	8	$\frac{1}{8}$	193	49	183

Since a 4-ft. frame is a convenient size for general purposes, the following table of wavelength ranges obtainable with tuning condensers of different values may be of value.

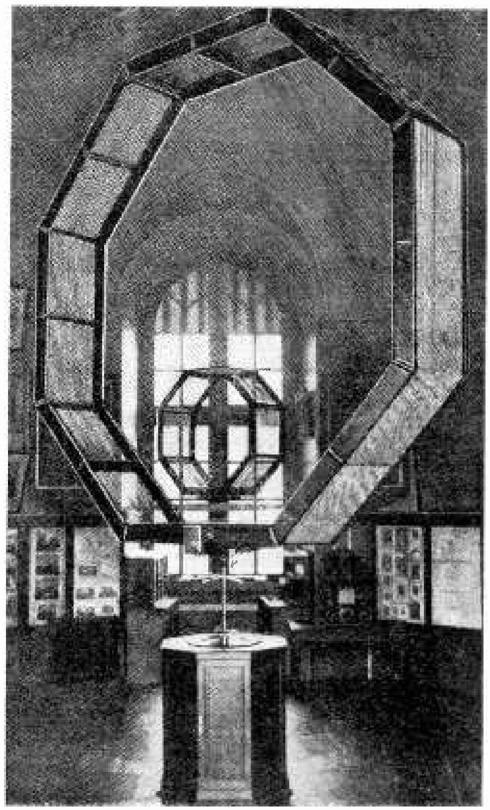


Fig. 5. A frame aerial in use at the Observatory, Paris.

Spacing of turns, $\frac{1}{2}$ inch. The wire used may be No. 22 D.C.C.

No. of turns.	Value of Parallel Condenser.					
	·00005	·0001	·0005	·001	·002	·003
1	—	65	128	178	250	310
3	130	155	290	400	550	675
6	230	380	500	710	1,000	1,200
12	430	490	920	1,250	1,700	2,050
24	760	880	1,600	2,100	3,000	3,600
48	1,550	1,775	3,150	4,300	6,000	7,000
72	2,200	2,650	4,800	6,400	8,800	11,000
120	3,930	4,500	7,900	10,000	14,700	17,700
240	7,600	9,000	15,650	20,500	27,200	32,900

Where it is desired to make use of ordinary electric lighting flex, the following data may be of value for reception on short wavelengths. In this case the condenser employed has a maximum value of 0·001 mfds. and the turns are wound without spacing.

No. of turns.	Size of Frame.	Approximate Wavelength Range (metres).
4	4 feet sq.	200 to 650
6	3 feet sq.	250 to 750
9	2 feet sq.	330 to 850

The photograph (Fig. 5), is included as of interest. This illustrates a frame aerial in use at the Observatory, Paris, for the reception of weather reports transmitted locally. H.S.P.

Accumulator Charging from D.C. Mains

It is now the general practice where direct current mains exist to charge filament heating accumulators, and also H.T. secondary batteries (if they are used), from them.

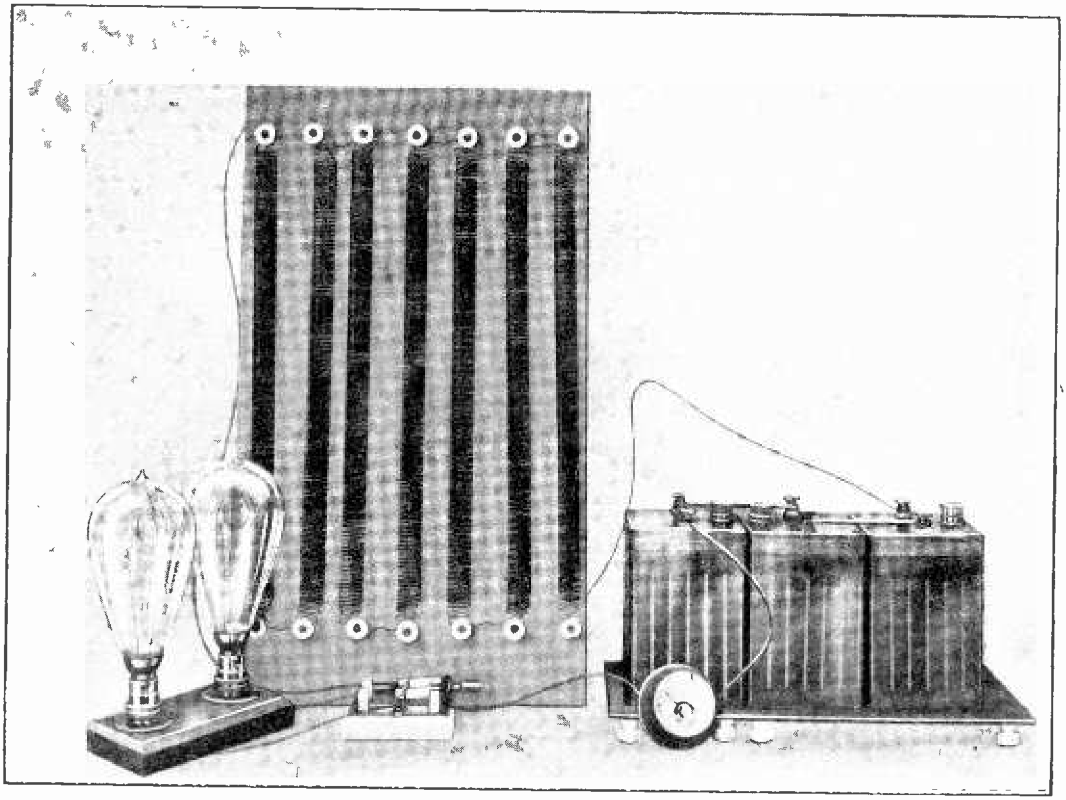
The process is quite simple, and the author trusts that a brief description of the method he employs is not out of place, as recently he was very much surprised to find the occupant of a house in which D.C. mains existed, laboriously transporting his accumulator to a garage half a mile away.

Public supply D.C. mains have voltages of between 100 and 250, and the dimensions of the resistance which has to be constructed will depend upon this voltage and the size of the accumulator to be charged. Large accumulators have a high charging rate, say of the order of 6 amperes. For smaller ones which are more generally used with wireless sets not employing more than three valves, the charging rate is about 2 to 3 amperes. It is always preferable to employ a low charging rate, provided of course that the accumulators are left in circuit for a sufficient length of time to ensure a full charge. A suitable charging rate is usually indicated on the label attached to the accumulator and with many types of accumulator may be taken as a figure representing one-tenth of the actual ampere hour capacity. To take an example, an accumulator may be rated at 40 ampere hours capacity, giving an actual discharge capacity of half this figure, that is 20 ampere hours. The charging rate for an accumulator of this size may be 2 amperes, consequently the duration of the charge, allowing for a moderate efficiency, should be about 13 hours.

To find the resistance value, which is measured in ohms, of a resistance suitable to restrict the charging current to 2 amperes, it is necessary to divide the supply voltage by the charging rate. Thus, if the supply mains have a voltage of 210, the resistance required must have a value of 105 ohms. Now to obtain this resistance one must make use of the special resistance wires on the market, such as "Eureka," "Contra," and many others. The makers of resistance wire will readily furnish such information as "resistance per yard," "yards per lb." and "current carrying capacity" for any given gauge. The gauge selected must be capable of carrying the required current without excessive heating, and then a simple calculation will show how many yards, and hence how many lbs. of wire will be required to produce a given resistance. This wire, which is somewhat springy, must be wound in the form of a number of spirals, and the best way of doing this is to wind it very tightly on a metal rod of about 1 in. in diameter, taking great care during winding that the turns do not slip loose, otherwise the finished coils will be rather uneven.

If the resistance wire is purchased from an electrical store, one can also obtain there a number of small china bobbin insulators having a diameter of about $\frac{7}{8}$ in. by $\frac{3}{4}$ in. to 1 in. deep, and furnished with a groove, and having a hole through the middle. These insulators are mounted as shown in the accompanying photograph on a piece of non-inflammable material such as stiff card asbestos, or better still, a material known as "Urolite." It is not possible to fix screws into these fireproof materials, consequently it is necessary to secure the china bobbins by means of small iron bolts.

lamp fitting, or a better plan still is to detach the rose at the ceiling and connect in an additional piece of flexible lead to the two points, and in addition to the two wires which pass down to the lamp. Switching on the current, and immersing the bared ends of this wire in a glass of water, a brisk effervescence on one of the leads will indicate that it is the negative. Great care must be taken, of course, that the two leads do not touch while the



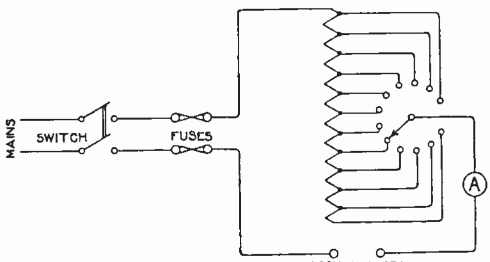
A Charging outfit made up to the description given. The Accumulators stand on an ebonite plate, supported by china bobbin insulators.

current is on. The negative lead should be joined to the negative terminal of the battery, and the positive lead to one end of the resistance wire, whilst the other end of the resistance wire is taken to the positive of the battery.

After mounting two rows of bobbins on to the fireproof board, the ends of the coils are twisted on to the bobbins, being themselves slightly stretched. The finishing end of one coil is connected to the beginning of the next so as to put the whole length of wire in circuit.

To bring the current from the mains on to the accumulator and charging board, an adaptor may be made use of, attached to a

An additional switch, of the type shown in the photograph, may be connected in circuit for completely disconnecting the charging arrangements from the mains. A small pattern ammeter connected in circuit also is a great advantage, as it not only indicates the charging rate, but also tells one at a glance whether the cells are on charge or not.



A circuit arranged for accumulator charging from D.C. mains. Provision is made by means of a twelve point switch for varying the amount of resistance in circuit, so that the charging rate can be adjusted according to the capacity of battery on charge.

A point of particular importance to be borne in mind is that the accumulators must be insulated from earth when connected to the mains, otherwise the effervescence during charging may cause the acid to froth over and thus connect the mains to earth. Not only may the results be serious to the accumulators on charge, but also, if they are in celluloid containers, there is a danger of fire. The enterprise of the experimenter may indicate to him that a leaden tray is just the thing to prevent the action of the frothing of the sulphuric acid from the cells on to the floor, or wherever they are standing, but he is cautioned against putting such an idea into practice as it is bound to result in a contact to earth of the supply mains through the conducting acid.

A special word of warning is also necessary with regard to the amount of current which it is safe to take from a house lighting circuit. Under ordinary conditions this should never be allowed to exceed 3½ amperes.

The charging of small accumulator cells of high voltage for use as H.T. batteries is best arranged through two lamps of the normal voltage of the supply circuit. One lamp is connected in each lead from the mains and the H.T. battery is joined across them. Thus the two lamps and the H.T. battery are in series.

When accumulator charging is finished, the circuit must not be broken by turning off the switch, or otherwise the battery will discharge again through other lamps which may be operated from that switch. It is necessary to break the leads passing to the charging outfit.

Accumulators are fully charged when the specific gravity has a value of about 1·250, and they are gassing freely. A good accumulator should not froth. The positive plates of a charged accumulator should be of a deep chocolate colour, and the negatives a whiteish-grey.

When charging one's own accumulators it is possible to keep them in very good trim and even to improve their condition on every charging. It is a good plan at the start to charge up the cells until they gas freely, and then tip away the acid and refill with pure sulphuric acid and distilled water made up to a gravity of precisely 1·250. This will ensure that the right range of gravities will be obtained during charge and discharge.

Never leave an accumulator in a run-down condition, and try to avoid charging when the cell is only partly discharged.

F.H.H.

IDEAL HOME EXHIBITION.

Readers are advised that the Ideal Home Exhibition, organised by the *Daily Mail*, will be held at Olympia from March 1st to 24th.

An important section of the Exhibition has been allotted to the National Association of Radio Manufacturers, who are arranging for wireless exhibits and demonstrations on a very big scale.

Electrons, Electric Waves and Wireless Telephony—XVII.

By Dr. J. A. FLEMING, F.R.S.

The articles appearing under the above title are a reproduction with some additions of the Christmas Lectures on Electric Waves and Wireless Telephony given by Dr. J. A. Fleming, F.R.S., at the Royal Institution, London, in December and January, 1921-1922. The Wireless Press, Ltd., has been able to secure the serial rights of publication, and any subsequent re-publication. The articles are therefore copyright, and rights of publication and reproduction are strictly reserved.

3. Practical Forms of Wireless Telephone Apparatus.

In actual practice the apparatus is a little more complicated. The high voltage required for the plate of the transmitting valve is not always obtained from a battery but from a direct current dynamo, which gives a voltage of several hundred, or even a couple of thousand volts.

Then the modulation of the plate current is not accomplished by placing the microphone-induction coil in the grid circuit of the oscillating valve, but in that of another valve called the control valve.

Lastly, the high voltage of the plate of the generating valve need not be obtained from a direct current dynamo, but by rectifying a low frequency alternating current.

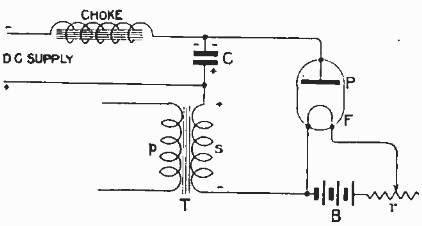


Fig. 90. Arrangement of circuits for rectifying an alternating current supplied from a transformer T by means of a Fleming valve and Condenser C.

These modifications will best be understood by the description of certain typical forms of wireless telephone transmitter in actual use.

It will perhaps be advisable first to explain the manner of using a two-electrode or Fleming valve to rectify high voltage alternating electromotive force, or change it to direct voltage.

If we connect to the plate *P* of a two-electrode valve one terminal of a condenser *C*, the other terminal of which is connected through the secondary coil *S* of an alternating current transformer *T* to the filament *F* of the valve (see Fig. 90), and if we supply the transformer with low frequency alternating current, then the plate of the condenser which is directly connected to the anode or metal cylinder of the valve will become charged with negative electricity.

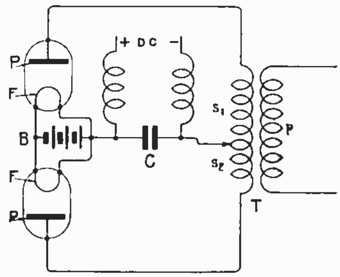


Fig. 91. Arrangement of circuits for rectifying both components of an alternating current supplied by a transformer T by means of two Fleming valves. The condenser C then supplies a direct current.

The reason is as follows. When the direction of the E.M.F. in the transformer circuit *s* is such as to make the plate *P* of the valve positively electrified, electrons are drawn out of the incandescent filament *F*, and neutralise this positive charge of the plate. The upper plate of the condenser *C* is then left negatively electrified. When the E.M.F. of the transformer reverses and the plate *P* becomes negative, it repels the escaping electrons and stops the emission from the filament. Hence, if the condenser *C* has a large capacity it will become a reservoir of electricity, and we can continually draw off from it a supply of negative electrons from its upper plate. As these electrons are supplied in gushes by the transformer, it is found advantageous to insert a spiral of insulated wire wound on a bundle of iron wires, called a choking coil or choker, as shown in Fig. 90. This serves to convert the intermittent gushes of electrons into a steady stream, which can be drawn off the *d c* terminals marked + and —.

In the above-described arrangement we only utilise and rectify every alternate phase, or half of the alternating current energy. By the use of two rectifying valves and a transformer with a connection to the centre of its secondary circuit, as shown in Fig. 91, we can rectify both phases, and convert all the alternating power of a transformer into direct current power. The two valves can have their filaments rendered incandescent by the same filament heating battery *B*. The reservoir condenser *C* has choke coils inserted in its exit wires marked *d.c.* + and −, and from these w can draw off direct current with a steady E.M.F.

The above appliances are all combined in the half-kilowatt wireless telephone cabinet designed by Marconi's Wireless Telegraph Company for radio-telephony. This consists of a cabinet in shape like a harmonium case or small piano, about 4 ft. high and wide, and 2 ft. deep. It contains all the transmitting and receiving gear effective for wireless telephony over a range of about 100 miles by day, but greater by night. This range corresponds to use with aerial wires of twin T type, 220 ft. long and 100 ft. high, with a natural wavelength of 360 metres. A view of the front and back of the cabinet is shown in Fig. 92.

By Courtesy of Marconi's Wireless Telegraph Co., Ltd.

Fig. 92. Half-kilowatt Valve Transmitting Set for Wireless Telephone as arranged by Marconi's Wireless Telegraph Company, Ltd. The transmitting valves are shown in the centre panel and the receiving valves on the right-hand bottom panel.

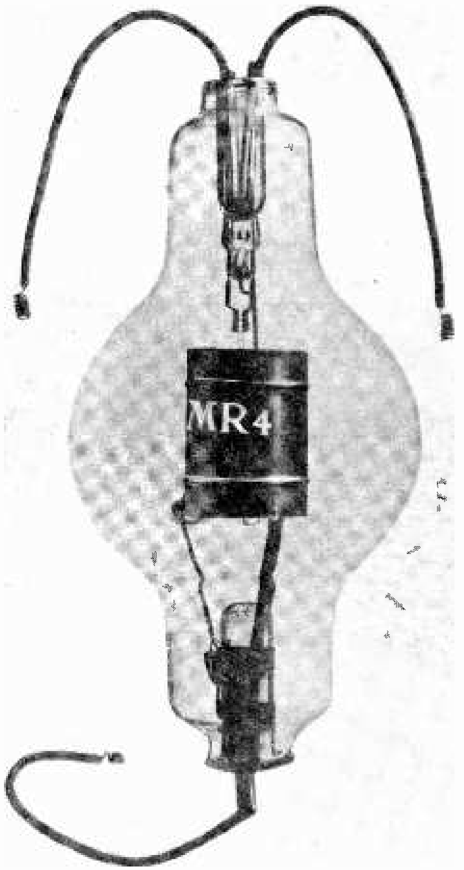
The transmitting part comprises three thermionic valves, two of three electrodes and one two-electrode rectifying valve. A picture of one of these valves is shown in Fig. 93.

In the actual transmitter, a view of which is shown in Fig. 92, one of the three-electrode valves is the power or generating valve; the other is the control valve; and the two-electrode valve is used for rectifying the alternate current supplied by a transformer in one of the lower cupboards, taking its primary current from a rotary converter, which transforms direct electric current into alternating current at a frequency of 150 cycles and 85 volts E.M.F.

The diagram of connections is shown in Fig. 94. It will be seen that the alternating current supply (A.C.) is fed into an alternating current transformer called the power transformer, and also into two smaller transformers which step down the voltage, and supply current at 12 volts for heating the filaments of the three valves. The electromotive force of the power transformer is rectified by the two-electrode valve on the right-hand side of the diagram, and used to charge two reservoir condensers connected to a smoothing choking coil, and these condensers supply a steady or direct high voltage to the plates or anodes of the two three-electrode valves on the left of the diagram.

The valve marked "power valve" has its plate and grid circuits coupled through a reaction coil, and high frequency oscillations are therefore created in the coil L_1, to the upper end of which is attached the aerial wave *A*, and its lower end to an earth plate. Continuous or undamped carrier waves are accordingly radiated from the aerial.

The amplitude of these waves is controlled by the microphone *M* in conjunction with the control valve (middle). It will be seen from the diagram that the grid of this control valve is connected to the secondary terminal of a transformer, in the primary circuit of which is a 3-cell battery and the carbon microphone *M*.

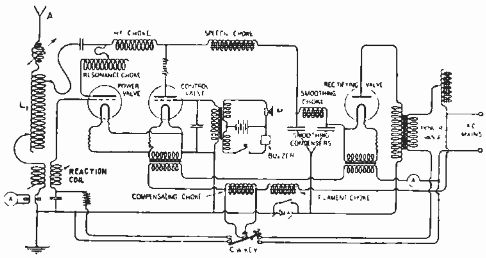


By courtesy of Marconi's Wireless Telegraph Co., Ltd.

Fig. 93. Large Three-electrode Transmitting Thermionic Valve for generating high frequency continuous currents.

On speaking to this microphone the electric potential of the grid of the control valve is varied in accordance with the wave form of the aerial speech waves, and this in turn fluctuates the plate or electron current in the control valve. These variations in the plate current are caused to affect in like manner the potential of the plate of the generating valve, and therefore the amplitude of the carrier waves emitted from the aerial. Accordingly we have the wave form of the speech sounds impressed upon the amplitude or height of the carrier waves and the transmitter affects in like manner the current in the distant receiver circuits.

This plant is designed to operate with wavelengths of 1,000 or 2,000 metres, and it is



By courtesy of Marconi's Wireless Telegraph Co., Ltd.

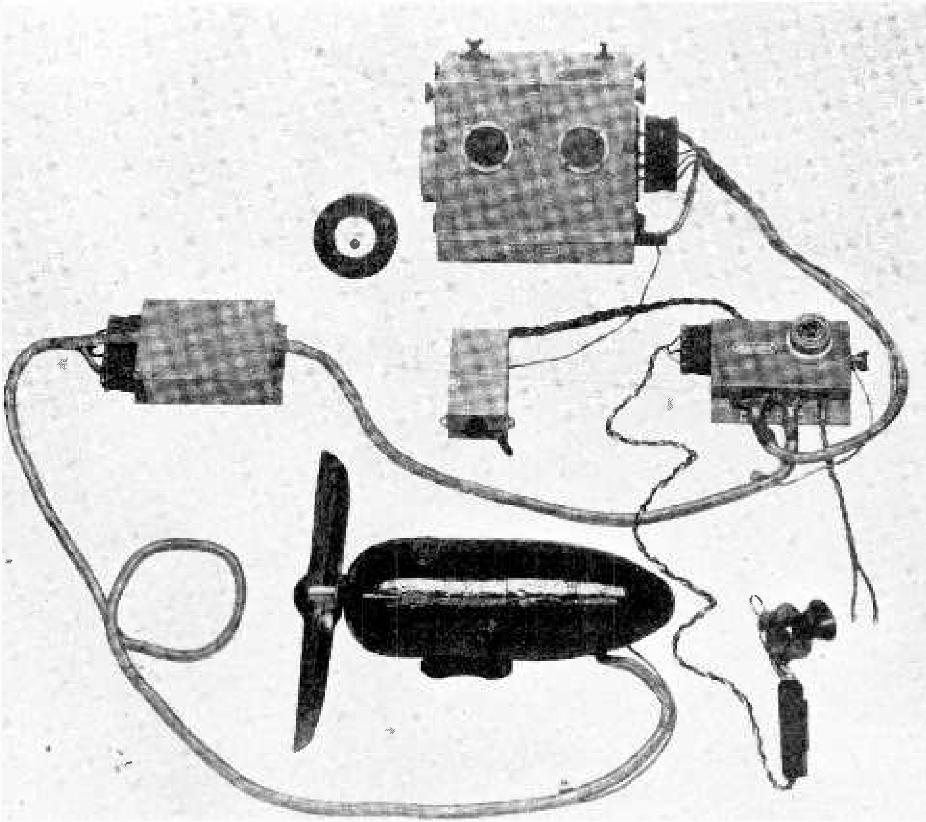
Fig. 94. Diagram of connections in the transmitter part of the half-kilowatt wireless telephone apparatus shown in Fig 90.

called a half-kilowatt plant because it employs about 500 watts in electric power to operate it. In more powerful transmitters the power valve is duplicated, or there may be three or more power valves, and two or more control valves. The necessary high voltage for the anodes or plates of these valves may be obtained from high voltage (1,000—2,000 volts) direct current dynamos, and in the case of aeroplanes the small high tension dynamo is driven by a little windscrew or windmill caused to rotate by the rush of the aeroplane through the air (see Fig. 95).

This dynamo may have two separate armatures, one providing a current of about 0.1 ampere at 1,500 volts for charging the valve anodes, and a low voltage armature providing a current of 5 amperes or so at 7 or 8 volts for incandescing the filaments of the valves.

An ingenious part of the equipment for aircraft in the aircraft plant of Marconi's Wireless Telegraph Company is the arrangement of remote control, in which all the valves and supply circuits of the transmitting part of the arrangement are brought into operation merely by pressing a switch on the handle of the speaking microphone, which is the only part the aeroplane pilot or observer need touch, or has within reach.

The layout of apparatus shown in Fig. 95 gives some idea of the apparatus as installed in an aeroplane. Connections are made by means of heavily insulated cables having plugs at their extremities, the instruments to which the connections have to be made being provided with sockets to receive them. The transmitter is similar to an ordinary telephone transmitter in shape, with the exception that there is no receiver attached, its place being taken by the head receiver telephones worn in the operator's cap.



By Courtesy of Marconi's Wireless Telegraph Co., Ltd.

Fig. 95. Aircraft Wireless Telephone set as made by Marconi's Wireless Telegraph Company. In the centre of the diagram at the bottom is shown the small direct current dynamo driven by a wind screw which supplies the high plate voltage for the generating valves.

(*To be continued*)

Elementary Lecture and Demonstration.

An Elementary Lecture entitled "Fundamental Principles of Radio Reception," with Experiments, will be given on Friday, February 16th, at 6.30 p.m., by Mr. Maurice Child at the Institution of Electrical Engineers, Victoria Embankment. This is the second of a series af Elementary Lectures arranged by the Radio Society of Great Britain.

Transatlantic Radio Telephony

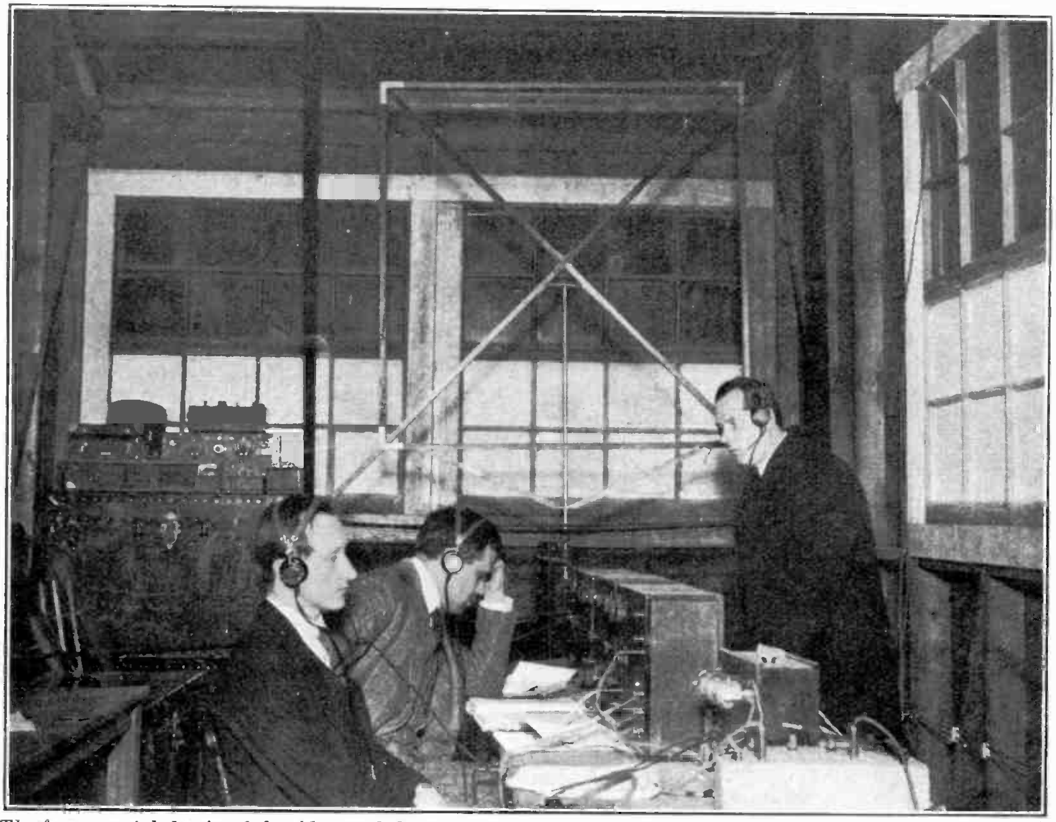
An advancement in the progress of long-range telephony was demonstrated in the early hours of Sunday morning, December 14th.

Arrangements were made for the reception in London of speech originating in New York, and those responsible for the execution of the programme are to be complimented on the success achieved.

A special transmitter was erected on Rocky Point, Long Island, and a wire connection made it possible for the speakers at 195, Broadway, New York City, to speak wirelessly from the Long Island Station to London.

The design of the apparatus used is due to the research work which has been carried out by the Radio Corporation of America and the American Telegraph and Telephone Company, in conjunction with the International Western Electric Company. It will be remembered that the American Telephone and Telegraph Company and the International Western Electric Company conducted Transatlantic telephony tests as long ago as October, 1915.

The transmitting apparatus, which was of the valve type, possessed many unique features. The speech currents from New York operated firstly a 300-watt oscillator modulator equipment, and the energy derived was applied to an outfit of 5 Kw. energy, which in turn was coupled to the main transmitting plant having an output of 60 Kw. Special valves had to be employed to handle the large power. The wavelength was of the order of 57,000 kilocycles. The arrangement of the circuits was such that the carrier wave was suppressed at the transmitter and was reintroduced by oscillating apparatus attached to the receiving aerial. The first transmission took place



The frame aerial, having 6 ft. sides, and the apparatus with which the signals were received. Mr. Freiis, the Research Engineer, is in the centre.

at 2 o'clock on Sunday morning, and there was not the slightest hitch or delay in the reception in London of the words spoken in New York. Right from the start every word was easily intelligible to the sixty listeners who were witnessing the experiments. The modulation was usually good, and in spite of the accent of the American speakers, there was no difficulty in immediately understanding every word spoken.

The first message by Mr. H. B. Thayer, President of the American Company, was of about ten minutes duration, and it was interesting to note, owing to special cable facilities arranged by the Western Union Cable Company, that a report of the reception in London was placed into his hands while he was still speaking.

This speaker was followed by General J. J. Carty, who is Vice-President of the American Company, and although his voice may not have been so suitable for telephony transmission, it was remarkable clear, and readily understood. He spoke of the weather conditions prevailing throughout the day in New York, and referred in particular to the fact that there had been a sharp snowstorm.

As the experiments continued, the speakers on the American side became very confident of the successful reception in London. References were made by the speakers to gentlemen of their acquaintance known to be present at the London demonstration, and the familiar tone made it hard to realise that the distance which separated the stations was about 3,200 miles.

The transmission continued until about 4 a.m.

A photograph of the receiving apparatus is shown on the previous page, and it is interesting to note that the reception was carried out by means of a frame aerial having sides of only 6 ft. The frame was coupled to a valve oscillator generating a frequency equal to that of the transmitting station, and was followed by a series of high frequency, detector and low frequency amplifiers. Eight valves in all were used to actuate 60 pairs of telephone receivers, and in addition, arrangements were made for switching in a loud speaker. The results from the loud speaker were as satisfactory as those given by the telephones, and when the listeners were asked during the demonstration whether they would prefer to listen to the signals from telephones or a loud speaker, they voted for the latter, indicating that an instrument of this sort was capable of producing magnification without the introduction of unpleasant distortion. The success of the tests was primarily


Some of the gentlemen who witnessed the demonstration. Many other well-known Radio Scientists were present.

due to Mr. Nichols and Mr. Freiis, well-known American radio engineers, whilst the organisation and technical arrangements were

Mr. H. W. Nichols, Ph.D., Research Engineer of the A.T. & T. Co., and Western Electric Co., Inc.

in the hands of Mr. F. Gill of the International Western Electric Company.

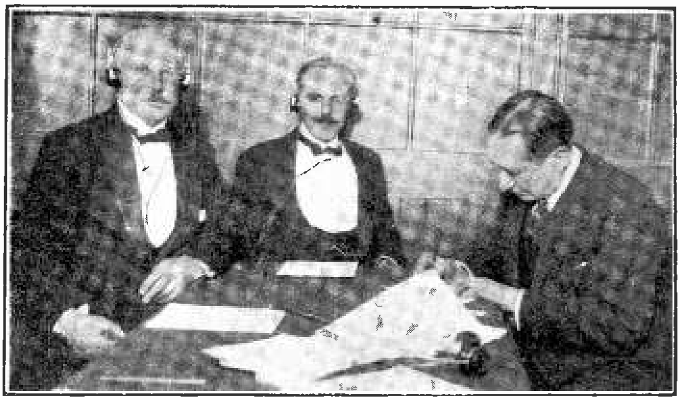
Among those present were :—

Senatore Marconi, Major Purves (Engineer-in-Chief of the Post Office), Sir Evelyne Murray (of the Post Office), Mr. Shaughnessy (of the Post Office Wireless Dept.), Dr. Eccles, Mr. Godfrey Isaacs (of the Marconi Company), Mr. A. A. Campbell Swinton, Col. Blandy, and other prominent gentlemen closely associated with wireless telegraphy.

A test of this sort is of particular interest at a time like the present when so much attention is being given to Transatlantic radiotelephony. Many radio workers in this country have recently distinguished themselves by receiving the signals from American broadcasting stations, but this demonstration is perhaps of greater commendation in view of the fact that it was carried out according to a pre-arranged programme, and can in no way be regarded in the light of a freak. One must bear in mind, of course, that the power employed on this occasion was much in excess of that of the broadcasting stations, which,

Major Purves, Engineer-in-Chief of the G.P.O., who listened to the American Telephony.

although ensuring a greater range, embodies many problems in control and modulation. It is now only necessary to consider a Transatlantic telephony service from the point of view of costs to determine whether the results achieved can be placed at the disposal of the public.



Sir A. Shirley Benn, Sir Evelyne Murray and Senatore Marconi, receiving the message.

Wireless Club Reports

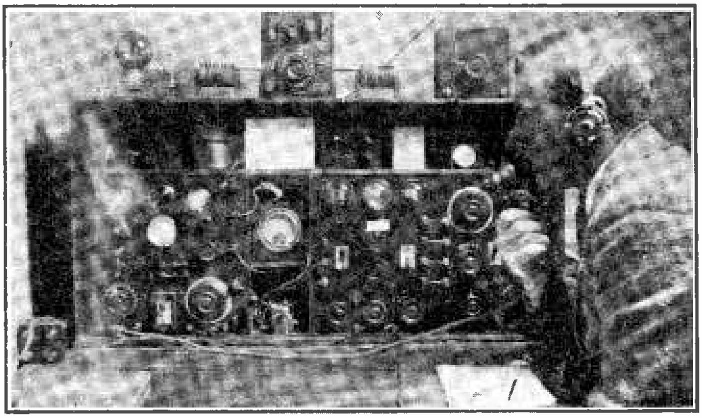
NOTE.—Under this heading the Editor will be pleased to give publication to reports of the meetings of Wireless Clubs and Societies. Such reports should be submitted without covering letter and worded as concisely as possible, the Editor reserving the right to edit and curtail the reports if necessary. **The Editor will be pleased to consider for publication papers read before Societies. An Asterisk denotes affiliation with the Radio Society of Great Britain.**

Correspondence with Clubs should be addressed to the Secretaries direct in every case unless otherwise stated.

Sunderland Wireless and Scientific Association.*

Hon. Secretary, A. Richardson, Westfield House, Sunderland.

Two short lectures were delivered before the Association at Westfield House on Saturday, December 30th, by Mr. H. G. MacColl and Mr. Holroyd. Mr. MacColl, whose subject was "A Method of Using Several Receiving Sets on one Aerial," described a method whereby as many as twenty-five sets could be operated from one aerial. This method, which was introduced by Dr. Turner, of Cambridge, was a modification of the usual "tuned anode" circuit. The aerial circuit, however, was made aperiodic by replacing the usual tuning inductance by a high resistance of the order of 20,000 ohms, the various receiving sets being connected across this. Tuning was done exclusively in the anode circuit of the first valve of each set.



Station belonging to Mr. C. Creed Millar (2 MG) *at Bearsden, Scotland.*

Mr. Holroyd, lecturing on "Some War-time Experiences of a Wireless Operator," gave a very pleasing account of the various types of wireless apparatus used in the Navy during the War, and told some amusing anecdotes of the Maltese station at Rinella.

On Tuesday, January 2nd, the new club-rooms of the Association at Westfield House, were opened by Col. Lynn Marr. The suite of rooms includes a large lecture and experimental room, reading-room, Secretary's office and cloak-room.

The Leicestershire Radio and Scientific Society.*

Hon. Secretary, Mr. J. R. Crawley, 269, Mere Road, Leicester.

The annual business meeting of the Leicestershire Radio and Scientific Society was held at headquarters, *The Leicester Mercury* office, on January 8th. Favourable progress was reported, and the Society has more than doubled its membership. The financial outlook also is more hopeful than it has yet been. A very hearty vote of thanks was accorded to the President, Mr. C. T. Atkinson, the Vice-President, Mr. H. E. Dyson, and the Committee for valuable services rendered. The officers for the current year are as follows:—Mr. C. T. Atkinson retains Presidency, and Mr. H. E. Dyson the Vice-Presidency; Treasurer, Mr. Rudkin; Messrs. Crawley and Pratt retain the offices of Hon. Joint Secretaries; the Committee consist of Messrs. Schofield, Miller and Challifour.

The business having been concluded, Mr. Bramall gave a short description of some of his apparatus, one very interesting feature of which was a condenser fitted with a vernier of his own design.

Hackney and District Radio Society.*

Hon. Secretary, Mr. C. Phillips, 247, Evering Road, N.16.

The annual meeting of the above Society was held at its headquarters, Y.M.C.A., Mare Street, Hackney, E.8., on Thursday, January 4th. The Chairman, Mr. H. A. Epton, presided over an attendance of some 50 members.

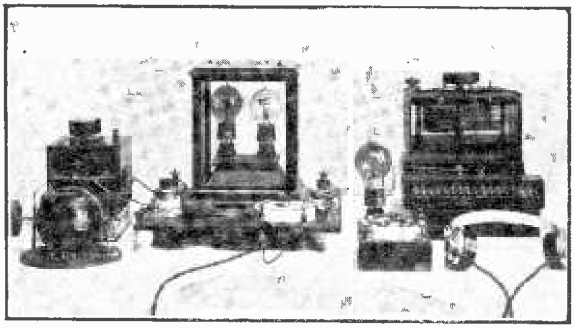
The Secretary presented a report of the Society's activities during the past year, and stated that the progress made had been very encouraging. The Treasurer presented the first balance sheet of the Society, which showed a cash balance of over £7, after having paid for the Society's set, which had been made by the Technical Committee.

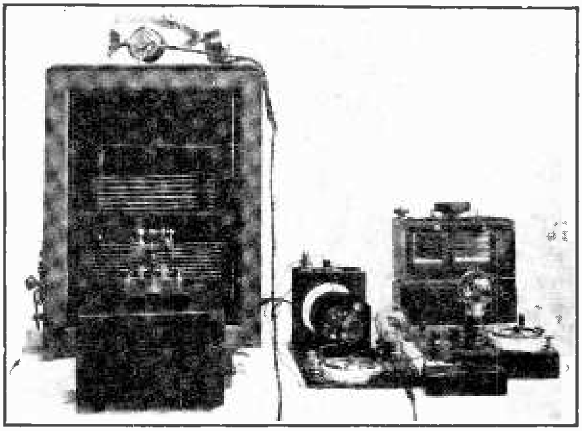
The election of officers and committee for the coming year then took place, the Mayor of Hackney being re-elected unanimously as President, and Messrs. Epton, Cunningham, Jenkins, and Kiernan, as Chairman, Vice-President, Treasurer and Librarian respectively. The Secretary, Mr. E. R. Walker, preferring to assist the Society in a technical capacity in future, retired from the position of Secretary, and in his place was elected Mr. C. Phillips. Mr. Bell was elected Assistant Librarian. A new Committee was also elected, consisting of Messrs. Walker, Morgan, Wall, Valins and Sandford.

During the evening a competition was held for the best crystal set made by the Y.M.C.A. boy members of the Society, and the prize, a pair of R.I. telephones presented by the Vice-Chairman, was won by Mr. Haynes.

In view of the very valuable work which has been done by the retiring Secretary, who was also the founder of the Society, it was unanimously decided to make him a small presentation.

The Chairman announced that it was hoped shortly to arrange a social evening and public demonstration.





The two photographs on this page show some of the apparatus made by Mr. Robert Oxenham, of Pretoria, South Africa, for his experimental station. Above is shown a long-wave set and in the lower photograph a short-wave set and transmitting gear constructed mainly from odds and ends.

Croydon Wireless and Physical Society.*

Hon. Secretary, Mr. B. Clapp, A.M.I.R.E., "Meadmoor," Brighton Road, Purley.

A meeting of the Croydon Wireless and Physical Society was held on Saturday, January 6th, at the Central Polytechnic, Croydon, at which Lieut. D. Sinclair, of the Air Ministry, lectured on "The Signals Organisation of Our Airways."

In his lecture, which was followed with great interest by the members, Lieut. Sinclair explained very fully the methods by which the machines on the air routes are controlled, and their positions determined by radiotelephony. He said that the wavelength of 900 metres was now used exclusively for communication with aircraft. Any messages required to be sent from one aerodrome to another are transmitted either by radiotelegraphy *via* the Air Ministry **(GFA)** on a wavelength of 1,400 metres, or by private landline, whilst weather reports are sent by the Air Ministry on a 1,680 wavelength. Some excellent lantern slides were shown, illustrating the aerials and apparatus at the W/T stations at several of the aerodromes in England.

The lecture was followed by a discussion in which the members showed the interest with which they had followed the lecture, by the many pertinent questions which they put to the lecturer. The meeting terminated with a very hearty vote of thanks to Lieut. Sinclair.

The Hon. Secretary will be pleased to give particulars to any person desirous of joining the Society, and the Hon. Treasurer, Mr. E. E. Hart, 267, Lower Addiscombe Road, Croydon, will be glad to receive any outstanding subscriptions for the current year.

The Wireless Society of Winchester.

Hon. Secretary, Mr. Albert Parsons, 65, Cromwell Road, Winchester.

Mr. Bolt, at the last meeting before the Christmas holidays, explained his experiences as an amateur.

The Rt. Hon. The Earl of Northbrook has agreed to become President of the Society.

An experimental licence has been granted, and the erection of the aerial is now under discussion. Rules have been drawn up by a special Committee.

The following two meetings were arranged to be occupied by the Secretary, the subject being "How to Wind Coils."

Ipswich and District Wireless Club.

Hon. Secretary, Mr. H. E. Barbrook, 46, Foundation Street, Ipswich.

On Monday, January 8th, a very successful and interesting evening was spent at the Society's headquarters, 55, Fonnereau Road, when members enjoyed what will be known as the first demonstration of broadcasting Grand Opera by Wireless.

The club set was used for this occasion, with the addition of a two-valve note magnifier, a microphone amplifier and loud speaker, kindly lent by Mr. H. E. Barbrook and Mr. Callender, thus enabling all present to "listen in" without the trouble of headphones.

Mr. Bird, with his customary vigour, was the operator for the evening, and having tuned in, **2 LO** was picked up, the reception being very clear.

The opera transmitted was the "Magic Flute" and the tuning of the orchestra was clearly heard, as was also the tapping of the conductor's baton. The music and singing came through with very little distortion, although the words of the singers were rather difficult to follow.

The Hon. Secretary would be glad to hear from amateurs in the district who are likely to become members. He would also welcome catalogues and any literature which might be of interest to members.

Weston-super-Mare and District Radio Society.

Hon. Secretary, Mr. J. P. Gorton.

This newly-formed Society held its first semi-open meeting at the Church Institute on Wednesday, January 3rd, when Mr. O. J. Carpenter, A.M.I.R.E., delivered the inaugural lecture, Mr. F. W. Shearmur, Chairman of the Society, presiding.

The lecturer's object was to set forth some of the chief phenomena associated with the transmission and reception of wireless signals. Introducing the subject with a few remarks on the ether, Mr. Carpenter proceeded to deal with the transmission of signals through this medium, emphasising the importance of the little-understood Heaviside layer in transmission over long distances. Mr. Carpenter then dealt with Dr. Fleming's invention of the two-electrode thermionic valve, and its revolutionising development, the three-electrode valve.

He had been surprised, when listening-in at Weston stations, at the amount of interference due to the improper use of local regenerative receiving apparatus, and he hoped that the formation of the Society would lead to the acquirement of knowledge which would check this evil.

Dealing with short-wave reception, Mr. Carpenter paid tribute to the experimental work which had been carried out by Mr. J. P. Gorton, a local resident.

The lecture was concluded with explanatory comments on a number of limelight illustrations depicting the great Marconi stations and many types of apparatus.

At the close a vote of thanks was accorded the lecturer and Mr. W. Tucker, who had supplied and operated the limelight apparatus.

The list of officers of the new Society is as follows:—President, Mr. J. E. Norman, J.P.; Chairman, Mr. F. W. Shearmur; Hon. Secretary, Mr. J. P. Gorton; Asst. Hon. Secretary, Mr. S. Tucker; Hon. Treasurer, Mr. R. S. Wort.

Coventry and District Wireless Association.

Hon. Secretary, Mr. H. H. Thompson, 44, Northumberland Road, Coventry.

At a meeting of the Association at their rooms, 128, Much Park Street, on Wednesday, January 3rd, the first of a course of lectures on the principles of radio communication was given by Mr. A. H. Burnand, A.M.I.Mech.E., A.I.N.A., formerly a lecturer on Engineering at University College, Southampton. The subject was "Waves in Air and Aether," and the lecturer commenced by dealing with the mechanical details underlying wave motion, with particular reference to the elasticity of the medium and the mass and inertia of the moving particles. Sinusoidal waves were especially considered and illustrations were given of the nature of longitudinal and transverse waves.

Dealing with the velocity of waves in different media, the lecturer explained the relationship existing between wavelength, velocity, and periodicity in all media. In illustrating the manner in which the "carrier wave" employed for the radio transmission of speech behaves, an interesting analogy was given with reference to the "carrier wave" produced by breathing, and the modulation of this wave by the agency of the lips, tongue, and vocal chords to produce articulate speech. In connection with this, reference was made to the relatively low frequencies of sound waves comprising speech and musical reproduction, *i.e.*, from about 30 to 2,000 per second, whereas on a short wavelength, such as is employed for broadcasting, the frequency of the electro-magnetic waves is 700,000 per second, so that in the production of one wave of sound at a frequency of 1,000 there would take place 700 vibrations of the aether. The lecture concluded with an account of natural and forced vibrations, the vibrations of strings, fundamental and harmonic vibrations, and some elementary remarks on resonance.

The lecture was followed with the closest attention by the audience, and the subjects were handled with such clearness as to be easily comprehended by any who were not already familiar with the subjects.

On January 17th a lecture was given before the Association by Mr. Clinker, of the British Thompson Houston Co., Ltd.

Tottenham Wireless Society.

Hon. Secretary, Mr. R. A. Barker, 22, Broadwater Road, Bruce Grove, Tottenham, N.17.

A meeting of the Tottenham Wireless Society was held at the club-rooms, 10, Bruce Grove, Tottenham, on January 3rd. There was a very good attendance, and everyone enjoyed an excellent lecture by Mr. H. Winter on the subject of "Telephone Receivers."

The Society, which is rapidly growing in numbers and is proving of great help to the wireless experimenters in the district, is looking forward with confidence to a successful year. All those who wish to avail themselves of the lectures and the experience of other experimenters should apply to the Secretary, Mr. R. A. Barker, 22, Broadwater Road, Tottenham, N.17., for full particulars.

The Pudsey and District Radio Society.

Hon. Secretary, Mr. W. G. A. Daniels, 21, The Wharrels, Low Town, Pudsey, Leeds.

A meeting was held at the Mechanics' Institute on Monday, January 1st, Mr. F. Wild, the Chairman, presiding. There was a good attendance of members, and a number of new ones were elected.

In dealing with the correspondence the question of affiliation with the Radio Society of Great Britain was raised. The proposal to erect an aerial permanently at the Mechanics' Institute was also discussed and application has since been made to the P.M.G. for the necessary licence.

A very interesting lecture on Valves, and their application to wireless, both for reception and transmission, was given by the Secretary, and was very much appreciated by all members present, many of whom joined in the vigorous discussion which followed.

The Chairman made reference to a subscription list now open, and which has already been subscribed to for the purpose of providing the Society with a receiving set of its own.

All desirous of joining the Society should communicate with the Secretary.

Cowes District Radio and Research Society.*

Hon. Secretary, Mr. L. Ingram, 1, Mill Hill Road, Cowes.

The Society held its first meeting at the new headquarters, the Gloster Restaurant, on January 3rd, when Mr. Bullen's lecture, entitled "Electrical

Units," was thoroughly enjoyed. The lecturer dealt with his subject in a very capable manner illustrating his points with simple analogies and clearly stating his facts. Following the lecture, and at the request of one of the members, a single valve set was converted from a long-wave to a short-wave receiver, and **2LO** was tuned in satisfactorily. At the conclusion of the practical demonstration, the Chairman (Mr. E. P. Bartlett) urged the members if they had any difficulties with their sets, to being them before the Society.

At the meeting on January 10th, after the usual half-hourly morse practice, Mr. Ellis again favoured the Society with an excellent lecture entitled "Meteorological Reports." He gave a list of the various forecasts and weather reports, explained their particular uses, to whom they were addressed, and the times at which they were transmitted. The Old International Code used in these reports was explained in detail, and a specimen report was deciphered. The lecturer concluded with a summary of the systems employed by the various nations.

After the lecture the broadcasting stations were tuned in on Mr. Benzie's four-valve set, which he had kindly brought along for the purpose.

The committee hope that prospective new members will send for information to the Hon. Secretary.

Streatham Radio Society.*

Hon. Secretary, Mr. S. C. Newton, A.M.I.E.E., "Compton," Pendennis Road, Streatham, S.W.16.

The January meeting of the above Society was held at the headquarters, Streatham Hill College, on the 10th when an interesting lecture was given by Mr. Gibbon of the Post Office Engineering Staff, illustrated by a number of lantern slides. The lecturer gave much valuable information on the development of radio work and the slides showed several well-known stations. A demonstration followed the lecture, when an Ultra IV Receiving Set, kindly lent by Messrs. Burndept Ltd., was admirably handled by Mr. F. O. Reed, and the strains of Covent Garden Opera filled the room from an Amplion loud speaker.

A hearty vote of thanks was given at the conclusion of the meeting to Mr. Gibbon, Mr. Reed and Messrs. Burndept, Ltd., for the pleasant evening they had afforded. The lantern was lent and operated by Mr. King, Treasurer to the Society.

The first annual dinner of the Society will be held on February 14th.

The Finchley and District Wireless Society.*

Hon. Secretary, Mr. A. E. Field, 28, Holmwood Gardens, Finchley, N. 3.

The above Society met on Monday, January 8th, when it was decided to hold future meetings at St. Mary's Schools, Church End, Finchley. In future the meetings will be conducted as follows :—7 p.m., an elementary lecture on the first principles of Wireless Telegraphy and Telephony ; 8 p.m., A demonstration and lecture of a more advanced character ; 9.30 till 10 p.m., Two "buzzer" classes, one for the novice and the other for those who wish to improve their speed. It is hoped that members will attend more regularly in future. Members are still needed, and all those interested are invited to communicate with the Hon. Secretary.

The Belvedere and District Radio and Scientific Society.*

Hon. Secretary, Mr. S. G. Meadows, 1, Kentish Road, Belvedere, Kent.

On January 10th, Mr. Burman read his paper on "High Frequency Amplifiers." He opened by explaining the meaning of the term "coupling." The three most common methods of high frequency coupling were then outlined, and the advantages of high frequency magnification were enumerated. The term "amplification factor" was made clear by means of blackboard sketches.

The resistance-capacity coupling was discussed. The efficiency of this system, depending on the value of the anode resistance, was explained by assuming the valve to be a simple varying resistance in series with the fixed anode resistance, and the variations in potential across the former, with the different values of anode resistance illustrated by numerical examples.

The tuned anode method of coupling followed, the lecturer pointing out the similarity of these two methods in many respects, and detailing the desirable features which the tuned anode possessed.

The meaning of "rejector" circuit was defined, and an elementary mathematical proof of certain statements made, was developed by the use of complex quantities. The result showed that in order to get maximum impedance at a given frequency, the capacity across the coil and the ohmic resistance of the coil must be a minimum, whereas the inductance should be as large as possible, consistent of course, with proper tuning. A circuit possessing these properties, it was explained, was very desirable from the point of view of selectivity, especially on "Broadcast" wavelengths, to reduce jamming from spark stations working close to the wavelength tuned in. The practical construction of an amplifier embodying these three systems of coupling will form the subject of a paper by the same lecturer, to be given before the Society shortly.

St. Barnabas' Wireless Club (Epsom).

Hon. Secretary, Mr. B. H. Hardy, "Oakhurst," 32, Pound Lane, Epsom.

The above Club gave a Wireless Demonstration at the St. Barnabas' Parish Room, Epsom, on Wednesday, January 10th, in aid of the proposed New Parish Hall.

Reception from Marconi House, including the opera "Pagliacci," was particularly loud and clear, and special thanks are due to one of the members, Mr. H. Penfold, whose four-valve receiving set was used on this occasion.

The Hall was filled to overflowing, and a collection at the door yielded a generous sum for the object mentioned. The demonstration was so successful in fact that it is proposed to give another at an early date.

There are a few vacancies for keen members, ladies or gentlemen, whether they possess any technical knowledge or not. The entrance fee, returnable, is 5s. and the subscription 1s. per month. Two series of lectures are being arranged to commence shortly, one for members who have no knowledge of wireless and the other for the advanced members.

The Club meets on Thursdays at 8 p.m., in the St. Barnabas' Parish Room, Hook Road, Epsom.

Electrostatic Capacity in Radio Circuits

By S. O. PEARSON, B.Sc.

NO doubt it has occurred to many amateur wireless experimenters that electrostatic capacity is used for two diametrically opposite purposes in radio work. For instance, telephones are usually shunted by a condenser to by-pass the high frequency component of the current, that is, to offer a path of low impedance to the high frequency component. On the other hand, the primary of a high frequency transformer is often shunted by a condenser in order to *increase* the impedance and so get the greatest possible potential difference across the circuit. To those who are not versed in the theory of electric circuits this would appear to be somewhat paradoxical; but it is quite consistent, and one of the objects of this article is to explain as clearly as possible what the conditions are under which capacity has these opposite effects.

The three constants of an electric circuit, namely *resistance*, *inductance* and *capacity*, are all present to some degree in every circuit; it is not possible in practice to obtain any one of these quantities without the presence of the other two. Every experimenter knows that an ordinary tuning inductance possesses not only resistance but also self capacity. In this case both the resistance and the self capacity are detrimental to efficient working but they cannot be entirely eliminated. It is not intended to dwell here upon the effects of resistance, inductance and capacity singly, but rather to consider their combined effect upon the relationship between pressure and current in a circuit.

Let us consider the impedance of an inductive coil having an inductance of L henries and a resistance of R ohms. but whose self capacity is negligible. When an alternating pressure of V volts at a frequency of f cycles per second is applied across the ends of the coil, then, neglecting self capacity, the current is given in amps by

$$A = \frac{V}{\sqrt{R^2 + \omega^2 L^2}}$$

where $\omega = 2\pi f$

and the Impedance

$$Z = V/A$$
$$= \sqrt{R^2 + \omega^2 L^2} \text{ ohms.} \quad . \quad . \quad . \quad (1)$$

This is the opposition which the circuit offers to the passage of an alternating current whose frequency is f cycles per second. The higher the frequency of the current the greater is the impedance and when we come to deal with radio frequencies the impedance of the circuit usually reaches a very high figure. A numerical example will make this clear.

Suppose the coil has an inductance of 1,000 microhenries (0.001 henry) and a resistance of 10 ohms, then at a frequency of 100,000 cycles per second, corresponding to a wavelength of 3,000 metres, the impedance is 628·4 ohms. This shows how small is the effect of the ohmic resistance in comparison

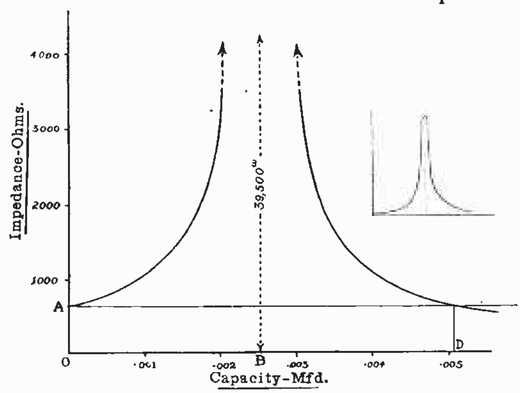


Fig. 1. Curve showing the relation between capacity and impedance. Inset: Full curve drawn to a smaller scale.

with that of the inductance at this high frequency; in fact if the resistance were neglected altogether an error of less than 0·01 per cent. would be involved. This is an interesting point and will be referred to again later.

If now the coil is shunted by a condenser of capacity C farads, the impedance of the circuit is given by

$$Z = \frac{1}{\sqrt{\left(\frac{R}{R^2 + \omega^2 L^2}\right)^2 + \left(\frac{\omega L}{R^2 + \omega^2 L^2} - \omega C\right)^2}} \quad . \quad . \quad . \quad (2)$$

using this expression to find the impedance of the circuit when the coil we considered above is shunted by a condenser of 0·002 microfarad we get $Z = 3{\cdot}772$ ohms at 100,000 cycles per

2792

second. We saw that the unshunted coil had an impedance of 628·4 ohms at this frequency, so that the addition of the condenser in parallel has considerably increased the impedance of the circuit.

The impedances have been worked out for various values of C and plotted as a curve in Fig. 1. It will be noticed that the impedance increases as the capacity is increased up to a certain point and then begins to decrease again as the capacity is still further increased. Evidently then there is a critical value of the capacity which makes the impedance a maximum. From the graph we see that the impedance reaches its maximum value when the capacity is about 0.0025 microfarad.

On examination of equation (2) we see at once that the impedance has a maximum value when

$$\frac{\omega L}{R^2 + \omega^2 L^2} - \omega C = 0$$

or $$C = \frac{L}{R^2 + \omega^2 L^2} \text{ farads} \quad \ldots\ldots (3)$$

At radio frequencies R is usually small compared with ωL and may be neglected without introducing any serious error.

Hence $C = L/\omega^2 L^2$

or $f = 1/2\pi\sqrt{LC}$, since $\omega = 2\pi f$.

This is the well-known formula for the resonance frequency of a circuit, but it must be borne in mind that this is only approximately correct when the circuit contains resistance. In this particular case we find that the impedance is greatest when the capacity is 0.00253 mfd. and that this maximum value of the impedance reaches the surprisingly high figure of 39,500 ohms. When the capacity is adjusted to this critical value the circuit is said to be *tuned* to a wavelength of 3,000 metres. It is when the circuit is thus tuned that its study is most interesting.

Let us find an expression for the impedance of the tuned circuit. When $C = L/(R^2 + \omega^2 L^2)$ the impedance of the circuit becomes

$$Z = \frac{1}{\dfrac{R}{R^2 + \omega^2 L^2}}$$

$$= \frac{R^2 + \omega^2 L^2}{R}$$

$$= L/CR \text{ ohms} \quad \ldots\ldots\ldots\ldots (4)$$

This is a very simple expression but is very important and a great deal of valuable information can be obtained from it. It should be mentioned here that when a circuit is tuned in this manner the E.M.F. and current are exactly in phase (*see* vector diagram Fig. 2) and hence the circuit is acting as a non-inductive resistance of L/CR ohms. This is sometimes called the *equivalent non-inductive resistance* of the tuned circuit.

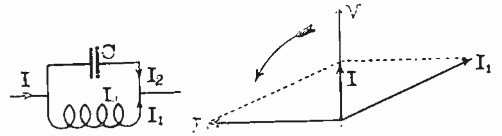


Fig. 2. Tuned circuit and Vector diagram.

When tuning a circuit to a certain wavelength or frequency the object in view is to arrange the circuit so as to offer the *greatest possible impedance* to the passage of a current of that frequency, but to offer low impedance to currents of any other frequency. This is where the ohmic resistance plays a very important part, since, as we have seen, the maximum impedance of a tuned circuit varies inversely as the ohmic resistance of the inductive coil and hence in any tuned circuit it is most essential that the resistance should be kept as low as possible. We saw previously that for an untuned inductive circuit the ohmic resistance had practically no effect at high frequencies, but it is just the reverse in a tuned circuit for it not only reduces the maximum value of the impedance in direct proportion, but what is worse, diminishes the sharpness of the tuning. In order to get selective tuning then, it is obviously very necessary to choose a coil with the lowest possible high frequency resistance, and this accounts for the use of " Litz " wire in high-class apparatus.

Further, we see that the maximum impedance of the tuned circuit is directly proportional to the ratio of inductance to capacity, so that L/C should be made as large as possible in order to obtain the greatest efficiency. It is very bad practice to shunt a small inductance by a large condenser in order to reach a certain wavelength; it is far better to increase the value of the inductance, but care must be taken that the resistance is not excessively increased at the same time, or no advantage will be obtained. The use of inductance coils wound with very thin wire should be avoided; much rather obtain an efficient circuit at the expense of compactness than the converse. The self capacity of an inductance coil is equivalent in effect to a condenser in parallel and therefore it is necessary that coils should be wound in such a manner as to reduce the self capacity to a minimum.

It is well worth noting what takes place when the capacity in parallel with the coil is increased beyond the critical value $L/(R^2+\omega^2L^2)$. Referring again to the impedance curve of Fig. 1, it will be observed that as the capacity is increased beyond the critical value represented by OB, the impedance of the circuit begins to diminish again; and when C is made infinitely large, equation (2) shows that the impedance of the circuit becomes infinitely small. Now the impedance of the unshunted coil was seen to be $\sqrt{(R^2 + \omega^2L^2)}$, represented by OA in the graph, and obviously there must be some particular value of the capacity which will make the impedance again equal to that of the unshunted coil. This value is represented by OD in the figure and can be found analytically by equating expressions (1) and (2) above, from which we get

$$C = \frac{2L}{R^2 + \omega^2L^2} \quad \ldots\ldots\ldots\ldots \quad (5)$$

which is just double the value required for maximum impedance. When the capacity is adjusted to this value the phase difference between the E.M.F. applied to the ends of the circuit and the current through the circuit is exactly the same as for the unshunted coil, but in the latter case the current leads the E.M.F. in phase, whereas in the former the current lagged behind the E.M.F. by the same angle, namely $\phi = \tan^{-1}\omega L/R$.

For all values of the capacity between $C = O$ and $C = 2L/(R^2 + \omega^2L^2)$ the resulting impedance of the circuit is greater than that of the coil alone. Hence when connecting a condenser in parallel with any inductive portion of a circuit in order to "by-pass" a current of a certain frequency, great care must be taken that the value of the capacity does not fall within these limits, or matters will be made worse instead of better. The capacity of the condenser should be at least eight or ten times the value required for resonance in order to act as an effective by-pass.

The Model Engineer Exhibition.

THE growing public interest in wireless and the consequent rapid development of the manufacturing industry was reflected in the arrangements of the recent exhibition organised by the *Model Engineer*, and held at the Horticultural Hall, Westminster, from January 5th to January 12th.

Second only perhaps to model railways, wireless equipment aroused the greatest share of the attention of the large number of visitors at the exhibition.

Messrs. F. Yates & Sons, Ltd., of 144, Church Street, Kensington, London, W.8., exhibited motors, dynamos, accumulators, general electrical accessories and a selection of wireless apparatus. The Grafton Electrical Co., of 54, Grafton Street, Tottenham Court Road, W.1, in addition to a range of wireless sets and components, displayed electric motors and dynamos, accumulators, batteries, electrical measuring instruments and other scientific apparatus. The Wainwright Manufacturing Co., Ltd., of 25, Victoria Street, London, S.W., were represented by an attractive display of wireless apparatus and accessories.

Messrs. A. W. Gamage, Ltd., showed a large and varied assortment of fittings and sets for wireless reception. The Peto Scott Co., of 64, High Holborn, London, displayed a selection of their specialities, including complete wireless sets and accessories. Messrs. G. Z. Auckland & Son, of 395, St. John Street, E.C., exhibited a large range of wireless apparatus manufactured by them, including receiving sets, amplifiers, accumulators and high tension batteries. Messrs. The Bowyer-Lowe Co., Ltd., of Letchworth, showed general wireless apparatus and parts.

The exhibits of Messrs. J. B. Bower & Co., Ltd., of Kingston Road, Wimbledon, consisted of crystal and valve sets, condensers, coils, and accessories. Messrs. Leslie McMichael, Ltd., of 179, Strand, London, W.C., exhibited wireless requisites of all kinds. Messrs. M. W. Woods, of 146, Bishopsgate, London, E.C., had on view a collection of their battery charging rectifiers, wireless transmitting generators, and receiving sets. Messrs. Economic Electric, Ltd., of 10, Fitzroy Square, London, W., displayed a large variety of scientific electric apparatus and components.

The prize in the competition for the construction of a variable condenser for wireless was awarded to Mr. C. F. Sayers.

Wireless Broadcasting of Opera from Covent Garden.

Described by W. J. CRAMPTON, M.I.E.E., Member I.R.E.

The achievement of Broadcasting Opera from Covent Garden is a subject which is at the present time of extreme interest to everyone associated either with wireless telephony or attracted by the music alone. The following account given by Mr. W. J. Crampton, Consulting Engineer to the Royal Opera House, describes what led up to the undertaking of this enterprise.

IN response to many inquiries as to the methods adopted for transmitting the operas produced at Covent Garden Theatre, through the London Broadcasting

Photo: Elliott & Fry, Ltd.

Dame Melba whose support of British opera and interest in this enterprise have contributed so largely to the extraordinary success achieved.

Station (2 LO), I hope the following details will be of interest to those who nightly listened-in, many of whom have questioned as to how it has been carried into effect.

As Consulting Engineer to the Royal Opera House I fully realised that if some form of agreement could be arrived at between the Opera Company and The British Broadcasting Company, the public would materially benefit by enjoying at home the services of the artists and orchestra connected with the opera. I therefore approached those concerned, and the proposition met, I am pleased to say, with a quick response.

The Opera House is situated some 400 yards from the Broadcasting Company's Studios, and the first essential was the installation of metallic circuits to connect the buildings. The General Post Office staff rapidly laid, through their existing conduits, a lead-sheathed multiple telephone cable. One pair of wires in this cable is employed for telephones so that the engineers of the Opera House may communicate direct with the studio and notify the correct times to switch over. The engineer on the prompt side of the stage is also in a position to inform the transmitting station from time to time exactly what is about to take place, and also has direct communication with those in charge of the magnifying equipment situated in the basement of the theatre. Consequently the necessary direct communication is effected between all those responsible for the broadcasting arrangements.

A Western Electric microphone has been fixed in close proximity to the footlights on the stage, and this is connected to a three-valve amplifier in the basement of the theatre by a triple cable, which amplifier is in turn connected by means of the lead-sheathed telephone

Mr. W. J. Crampton.

cable, direct to the transformer in the Broadcasting Company's studios, and from the transformer connection is made to the transmitting control valve at the broadcasting station.

Reports which have come to hand from various distant receiving stations, including Edinburgh and Paris, are extremely gratifying. The clearness and purity of tone are all that can be desired.

We are indebted to the following gentlemen who, in the service of the British Broadcasting Company, have so ably assisted in the onerous duties necessary to the successful issue of this innovation :—

First and foremost, Mr. Burrows, Director of Programmes, who is so well known, and who very quickly appreciated the significance of the proposition.

Captain Lewis, his able assistant.

Mr. Stanton Jeffries, Musical Director of the Broadcasting Company, whose knowledge of music renders his services on the prompt side so valuable.

Mr. Rickard and Mr. Wright, who take charge of the amplifying equipment in the basement under the stage. Their's is by no means an envious position, controlling their portion of the apparatus down below the stage.

The G.P.O. Engineering Department, who so rapidly and efficiently installed the metallic lines between the buildings.

I am convinced, from reports received personally, that the transmissions have met with distinct appreciation, and believe it is the forerunner of greater development which will be, I am sure, taken full advantage of as it occurs, to maintain the interest of all those who have taken up wireless not only as a pleasant form of amusement, but also as an essential feature of our daily life.

Such transmissions as these should be the more readily appreciated by those who, through sickness or infirmity, are unable to attend the theatre itself, and those who having seen and heard the operas may have pleasant memories revived.

Notes.

The Institution of Electrical Engineers.

The paper to be given on January 26th, 1923, will be "The Wireless Telephone Service to the Bar Lightship at Liverpool," by Mr. E. A. Payne, and not as stated on the green meetings card of the Institution.

A Wireless and General Trade Exhibition.

A trade exhibition of which wireless apparatus will form an important feature is to be held at Northampton from March 19th to 24th. The motor trade and many other important industries of the Midland counties will be represented, and special railway facilities will be arranged in connection with all the principal towns of the Midland area. The wireless section will also include exhibits of electrical and lighting plant, and will be open to both manufacturers and their agents. The Hon. Secretary is Mr. J. H. Wilson, St. Katherine's Street, Northampton.

A New Radio Club.

A Radio Club has been formed by the staff and employees of the Sunbeam Motor Car Company, Ltd., of Wolverhampton, and a room has been placed at their disposal through the kindness of the Company. The inaugural meeting was held on January 18th, when the policy and aims of the Club were formulated.

A wireless society is also being formed at Winsford, Cheshire, and already over thirty names of persons interested in the movement have been received. Those who have not yet done so are requested to communicate with Mr. S. Oakes 188, Weaver Street, Winsford.

An Apology.

Wireless Installations, Limited, desire to tender apologies for their inability to despatch some of their Christmas orders with the usual promptness. The delay was occasioned by an unprecedented pressure of business which, however, has now been relieved.

Manchester Wireless Traders' Association.

The preliminary steps have been taken in the formation of an association to be called the Manchester Wireless Traders' Association, and a committee representative of the principal firms in the trade has already been elected.

Honour for a German Engineer.

Dr. Alexander Meissner, the well-known German engineer and investigator, has been awarded the degree of "Doctor Engineer" in recognition of his services and in particular his address on "The Evolution of the Methods of Transmission and Reception of Wireless Telegraphy," at the Annual Academic Celebration at the Munich Technical High School, on December 7th, 1922.

Broadcasting in Cuba and Porto Rico.

Operating with a range of 2,000 to 2,400 miles, two new stations have recently been opened in the West Indies at Cuba and Porto Rico respectively for broadcast services. The Cuban station is of 400 watts capacity, and operates on the 400 metre wave, while the Porto Rico station is of 250 watts capacity, its call letters are **WKAG** and the regulation announcements are made in English.

A Wireless Firm's New Branch.

The Stirling Telephone and Electric Co., Ltd., of Telephone House, Tottenham Court Road, London, have recently opened a branch at 14, St. Peter's Square, Manchester, where a range of their principal types of telephones and radio apparatus will in future be on exhibition.

Wireless Telegraphy for Rescue Work in Mines.

A series of tests was recently carried out at the experimental coal-mine of the United States Bureau of Mines in order to determine whether wireless telegraphy afforded the possibility of communication between rescuers and miners entombed following fires and explosions. It was shown in these experiments that signals could be distinctly heard through 50 feet of coal strata, although the audibility fell off rapidly as the distance was increased. It is thought that with longer wavelengths than those used (200 to 300 metres) absorption could be considerably reduced and this method of communication made practically effective at least under certain conditions. An account of amateur experimental work in this connection formed the subject of a note in the issue of the *Wireless World and Radio Review* for October 28th, 1922.

A Bibliography of Wireless Publications.

The predominating feature of the bi-monthly Bulletin issued by the Coventry Public Libraries Committee is a valuable bibliography of books and periodicals relating to wireless telegraphy and telephony. In a foreword to this section Sir Henry Noble, M.I.E.E., Chairman of the British Broadcasting Committee, refers to the extraordinary progress made in this branch of science during the last few years, and outlines the developments contemplated in "broadcasting."

Precision Standardisation of Radio Frequencies.

The United States Bureau of Standards has developed a very precise method of standardisation of radio wavelengths and frequencies. By the process used the frequency of radio waves is compared with that of an audible musical note, a tuning fork being mounted in such a way that it may be made to control the frequency of an oscillatory circuit. The frequency of another oscillatory circuit operating at much higher frequencies is then compared with it by means of a cathode-ray oscillograph. The latter instrument consists of the cathode-ray tube, a special kind of vacuum tube in which the narrow stream of electrons is subjected to the action of electric fields applied by the two alternating current generators. When neither generator is operating, the electrons impinging on the active screen at the end of the tube cause a single luminous spot. If one generator is connected the spot is deflected back and forth along the single line, horizontal or vertical, as the case may be, with such rapidity that it appears as a solid line. If both generators are applied simultaneously, the spot oscillates both horizontally and vertically, and appears in general as a blurred luminous rectangle. If however the frequencies of the two generators bear a simple ratio, such as four to one, the spot traverses and re-traverses a definite simple path, forming a figure by which the frequency ratio may be recognised. It has been found possible to compare frequency ratios as high as 21 to 1. The bureau is at present engaged in the standardisation of a high-precision standard wavemeter by this means. A tuning fork of known frequency, approximately 1,000 cycles per second, is used as the basis of the standardisation. A low-frequency generator is tuned to successive multiples of this frequency by means of the cathode-ray oscillograph, and corresponding settings of the wavemeter are obtained. A third generator is similarly tuned to multiples of these frequencies, and thus by successive stages the standardisation is extended to include frequencies as high as 5,000 kilo-cycles (60 metres). It is intended that this wavemeter be used as the basic standard for the standardisation of commercial wavemeters.

French Broadcasting Times.

The times of the wireless telephony transmissions from the Eiffel Tower and the Radiola Concerts are now given as follows:—Eiffel Tower (2,600 wave), 11.15 a.m., weather reports (duration 10 minutes): 6.20 p.m., weather reports and concert occupying about half an hour; 10.10 p.m., weather reports (duration 10 minutes). With regard to the Radiola Concerts (1,565 wave) the exact times are:—5.5 p.m., news items; 5.15 p.m., concert till 6 p.m.; 8.45-p.m., news items: 9 p.m., concert till 10 p.m.

Celebrating Australia Day from 2 LO.

Friday, January 26th, is Australia Day and it is understood that an appropriate programme has been arranged for broadcasting from **2 LO**, the British Broadcasting Company's London station. It is announced that the High Commissioner of Australia will broadcast an address. Australian talent will provide the musical entertainment and amongst those whom it is hoped will take part are:—Madame Ada Crossley (accompanied on the organ by Mr. Arthur Mason), Miss Florence Austral, Miss Gertrude Johnston, Messrs. Harold Williams, Malcolm, McEacharn, Alfred O'Shea, David Kennedy, Amadio, and the celebrated pianist, William Murdoch.

Amateur Wireless Prohibited in Sweden.

It would appear from reports received that owing to Government regulations in Sweden nothing has been done to stimulate popular interest in amateur radiotelephony. The use of wireless apparatus is controlled by the Royal Telegraph Board and though private firms may use it under licence they have not so far taken advantage of this right. Apparently there is only one firm in Sweden manufacturing radio apparatus and this is comparatively small. Swedish electrical dealers have been trying recently to obtain modification of the present regulation which forbids the use of radio apparatus by amateurs and there is little doubt that such a change would lead to a great expansion of the wireless trade in Sweden.

Books Received

THE RADIO AMATEUR'S HANDBOOK. By A. Frederick Collins. (London: *George G. Harrap & Co., Ltd.*, 330 pp., 8″ × 5½″. Illustrated. Price, 7s. 6d. net.)

METAL TURNING MADE EASY. (London: *Cassell & Co., Ltd.*, La Belle Sauvage, E.C.4. Illustrated. 152 pp. Price 1s. 6d net.)

IDEAS FOR THE RADIO EXPERIMENTERS' LABORATORY. By M. B. Sleeper. (New York: *The Norman W. Henley Publishing Co.*, Price $75.)

Reception of American Broadcasting Station

Particulars are given below of the reception in this country of certain of the American broadcasting stations. In addition to those below, many other reports have been received, though insufficient details have been supplied to conclude with certainty that the signals were of American origin. In many cases details of the reception of the broadcasting stations have been included in reports relating to the Transatlantic Tests, and particulars will be extracted and published as soon as all the correspondence relating to the tests has been dealt with.

Date			Name.	Location.	Apparatus.								Station Heard.
					HF			Detector		LF			
Nov.	Dec.	Jan.						V	C				
23													
24			C. M. Denny ..	Bebington, Ches.									
25			— Kelman ..	Guernsey, C.I. ..									WDY
26			R. J. H. D. Ridley of Burndept, Ltd.	Norwood, London		×	×	×		×			WJZ
26			E. H. Wilding ..	Wigan, Lancs. ..				×		×	×	×	WJD
	2		C. Keith Murray	Romsey, Hants ..			×	×		×			?
	2		W. R. Stainton ..	Leigh, Lancs. ..				×		×			WJZ
	3		do.	do.				×		×			WJZ
	3		F. W. Higgs ..	Bristol			×	×		×	×		WJZ
	8		W. B. Parker ..	Monkseaton. Northumberland			×	×		×			WJZ
	10		W. R. Stainton ..	Leigh, Lancs. ..				×		×			WJZ
	10		A. L. Gay ..	Darlington, Durham.			×	×		×			WJZ
	10		B. Gibson ..	Herne Bay ..			×	×		×			WJZ
	10		R. W. Galpin ..	Herne Bay ..			×	×		×			WJZ
	10		W. H. Webb ..	Manchester ..			×	×		×			WJZ
	10		C. Shearston ..	Portsmouth ..	×	×	×	×					WJZ
	10		A. H. Reade ..	Oxton, Birkenhead									WJZ
	10		N. C. Hardman ..	Manchester ..				×			×		WJZ
	10		J. W. Riddiough	Baildon, Yorks ..			×	×					WME
	10		Percy B. Todd ..	Lincoln			×	×					WJZ
	11		D. A. Brown ..	Birmingham ..				×		×	×		WJZ
	11		A. V. Chambers	Wimbledon, S.W.				×		×	×		WJZ
	11		H. Aitken ..	Salford			×	×		×			WJZ
	11		C. H. Nokes ..	Ripley, Surrey ..			×	×		×			WJZ
	12		A. E. D. Kennard	Wangford, Suffolk									WJZ
	14		A. S. Gosling ..	Nottingham ..				×					?
	14		C. S. Bishopp ..	Cullompton, Devon				×					?
	14		W. B. Parker ..	Monkseaton, Northumberland			×	×					?
	18		F. Harper-Shore	Farnborough. Hants.				×		×			WJZ
	18		W. R. Stainton ..	Leigh, Lancs. ..				×		×			WJZ
	19		C. M. Denny ..	Bebington, Cheshire.				×					WJZ
	19		J. H. Hill ..	Farnborough. Hants.			×	×		×			WJZ / WBY
	20		O. F. Keurl ..	Bath				×		×			WEY
	20		H. S. Woolley ..	Nottingham ..			×	×		×			WDY
	20		Lott	Burnham-on-Sea									WJZ
	20		J. W. Partington	Camborne, Cornwall			×	×		×			WHI
	20		Nesbit Burns ..	Somerset ..				×					WJZ
	20		H. L. Bowen ..	Bath			×	×		×	×		?
	23		T. B. Trott ..	Plymouth ..			×	×		×	×		WJZ
	23		G. D. Adams ..	Pinner, Midx. ..		×	×	×		×			?
	23		G. P. Kendall ..	Leeds									WJZ
	24		A. Meredith ..	Shrewsbury ..				×		×			?
	24		A. Krause ..	Sutton Coldfield ..				×					WJZ
	24		R. C. Neale ..	Farnborough ..			×	×		×	×	×	WJZ
	25		J. Ashworth ..	Bolton			×	×		×	×		WJZ
	25		E. W. Null ..	Colchester ..									WDY

Date. Nov.	Date. Dec.	Date. Jan.	Name.	Location.	Apparatus. HF	Detector V	Detector C	LF	Station Heard.
	25		P. G. A. H. Voigt	London, S.E.23 ..	× ×		×		WJZ
	25		J. W. Partington	Camborne, Cornwall.					WGY, WGY
	25		F. Williams ..	Acton, W.3 ..		×		×	?
	27		H. C. Gooding ..	Stowmarket ..	×	×		×	?
		2	H. R. Goodall ..	Southampton ..	×	×		× ×	?
		7	A. F. Baldry ..	Wembley, Midx.	×	×		×	WJZ
		8	W. R. Stainton ..	Leigh, Lancs. ..					WJY
		8	W. R. N. Ward ..	Teddington, Midx.	×	×		× ×	WJZ
		13	W. R. Stainton ..	Leigh, Lancs. ..					WGY
		13	W. B. Parker ..	Monkseaton, Northumberland	×	×		×	WJZ, WDAC
		14	A. E. Berlyn ..	Birmingham ..	×	×			WJZ, WZY, WDAF
		16	V. M. Cartnell ..	Southport ..					WGY
		17	F. D. B. Cobb ..	Margate	×	×		× ×	WJZ
		17	W. D. Taylor ..	Sunderland ..	–	×			WJZ

Calendar of Current Events

Saturday, January 27th.

LAMBETH FIELD CLUB AND MORLEY COLLEGE SCIENTIFIC SOCIETY.

At 7.30 p.m. At the Physics Laboratory, Morley College, S.E.1. Practical night.

Sunday, January 28th.

At 3.5 p.m. *Daily Mail* Concert from **PCGG**, The Hague, on 1,050 metres.

Monday, January 29th.

9.20 to 10.20 p.m. Dutch Concert, **PCGG**, The Hague, on 1,050 metres.

IPSWICH AND DISTRICT WIRELESS SOCIETY.

At 8 p.m. At 55, Fonnereau Road. Lecture by Mr. H. M. Campbell, A.M.I.E.E.

Tuesday, January 30th.

Transmission of Telephony at 8 p.m. on 400 metres, by **2 MT**, Writtle.

LOWESTOFT AND DISTRICT WIRELESS SOCIETY.

At St. Margaret's Institute, Alexandra Road. Lecture by Mr. F. E. Thirtle.

PLYMOUTH WIRELESS AND SCIENTIFIC SOCIETY.

Meeting.

Wednesday, January 31st.

EDINBURGH AND DISTRICT RADIO SOCIETY.

At R.S.S.A. Hall, Lecture on "Amateur Research Work," by M. G. Scroggie, B.Sc.

HALIFAX WIRELESS CLUB AND RADIO SCIENTIFIC SOCIETY.

Questions and Answers Evening.

COWES DISTRICT RADIO AND RESEARCH SOCIETY.

General Meeting.

Thursday, February 1st.

Silvanus Thompson Memorial Lecture. At the Technical College, Leonard Street, E.C.2. At 7.30 p.m. Sir Oliver Lodge, F.R.S., on "The Basis of Wireless Communication." In the Chair: Sir Charles Parsons, K.C.B.

LUTON WIRELESS SOCIETY.

At 8 p.m. At the Hitchin Road Boy's School. Practical Work and Experiments.

STOKE-ON-TRENT WIRELESS AND EXPERIMENTAL SOCIETY.

Lecture on "A Broadcasting Crystal Receiver," by Mr. T. R. Clark.

HACKNEY AND DISTRICT RADIO SOCIETY.

At the Y.M.C.A., Mare Street, E.8. Lecture on "Electrical Units and Ohm's Law." By Mr. Francis. At 9.20 to 10.20 p.m. Dutch Concert from **PCGG**, The Hague, on 1,050 metres.

Friday, February 2nd.

SHEFFIELD AND DISTRICT WIRELESS SOCIETY.

At 7.30 p.m. At the Dept. of Applied Science, St. George's Square,

LEEDS AND DISTRICT AMATEUR WIRELESS SOCIETY.

Lecture on "Vacuum Tubes: Their History and Phenomena." By Mr. E. M. Washington.

BELVEDERE AND DISTRICT RADIO AND SCIENTIFIC SOCIETY.

Lecture on "Reception of the Transatlantic Amateur Stations," by Mr. C. E. Morris.

BROADCASTING STATIONS.

Regular evening programmes, details of which appear in the daily press, are now conducted from the following stations of the British Broadcasting Company :—

London	**2LO**	369 metres.
Birmingham	**5IT**	420 ,,
Manchester	**2ZY**	385 ,,
Newcastle	**5NO**	400 ,,

Questions and Answers

NOTE.—This section of the magazine is placed at the disposal of all readers who wish to receive advice and information on matters pertaining to both the technical and non-technical sides of wireless work. Readers should comply with the following rules :—(1) Each question should be numbered and written on a separate sheet on one side of the paper, and addressed "Questions and Answers," Editor, THE WIRELESS WORLD AND RADIO REVIEW, *12/13, Henrietta Street, London, W.C.2. Queries should be clear and concise. (2) Before sending in their questions readers are advised to search recent numbers to see whether the same queries have not been dealt with before. (3) Each communication sent in to be accompanied by the "Questions and Answers" coupon to be found in the advertisement columns of the issue current at the time of forwarding the questions. (4) The name and address of the querist, which is for reference and not for publication, to appear at the top of every sheet or sheets, and unless typewritten, this should be in block capitals. Queries will be answered under the initials and town of the correspondent, or, if so desired, under a "nom de plume." (5) In view of the fact that a large proportion of the circuits and apparatus described in these answers are covered by patents, readers are advised before making use of them, to satisfy themselves that they would not be infringing patents. (6)* **Where a reply through the post is required every question sent in must be accompanied by a postal order for the amount of 1s., or 3s. 6d. for a maximum of four questions.** *(7) Four questions is the maximum which may be sent in at one time.*

"VALVE" (Woolwich) *asks (1) Is he allowed to make up wireless components and wireless receiving sets. (2) Is it possible for him to become a member of the B.B.C. (3) What sum has to be paid down to become a member.*

(1) There is no reason why you should not manufacture wireless components and receivers, although, of course, the question of patents requires consideration. (2) and (3) We understand that any bona fide manufacturer may become a member of the B.B.C., and we suggest you communicate with the Secretary for further particulars.

"BORDER" (West Ham) *asks (1) Why a tuning arrangement, when connected up with one receiver, will not tune up to such a high wavelength as when connected up with a second receiver. (2) Why is it that when the tuning condenser is connected in series with the A.T.I. the signals are reduced in strength. (3) Would a receiver built up according to the diagram referred to generate oscillations in the aerial circuit. (4) Is it correct to use a 4-volt L.T. battery and 45-volt H.T. battery.*

(1) Without a more exact knowledge of the receiver we cannot say why the wavelength reached with one arrangement is less than with the other. We suggest you increase the capacity of the reaction condenser to 0·0002 mfds. (2) The aerial condenser should have a value of 0·001 mfd. If the capacity is too small, a reduction in the strength of signals may be expected, especially when you have a large capacity aerial. (3) The circuit referred to can certainly generate oscillations in the aerial circuit unless care is exercised. (4) It is generally better to employ a 6-volt L.T. battery and a 60-volt H.T. battery, so that sufficient energy is available.

"S.H." (Chorley) *submits a diagram of connections, and asks (1) Over what distance he may expect to hear signals. (2) Why, with a certain combination of coils, short wavelength signals are received. (3) Should the transmissions from* **2 LO** *and* **2 MT** *be audible using this receiver, the receiver being located just north of Manchester. (4) Should it be necessary to use a microphone amplifier in order to operate a loud speaker, or is it possible to use note magnifiers.*

(1) and (3) We suggest you cut out the 0·0005 mfd. tuning condenser which is connected across the A.T.I., but retain the 0·001 mfd. condenser which is in series. The primary of the high frequency transformer should be tuned with a small condenser having a maximum value of 0·0002 mfds., otherwise the diagram is correct. The range of the receiver of course depends upon the power of the transmitting station, but we consider you should hear the transmissions from **2 LO** and **2 MT** with careful tuning. (2) The peculiar tuning adjustments will no longer be necessary if the alterations suggested in (1) are acted upon. (4) A microphone amplifier may be used if desired, but a note magnifier will do equally as well.

"T.W.B." (West Dulwich) *submits a diagram of connections and asks (1) Whether he should receive the* **2 LO** *and Croydon transmissions. (2) What type of telephones to use. (3) What licence to obtain. (4) The correct method of tuning broadcast transmissions when a two-coil slider is used.*

(1) A variable condenser should be connected to the circuit as indicated in the diagram 2 submitted. The blocking condenser should have a value of 0·001 mfds. (2) We suggest you use the 8,000 ohm telephones with this receiver. (3) As you have constructed the receiver yourself, it will be necessary to obtain an experimental licence before you connect it with an aerial. (4) The slider connected to the secondary circuit should be moved so that it includes about a quarter of the coil in the circuit. The slider connected with earth should then be varied until signals are received. Fine tuning is carried out with the condenser.

"A.M." (Stowmarket) *submits a diagram of connections of his receiver, and asks whether it is a non-radiating circuit.*

As the reaction coil is coupled with the tuned anode winding, it is not likely that oscillating energy will be generated in the aerial circuit. In the diagram the grid leak is shown connected across the grid condenser, and as you are using a tuned anode coil, the +H.T. is connected through the grid leak with the grid of the detector valve. This is incorrect. The grid leak should be joined between the grid of the detector valve and its filament, generally to positive.

"BULLER" (E.10) *has two formers, and asks (1) What wire to wind on each, it being desired to use one for the A.T.I. and the other for the secondary circuit. (2) The number of tappings to be taken from each coil. (3) The approximate wavelength range covered.*

(1) and (2) We suggest you wind the former 4″ in diameter and 12″ long with No. 24 D.C.C., taking 20 tappings. The small coil can be used for the secondary circuit and should be wound with No. 28 D.C.C., and 12 tappings should be taken. (3) The wavelength range would depend upon the values of the tuning condensers used and the size of the aerial, but under normal conditions. The wavelength range would be from 200 to 10,000 metres.

"NIL DESPERANDUM" (Southport) *asks (1) The wavelength range of his set. (2) How many plates are required for various variable condensers. (3) Whether he can get back numbers.*

(1) The wavelength range is from about 300 metres to 5,000 metres. (2) The formula for calculating the capacity of variable condensers is :

$$K = \frac{0{\cdot}0885K(N-1)R^2}{t} \text{ m.mfds.}$$

N = total number of plates.
R = radius of moving plates, cms.
t = spacing, cms.

You will require 95 plates for 0·001 mfds., 49 plates for 0·0005 mfds., 21 plates for 0·0002 mfds., assuming the spacing washers are ⅛″ and the plates are 20 S.W.G. (3) You will be able to obtain back numbers from the Mail Order Dept., The Wireless Press, Ltd., 12-13, Henrietta Street, London. S.W.2

"E.H." (Middlesex) *submits a list of appartus in his possession and asks for a suitable circuit.*

The proposed arrangement of apparatus is quite suitable, and is the best which can be provided using a single valve. As a suggestion, why not use the valve as an H.F. amplifier, and a crystal as detector, as indicated in several recent issues The tuning range of the coil is from 200 up to just over 1,000 metres. With the condenser in parallel, the range will be further increased up to about 2,500 metres.

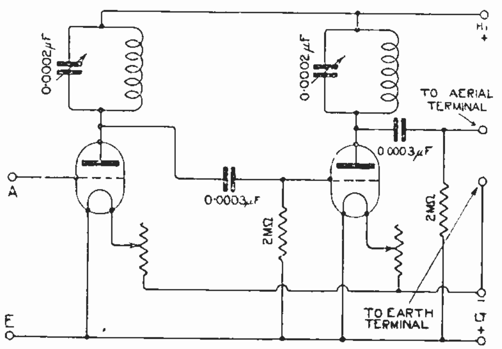


Fig. 1.

"A.G.L." (Sutton Coldfield) *asks (1) Whether he can add 2 H.F. connected valves without altering the wiring of his present set. (2) For a suitable circuit.*

(1) and (2) You can add a panel containing 2 H.F. connected valves without disturbing the wiring of your present panel. See Fig. 1. Suitable valves are indicated.

"CONSTANT READER" (Merioneth) *submits particulars of components in his possession, and asks (1) What other parts are required to make his crystal set quite efficient. (2) What is the wavelength range obtained. (3) For a suitable circuit.*

(1) We suggest you use an aerial tuning condenser having a maximum value of 0·001 mfds., and a

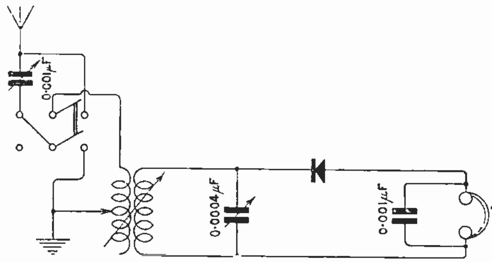


Fig. 2.

closed circuit tuning condenser with a value of 0·0004 mfds. (2) The wavelength range will depend partly upon the dimensions of your aerial, but will be approximately from 200 to 4,500 metres. (3) See Fig. 2.

"H.C.G." (Shepherd's Walk, N.1.) *asks (1) Where to connect a switch in order to cut out the H.F. or L.F. valve as desired. (2) What is the resistance of the Western Electric marine loud speaker. (3) Would* **PCGG** *transmissions be received with a three-valve set using one H.F., one detector and one L.F. valve. (4) The aerial coil is of good size, and the reaction coil couples with it. What is a suitable size of reaction coil.*

(1) The method of switching is shown in Fig 1, page 449, in the issue of December 30th. (2) We regret we have no particulars regarding this instrument. (3) With careful tuning and adjustments we consider you should certainly hear the transmissions referred to. (4) When receiving short wavelengths it is sometimes necessary to use a reaction coil with more turns than the aerial coil, but when receiving the longer wavelength signals the reaction coil has generally fewer turns than the aerial coil. It is well to bear in mind when using reaction in this manner, the generation of oscillations in the aerial circuit causes interference with other experimenters in your neighbourhood. This interference is very unpleasant, and great care should be exercised to prevent the generation of oscillations.

"H." (Croydon) *asks (1) What combination of valves is necessary to obtain the transmissions from Manchester, The Hague and Paris. It is desired to use a loud speaker. (2) Is it to be expected that the signal strength will be louder when a double circuit tuner is used instead of a single circuit tuner. (3) Which arrangement would give the least distortion —a microphone amplifier or a valve note magnifier.*

(1) We suggest you use a four-valve receiver comprising one high frequency, one detector and two L.F. valves. With a good aerial, signal strength should be sufficiently loud to operate

a loud speaker. If you are badly screened or if the aerial is low, we suggest you use two high frequency valves. The valves may be coupled by means of the tuned anode arrangement. (2) The object of a two-circuit tuner is not always to give increased signal strength, although it will slightly increase the signals on occasions. The great advantage is the gain in selectivity which may be obtained. It is generally worth while from this point of view alone to use a two-circuit tuner. (3) We do not think there is much to choose between the two methods of low frequency amplification, provided each is properly designed. The question of cost should be considered.

"R.B." (Newcastle) *asks for a diagram of a three-valve receiver showing the connections of a series-parallel switch, a tune stand-by switch, reaction coil reversing switch, and switches to cut out the high frequency and low frequency valves.*

See Fig. 3.

nected across the primary winding of the transformer connected in the anode circuit of the first valve. A similar condenser should be connected across the telephone transformer, or the telephones, if high resistance telephones are used.

"SAD" (Coventry).—As you have constructed your receiver yourself, you are not allowed to purchase a "Broadcast" licence, but you must satisfy the Post Office that you are a competent person and have some definite object in view before you will be granted an experimenter's licence. If you cannot satisfy the Post Office, you are required to purchase a receiver which bears the stamp of approval.

"J.C." (Banbury) *asks* (1) *Whether he is likely to radiate energy from the aerial when the reaction coil is coupled with the tuned anode coil.* (2) *How many turns of No. 24 D.C.C. wire wound on a 1½″ former will be required to give the following wavelengths, using a 0·00075 mfd. variable condenser:—350 to 450, 500 to 600, 900 to 1,085.* (3) *How many turns of wire (a specimen of which is submitted) will be required for a high frequency transformer.*

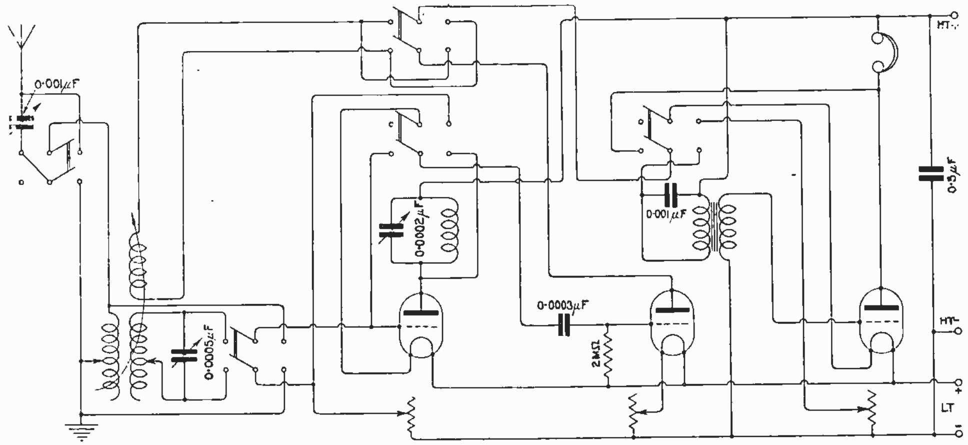


Fig. 3.

(1) As the reaction coil is coupled with the tuned anode coil, it is hardly likely that you will generate oscillating energy in the aerial circuit. (2) To tune up to 450 metres, 75 turns of No. 24 D.C.C. wire should be wound on the 1½″ diameter former. To tune up to 600 metres, 120 turns on the 1½″ former, and to tune up to 1,085 metres, 272 turns will be required. (3) Each primary and secondary slot should be wound with 100 turns of the No. 38 S.S.C. wire, sample of which was submitted. The primary of the transformer should be tuned with a condenser having a maximum value of not more than 0·0002 mfds.

"E.J.B.R." (Northumberland) *refers to the receiver described on page 780 of the September 16th issue, and asks* (1) *What alterations are necessary to the reaction arrangements, in order that the circuit will be approved by the Post Office.* (2) *The correct method of joining up a high frequency transformer, which consists of two coils mounted closely together.*

(1) The only alteration necessary to the receiver is that the reaction coil should be coupled with the high frequency transformer instead of the aerial tuning inductance. (2) The coils which form your high frequency transformer are connected in exactly the same way as indicated in the diagram, but of course the coils are not marked "O.P." or "I.P." If suitable coils are used, the result should be as good as with the arrangement proposed in the article.

"H.A.C." (Norwich) *submits a diagram of his receiver and asks* (1) *Whether a condenser should be connected in the first valve circuit.*

A fixed condenser of 0·001 mfds should be con-

"J.B.A." (Dumfries) *submits a diagram and particulars of his receiver and asks* (1) *Why the addition of the high frequency connected valve does not increase the signal strength.* (2) *Why signals* *fade sometimes.* (3) *Whether the proposed transmitter is suitable.* (4) *Whether the power buzzer which he has by him will deliver* 1,000 *volts.*

(1) In the diagram submitted, the +H.T. lead connects with the anode winding of the first high frequency transformer, but with the grid winding of the second high frequency transformer, otherwise the circuit is correct. We suggest you use the tuned anode method of high frequency amplification. The anode winding should be tuned with a small condenser not exceeding 0·0002 mfds. A number of circuits have been given recently. (2) The fading experienced is probably due to the aerial swinging. As your aerial is a very long one, if the fading is not due to this cause, we suggest you examine the receiver, making sure the grid condensers and leaks are in good order. (3) The transmitter suggested should form a very suitable experimental transmitting set. We suggest you do not interfere with the side tone condenser. Wavelength adjustments should be made by changing the aerial inductance, if necessary, by reducing the horizontal length of the aerial. (4) The power buzzer connected as in the diagram submitted should provide an ample supply of high tension for the transmitter. The two choke coils shown in the diagram are essential to assist in smoothing out the pulsating high tension current. Two banks of Mansbridge type 2 mfd. condensers should be connected across the supply.

"**B.J.L.**" **(Dovercourt)** *asks* (1) *For a diagram of a tuning panel to give selective tuning.* (2) *What are suitable values for the variable condensers.* (3) *How can one avoid capacity effects due to the hand.* (4) *Whether it is necessary to use different anode voltages for high frequency, detector, or L.F. connected valves.*

(1) See Fig. 4. The coils are all variably coupled together. The switch in the aerial circuit is to join the tuning condenser in series or parallel

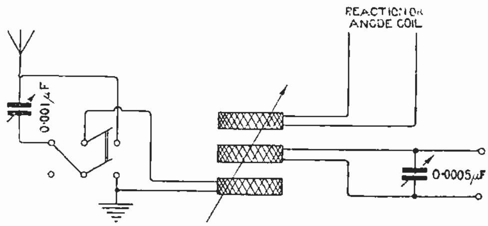


Fig. 4.

as required, and the secondary circuit is tuned with a variable condenser having a maximum value of 0·0005 mfds. When receiving short wavelength signals, it is not necessary to tune the reaction coil. (2) Suitable values for the condensers are indicated in the figure. (3) We suggest you fit an extension handle to the tuning condenser. You will find that adjustments of filament current and anode potential are necessary before good results are obtainable. (4) We suggest you use a common H.T. battery for the amplifier, and tap off, say, 45 volts for the high frequency and detector valves, and about 60 volts for the note magnifying valve.

"**B.V.G.**" **(Barnsbury)** *asks for a diagram of a two-valve receiver which he can build out of components already in his possession.*

See Fig. 5.

"**R.S.**" **(Glasgow)** *asks* (1) *Whether, when receiving, he is likely to be interfered with by power lines situated a short distance away.*

We have examined the sketch, showing the position of your aerial, and we think the interference, if any, will be slight. More trouble is

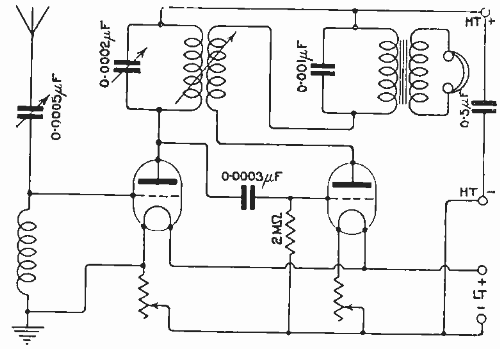


Fig. 5.

likely to be experienced by induced currents from the telegraph wires, and it would be better if you could run the aerial at an angle with the wires.

"**G.A.P.**" **(Huddersfield)** *proposes to construct a two-valve receiver, and asks* (1) *What are suitable dimensions for the aerial tuning inductance, the anode inductance, and the reaction coil which is to couple with the anode coil.* (2) *What is the best coupling arrangement to provide for the anode and reaction coils.*

(1) As you wish to receive only short wavelength signals, the aerial coil may consist of a winding 4″ in diameter and 5″ long of No. 22 D.C.C. Ten tappings should be taken. The anode coil may consist of a winding 4″ in diameter and 4″ long of No. 30 D.C.C. with ten tappings. The reaction coil may be 3″ in diameter and 4″ long, with No. 34 S.S.C. wire, with four tappings. (2) The anode and reaction coils may be made after the manner of a loose coupler, the reaction coil sliding inside the anode coil. If it is desired, plug-in coils may be used, in which case a two-coil holder is useful.

"**G.J.W.**" **(Highgate)** *wishes to construct a three-valve receiver, making use of a number of panels, and asks for a suitable diagram of connections.*

We would refer you to the diagram given on page 181, November 4th issue.

"**H.P.**" **(Abertillery)** *asks which type of receiver would best suit his requirements.*

We suggest you construct an aerial 40 ft. high and 50 ft. long, as suggested. A single wire would be quite suitable. A four-valve receiver, comprising one high frequency, one detector, and two L.F. valves would be a good combination. We would refer you to the diagram, Fig. 1, page 515, January 13th issue.

"**DETECTOR**" **(Rugby)** *enquires* (1) *Whether a L.F. amplifier may be added to a crystal set.* (2) *The best crystal to use with a wire contact point.* (3) *How to tune with a two-slide tuner.* (4) *Whether a certain crystal combination is good.*

(1) An L.F. amplifier may certainly be connected to a crystal receiver, but we suggest you add a H.F. valve, then use the crystal detector, and finally amplify at L.F. Several circuits have recently appeared. (2) We suggest the use of silicon or synthetic galena. (3) We cannot give precise instructions on tuning. Why not join a Wireless Society, where the members will be only too pleased to assist you, or you would find the book, "Crystal Receivers for Broadcast Reception," by P. W. Harris, price 1s. 6d., very useful. (4) We cannot say, but you will find the crystals mentioned above give satisfactory results.

"**ONE V. SUPER**" **(Walthamstow)** *asks several questions about the Armstrong super-regenerative receiver described in the issue of September 2nd, and asks* (1) *May duolateral coils be used for* L_1 *and* L_2. (2) *What are the relative positions of the coils* L_3 *and* L_4. (3) *Can all the variable condensers have a maximum value of* 0·001 *mfds.* (4) *Particulars of choke coil.*

(1) Duolateral wound coils may be used in this circuit. (2) The relative positions of the coils L_3 and L_4 is a matter of importance, as you should change the positions of these coils until best results are obtained. (3) The variable condensers may all possess a maximum capacity of 0·001 mfds., but in this case the coils should be made of larger inductance. (4) An iron core choke can be made by winding 5,000 turns of No. 40 S.S.C. wire on an iron wire core 3″ long by ½″ diameter.

"**A.H.H.**" **(Keighley)** *asks whether it is possible to charge accumulators from A.C. mains.*

It is quite possible to charge accumulators from A.C. mains provided apparatus for converting the alternating current into direct current is employed. Of course a motor generator may be used, the motor being driven by the alternating current of the generator delivering direct current, but for small installations it is better to install a rectifier such as the Tungar or the Homcharger. A description of the methods employed for charging accumulators from A.C. mains will appear in this journal in the near future.

"**K.G.S.**" **(W.5)** *submits a diagram of his receiver and asks* (1) *Whether a set wired according to the diagram would generate oscillations in the aerial circuit.* (2) *Could the aerial coil, anode coil, and reaction coil, all be mounted in a three-coil holder.* (3) *Are Dewar switches suitable for use as a series parallel switch in the aerial circuit.*

(1) The diagram of connections submitted is quite suitable and will not generate oscillations in the aerial circuit. (2) No advantage would be gained by using a three-coil holder. The anode coil and reaction coil may be mounted in a two-coil holder away from the aerial coil. (3) This type of switch may be used if desired provided it is of the anti-capacity type. If the springs are spaced closely together the switch has a large capacity, and is not very suitable. An ordinary two-pole throw-over type switch is useful.

"**IDDYUMPTY**" **(Grimsby)** *asks* (1) *Why questions submitted a day or two before Christmas have not yet been answered.* (2) *Can we suggest any means of reducing interference experienced from stations transmitting morse signals. (The receiver comprises three valves—one H.F., one detector, and one L.F.)* (3) *Why is difficulty experienced in receiving telephony with the aerial tuning condenser and aerial tuning inductance in series.*

(1) As your letter containing queries was received just before Christmas, we do not think you can expect to receive replies to your queries in an issue before the date of your second letter, the first week in January. We would point out that a large number of queries are received, and some time must elapse between the date of receipt and the date of publication, as the queries are dealt with in rotation. (2) As you are employing a three-coil tuner with a tuned anode coil we think you should be able to tune out morse signals, especially if the anode coil is tuned with a variable condenser. However, a frame aerial may be used instead of an open aerial, and another H.F. valve connected to compensate for the reduction in signal strength caused by the change. The method of connecting H.F. valves is given in all issues of the journal. (3) No difficulty should be experienced in tuning-in signals with the aerial tuning condenser and inductance in series provided suitable values are used. The aerial tuning condenser should have a maximum value of 0·001 mfds., and the inductance will probably be larger than the closed circuit inductance. Too small a value of A.T.C. will result in very poor signal strength and tuning will be very difficult.

"**W.H.G.C.**" **(W.C.1)** *asks* (1) *The dimensions of fixed condensers to give a capacity of* 0·001 *and* 0·0002 *mfds.* (2) *What former is used to calculate the capacity of fixed condensers.* (3) *Could a grid leak be made by drawing a line* 1¾″ *long with a hard graphite pencil upon a piece of suitable material.* (4) *Why are results, using an ex-Government telephone transformer marked* 15/75, *no better than when the receiver is used alone in the anode circuit.*

(1) The 0·001 mfd. condenser may have six plates, each having an overlap of 2 × 1 centimetres. The 0·0002 mfd. condenser may have two plates with an overlap of 2 × 1 centimetres, the mica in each case being 2 mills. thick. (2) The capacity C of a condenser $= \frac{0{\cdot}0885ks\,(n-1)}{T}$ where k is the specific inductive capacity of the dielectric and varies between 5 and 8 for mica. S is the surface area of the metal foil which is overlapping, n is the total number of plates, and T equals the thickness of the dielectric in centimetres. The capacity is given in micro-micro-farads. (3) The grid leak constructed in the manner described has a certain amount of use, but it is better to purchase one, as they are quite inexpensive, and have a considerable life. (4) The telephone transformers referred to are not at all suitable for connecting in the anode circuit of a valve. A telephone transformer would have a ratio of the order of 1 to 5 or 6, and the primary winding would consist of about 5,000 turns of No. 42 S.S.C. wire.

D 2

"**S.E.M.**" **(Colchester)** *asks* (1) *Whether the diagram submitted is correct.* (2) *How to reduce the noises induced by near-by electrical machinery.* (3) *When receiving short wavelength signals, is it better to connect the aerial tuning condenser in series or parallel with the aerial tuning inductance.* (4) *What are suitable values for the coupling condensers shown in the diagram referred to in question* (1).

(1) and (3) When receiving short wave transmissions, the aerial tuning condenser should be in series with the aerial tuning inductance. The connections are quite suitable for a low frequency amplifier. It would be better to use one high frequency connected valve to amplify the signals before they reach the detector valve. We suggest you convert the receiver to form a combination of one high frequency, one detector, and two low frequency valves. The function of the high frequency valve is to amplify the signals so that good operation of the detector valve may be obtained. (2) It is a very difficult matter to eliminate interference of the sort experienced. We suggest you screen the receiver and pay particular attention to the earth lead. The earth lead should be as short as possible and should make good contact with the ground. (4) The aerial tuning condenser may have a value of 0·001 mfd. The coupling condensers should have a value of 2 mfds., and the by-pass condensers 0·001 mfd.

"**A.L.**" **(Norway)** *refers to the American short wave tuner described in the issue of June 3rd, 1922, and asks* (1) *How to convert the receiver so that it will receive continuous wave signals.* (2) *May the tuner be used for the reception of telephony.* (3) *What is the gauge and insulation of the samples of wire submitted.*

(1) To increase the wavelength range of this receiver, a tapped tuned anode coil may be inserted in each of the circuits according to the wavelength range which you wish to cover. If the coil in the anode circuit is coupled with the coil in the secondary circuit, you have an ordinary reaction circuit, and when the coupling is sufficiently tight, incoming C.W. signals may be received by the beat method. (2) The receiver is quite suitable for the reception of telephony without alteration. (3) The sample of smaller wire submitted is No. 44 S.W.G. S.S.C. The larger wire is No. 38 S.W.G. S.S.C. The No. 38 wire is suitable for winding a reaction coil.

"**GREENHORN**" **(Notts.)** *asks* (1) *Whether a loud speaker may be used in place of telephones without altering the arrangement of the receiver.* (2) *What resistance telephones would be used.* (3) *How many coils are required in his receiver.* (4) *Are Siemens Halske valves suitable for his receiver.*

(1) A loud speaker may be used without any alteration to the wiring of the receiver. The resistance of the loud speaker should be similar to that of the telephones which it replaces. (2) If a telephone transformer is used, low resistance telephones may be connected. If it is proposed to join the telephones directly in the anode circuit of the last valve they must have high resistance. 4,000 ohms is suitable for the latter case, and 60 for the former. (3) The number of coils required depends, of course, upon the range of wavelengths over which it is desired to receive signals. If you purchase these coils, care should be taken to purchase those which used in conjunction with the tuning condenser will give the desired range. (4) Siemens Halske valves may be employed in your receiver if desired, but we suggest the use of "R" type valves. An "R" type valve requires 60 volts for the anode, and 6 volts for the filament.

"**C.B.**" **(Clapham)** *wishes to construct a number of basket coils with the materials in his possession which will enable him to tune up to 3,000 metres.*

We suggest you wind six coils, each having 50 turns, using the 2″ diameter former which you have by you. The 22 gauge wire is quite suitable. The coils should be connected in series and the tappings brought to a switch. The coils should be spaced about ⅛″, in order to keep down the self-capacity as far as possible.

"**HOM DE OZZ**" **(Brighton)** *asks* (1) *Why he hears the* **FL** *telephony transmissions on 1,400 metres as well as 2,600 metres.* (2) *Why other telephony transmissions are heard on a wavelength of 340 metres as well as 1,565 metres.* (3) *Why, with tapped anode reactances, it is often possible to get the best results when the switch arm is making contact on two studs simultaneously.*

(1) and (2) We cannot say the exact reason why you should hear the transmissions referred to on other than the correct wavelength. In all probability you are hearing a harmonic. (3) With a tapped anode reactance which is self-tuned, it is not possible that the natural period of the winding is the same as that of the signal. Moving the switch arm so that two studs are bridged at the same time brings the wavelength of the coil more nearly equal to that of the signal. If the coil were tuned with a variable condenser, it would not be found that better results are obtained with this adjustment.

"**H.J.P.**" **(Edmonton)** *submits a diagram of his receiver and asks whether the switching arrangement is correct.*

The arrangement submitted is quite suitable for your purpose. When using reaction in the manner indicated in the sketch, care must be taken that oscillating energy is not transferred to the aerial circuit. The aerial tuning condenser should be connected in series with the aerial tuning inductance when receiving short wavelength signals.

SHARE MARKET REPORT

Prices as we go to press on January 19th, are :—

Marconi Ordinary	.. ..	£2	6	0
,, Preference	.. ..	2	0	0
,, Debentures	.. ..	105	10	0
,, Inter. Marine	.. ..	1	9	0
,, Canadian	.. ..		10	9

Radio Corporation of America :—

Ordinary	.. .. ..		16	6
Preference	.. .. ..		13	8