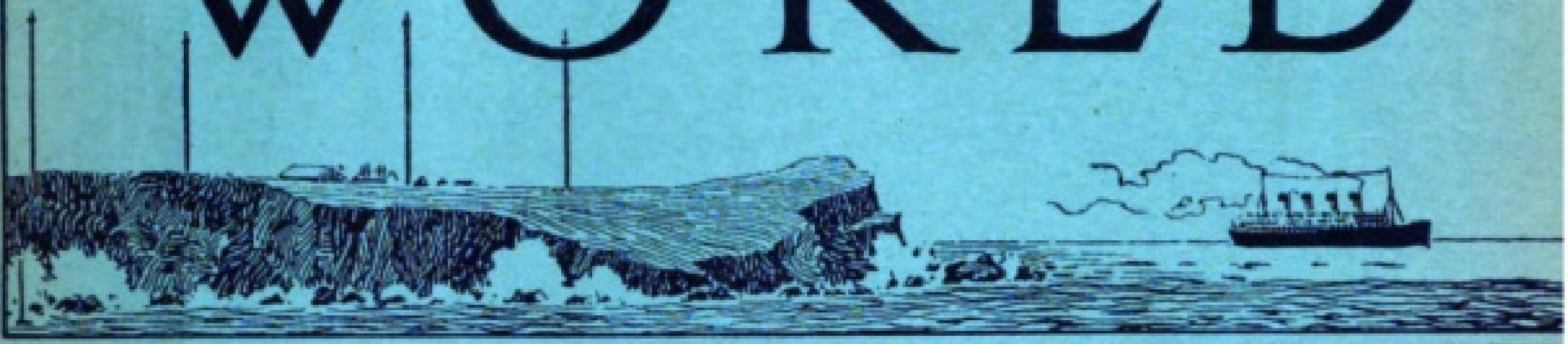
The WIRELESS WORLD



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THE WIRELESS WORLD

THE OFFICIAL ORGAN OF THE WIRELESS SOCIETY OF LONDON

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LATTICE-WOUND COILS

By Philip R. Coursey, B.Sc., A.M.I.E.E.

Before giving a more detailed description of the duolateral winding for long-wave coils, which was mentioned at the end of the article on "Multilayer Windings," * a brief reference will be made to a new type of multilayer winding which has recently been developed. † It is a combination of two windings, one of the ordinary spiral-layer type, and the other a lattice, somewhat similar to the honeycomb, but with a shorter pitch. These two types of winding are used in alternate layers. Unlike the honeycomb, however, the lattice winding has a small swing, so that the wire crosses from side to side of the layer several times before completing one turn, while one turn only is used for each layer. This lattice winding, therefore, forms merely a means of separating the proper layers of the coil, and thus reducing its self-capacity. The alternation of the types of winding in this way is equivalent to building a coil with spaced layers similar to that shown in Fig. 8 ‡ of the article on "Multilayer Windings."

Fig. 1 illustrates a coil built upon these lines, and clearly shows the outline of the wire zigzag or lattice used to separate the layers of spiral winding. This wire spacing makes a rigid mechanical support for the layers, and also provides a small addition to the inductance of the coil, although at the same time the resistance of the coil would be somewhat increased. It is not obvious without the results of careful tests whether

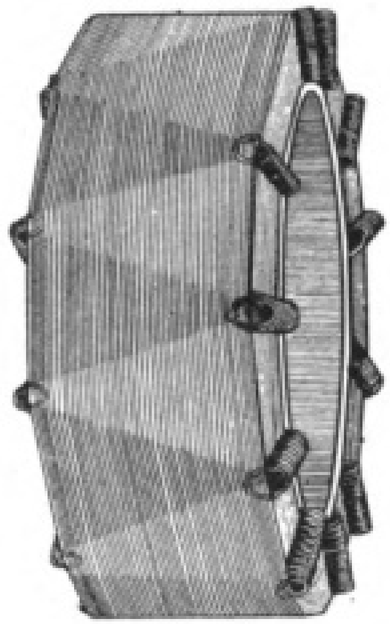


Fig. 1.

or not this coil would show any practical advantages over a honeycomb or duolateral winding, although it is perhaps somewhat easier to build.

In order to support the coil when winding a former should be used, provided with a double row of pins—one row of pins for each face of the coil—arranged radially around its periphery. Fewer pins will be required than for a honeycomb or duolateral, and in the example illustrated in Fig. 1, only eleven on each face have been used. The two rows of pins should be staggered in order to obtain a proper zigzag, as is evident from the coil illustrated. The pins

* A short description of this winding was published in *Everyday Engineering Magazine* for August, 1920, from which Fig. 1 was taken.
† *The Wireless World*, October 30th, 1920.
‡ *The Wireless World*, October 16th, 1920, issue.

may be withdrawn when the winding is finished, leaving a series of loops projecting on each side. It is possible to make use of these to pass rods through for securing the coil to its stand or holder, if so desired, and in order to secure greater rigidity the outer row of loops may be bent over the end-turns of the outside layer, as may be seen from the figure.

The duolateral winding is of very similar type to the honeycomb, which has already been described in these columns, but in this case the turns of the successive layers do not come radially over each other, but those in alternate layers do. The turns of the second layer are spaced midway between the turns of the first, and so on. This leads to an increased effective spacing between the adjacent turns of wire as may be seen by an inspection of Fig. 2, in which the two types of winding are compared in cross section. The duolateral coil is thus a special form of honeycomb coil in which the original cells of the honeycomb formed by the first layer are each divided up into four similar smaller cells by the windings of the second layer. Thus in appearance the separate cells of the coil are much smaller, although similar in shape, when viewed in a radial direction.

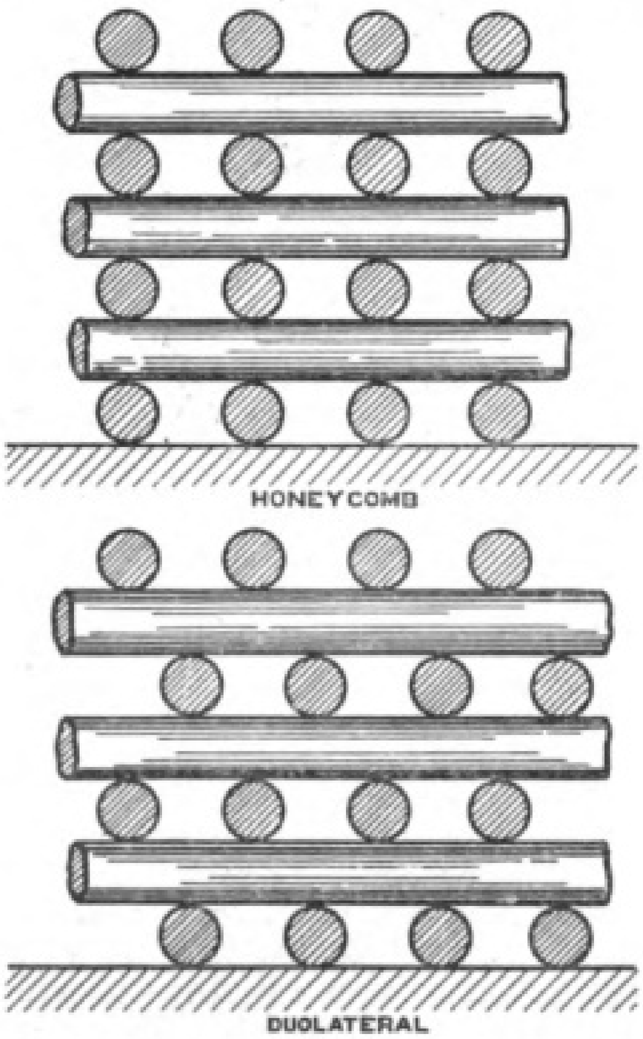


Fig. 2.
Comparison of Honeycomb and Duolateral Windings in cross-section.

The criterion for a duolateral winding is therefore that the angular advance of each turn in degrees when multiplied by an integral number of turns should give 720° (*i.e.*, two layers) exactly, and *not* 360°.

Expressed mathematically the honeycomb and the duolateral windings may be written as follows :—

$$n \times V = 360° \quad \ldots \quad \text{Honeycomb.}$$
$$(2n+1)V = 720° \quad \ldots \quad \text{Duolateral.}$$

where V is the angular advance per turn in degrees and n is the number of complete turns per layer. This last quantity must be a whole number.

Applying the above to the honeycomb winding of which details were given in the article on "Multilayer Windings," we have $V=12°$, and $n=30$, whence $n \times V = 30 \times 12° = 360°$, so that we see the above condition is satisfied.

If we try $n=30$ for a duolateral we get $(2 \times 30+1) \times V = 720°$, or $V = 11{\cdot}803°$. As this number is not very convenient for setting out for a hand wound coil, it may be worth while to try and find such a value for n that V works out to an integral number of degrees if possible. By trial it is easily found that $V=16°$ and $n=22$ will satisfy this condition, since $(2 \times 22+1) \times 16 = 45 \times 16 = 720°$, while 22×16 does not equal 360°. We may therefore work out a duolateral winding for these values, obtaining the figures given in Table I, although this winding scheme can be taken only as an indication of the chief outlines, and the experimenter should easily be able to modify it to suit his own special requirements.

In connection with these two types of coil it is worth noting here that V should always be a fairly small number, so that the wire returns to only just beyond its starting point at the end of each turn.

To construct a duolateral wound coil in accordance with the data in Table I, we shall require a central former provided with two rows of pins as in the case of the honeycomb coil, but in this case spaced 8° apart instead of 12°. The front and back rows should be staggered as before. From Table I it is evident that the winding will repeat itself in the third layer—*i.e.*, the turns of the third layer will be radially over those of the first, and the fourth layer over the second.

TABLE I.

DUOLATERAL WINDING WITH 16° ADVANCE.

FIRST LAYER.		SECOND LAYER.	
Front Face.	Back Face.	Front Face.	Back Face.
0°	188°	8°	196°
16°	204°	24°	212°
32°	220°	40°	228°
48°	236°	56°	244°
64°	252°	72°	260°
80°	268°	88°	276°
96°	284°	104°	292°
112°	300°	120°	308°
128°	316°	136°	324°
144°	332°	152°	340°
160°	348°	168°	356°
176°	4°	184°	12°
192°	20°	200°	28°
208°	36°	216°	44°
224°	52°	232°	60°
240°	68°	248°	76°
256°	84°	264°	92°
272°	100°	280°	108°
288°	116°	296°	124°
304°	132°	312°	140°
320°	148°	328°	156°
336°	164°	344°	172°
352°	180°	0° (Third &c. Layer.)	188° &c.

It is possible to carry these multi-lattice windings to further stages, giving tri-lattice, quadri-lattice coils, etc., in which the winding repeats itself after three or four layers respectively, but besides being complicated to wind they possess few advantages over the simpler duolateral.

It may be noted that an additional useful feature of these lattice coils is the possibility of putting on another complete and independent winding between the turns of the first. In this way two very closely coupled windings can easily be constructed on the one former. Such windings are useful for wavemeters and other similar purposes, as the inductance can be varied by connecting these windings in series or parallel.

For example, suppose we consider a lattice winding, either of the honeycomb or duolateral type, with two other similar windings, put on in the spaces between the first. The coupling between these windings will be very close, so that the mutual inductance between any two of them will be very little less than the inductance of either.

Thus, suppose each winding alone has an inductance of 1,000 microhenries, that of two of the windings in series will probably be of the order of 3,900 microhenries, while the three in series may reach a value of say 8,700 microhenries.

A wide range of tuning values is thus possible with a very compact inductance, but such schemes at the same time introduce additional capacities between the turns of the separate windings, which may reach considerable proportions. These capacities, in some circumstances, may seriously interfere with the tuning qualities of the coil, and should therefore be avoided whenever possible.

There is always the possibility of internal resonance between the parts of the coil with a harmonic of the frequency in use, or of resonance taking place in the turns of one of the unused windings.

Although this scheme has been recommended by some workers, it does not seem one which should be encouraged, especially for wavemeter work, where accuracy is of prime importance. For purely loading inductance purposes on long wavelengths it has possibly some advantages, although, generally, greater convenience in use may be obtained by using a number of separately wound complete lattice coils and arranging these adjacent to one another, so that by varying the distances between the coils the inductance of the whole arrangement can be varied quite easily over a considerable range.

GENEVA WIRELESS STATION

THE Geneva Wireless Station, by means of which journalists attending the Conference of the League of Nations are securing a rapid distribution of their messages, is situated on the Bel Air plateau, at Chene Bourg, about three miles south of the city and at an elevation of about 1,400 feet.

The station embodies all the latest developments in commercial wireless, including a Marconi valve transmitter, operated automatically at high speed ; but the outstanding feature in this instance is unquestionably the speed with which the station has been erected. Wireless engineers were called upon to do many unusual things during the war, and invariably accomplished their task, but in the case of the Geneva Station, a normal three months' undertaking has been completed in a fortnight.

This unique performance, which includes the erection of a lattice steel tower 200 feet high, has only been made possible by the enthusiastic co-operation of the Swiss Federal and local authorities and all grades of Swiss workmen. The first wireless gear, owing to delays on the railways, did not reach Geneva until November 4th, yet on Tuesday, November 9th, the station was commencing its trials. The station was completed and the service commenced on November 15th, the day the Conference opened. On that date no less than ten thousand words were cleared within a few hours after the commencement of the sitting.

Three special buildings have been constructed on the site, the first being the power plant. Here, current obtained from the Geneva electric service is made to drive a motor, which in turn rotates a specially designed generator. As a precaution against any interruption by the failure of the external current supply, the plant is duplicated, the second motor being driven by an Austin petrol engine.

In the second building are housed the 6-kilowatt valve transmitter, the high-speed signalling devices, and all the usual wireless auxiliaries, whilst in the third building, nearest the aerial tower, are the instruments for the translation of the messages into tape form, which tape is fed at high-speed through a Wheatstone automatic transmitter. This building is in direct telegraphic and telephonic communication with an office in Geneva, adjoining the Conference Hall, and also with a station five miles distant, where the acknowledgments from various European stations are received.

The transmitting aerial is of the umbrella type. The earth system is located beneath these aerials.

Motor-cyclist despatch riders are being employed to supplement the telegraphic communications between Geneva and the wireless station.

Direct wireless communication is being provided by this station between Geneva and a specially-erected receiving station at Witham, Essex, which is connected by telegraph to London. The transmitting station in this country, a 15 K.W. valve transmitter, is at the Marconi's Works, Chelmsford, and is in direct telegraphic communication with Witham.

Wireless services from Geneva to Nauen (Germany), Amsterdam, Budapest, and Lyngby (Denmark), have been arranged, and it is hoped to extend the scheme to Norway, Spain, Italy, and other European countries.

It is interesting to note that this is the first occasion upon which the newspaper world has had at its disposal a channel of rapid communication in which Press messages have priority over ordinary commercial traffic.

This new station, which notwithstanding the haste observed in its construction has nothing makeshift about it, but is on the contrary an example of the *dernier cri* in radio engineering.

This service, besides relieving the Continental telephone and telegraph lines of an enormous weight of traffic, enables the delegates of the League of Nations a freer use of these means of communication, and is an excellent demonstration of the value of radio telegraphy in the quick dissemination of news.

NOTES AND NEWS

Institution of Electrical Engineers.—On Wednesday, November 24th, the session of the Wireless Section was opened by the delivery of an address by the Chairman, Dr. W. H. Eccles. Mr. Lt. B. Atkinson, the President of the Institution, took the Chair, and the Section was honoured by the presence of Dr. Alexander Graham Bell, the veteran inventor of the telephone. After his introduction by the President, Dr. Bell, who was received with acclamation, made a short speech, in which he said that the growth of the telephone had bewildered him and surpassed his most sanguine expectations. He was very glad to meet the members of the very advanced Wireless Section of the Institution. Dr. Bell instanced as an example of the progress of his invention, in conjunction with wireless waves, the recent experiments at Arlington (near Washington) when communication was established with the Eiffel Tower, Paris, and speech was heard at Honolulu.

Dr. Eccles's address sketched the history of the Section and of the recent developments in wireless. The formation of the Section was the outcome of a suggestion to form a body on the lines of the American Institute of Radio Engineers, when the Institution stepped in and offered its help, with the result that the Section was organised. The speaker then dealt with the immense progress allowing the introduction of the thermionic valve and other devices.

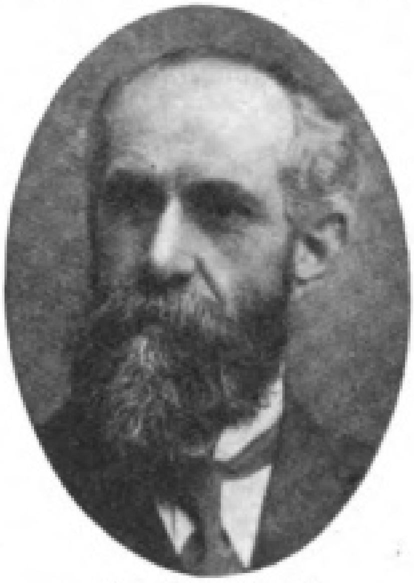
Wireless Telegraphy and Telephony.—The inaugural address of the 167th session of the Royal Society of Arts was delivered by Mr. A. A. Campbell Swinton, F.R.S., Chairman of the Council of the Society, on Wednesday, November 17th. The lecture was divided into two parts, the first dealing with radiotelegraphy, and the second with the more special problems of wireless speech transmission. After a few introductory remarks outlining the methods of radio communication, the more recent developments in the recording of wireless messages were demonstrated with the aid of a Creed receiving perforator and printer. The evening press message from Horsea station sent at 20.00 G.M.T. was tuned-in and rendered audible to the crowded audience, while at the same time the Creed perforator was put into operation, recording the message as a series of holes in a paper tape. This tape was then passed through the printer which translated it into ordinary letters printed on a paper strip. (See proceedings of Wireless Society of London, page 641.)

Subsequently a special message was sent from the Eiffel Tower through the courtesy of Général Ferrié, by means of an automatic transmitter operated by a punched paper-tape. This message was also taken down on the Creed perforator, afterwards emerging from the printer as a printed slip, which was shown to the meeting by projection on a screen.

In the second part of the lecture the especial difficulties of radiotelephonic transmission and amplification were pointed out, and a successful demonstration given of radiotelephonic reception on a short wavelength. The incoming speech was amplified to be audible to the entire audience—whistling being particularly good.

Amateur Call-Signs.—The following additions should be made to our amateur call-sign list :—**2 I N**; Mr. J. F. Fish, Blackpool. Hours of working, 8—10 p.m. G.M.T. Spark and C.W. **2 I D**; Mr. E. S. Frith, Thames Ditton. Hours of working, (100 watts), 3.30—4.30 p.m. and 8.30—9.30 p.m. G.M.T. Wavelength 180 metres, C.W. and telephony.

Mr. F. G. Creed, a practical telegraphist and inventor, left the service of the Central and South American Telegraph Company in 1896, returning to England in order to develop his inventions. He invented the first keyboard perforator for preparing punched Wheatstone slip, in 1897-8. This



Mr. F. G. Creed.

was rapidly followed by the Creed Receiving Perforator, the Creed Printer, and numerous other inventions and devices for improving and speeding up existing telegraph systems. A description of the Creed instruments is given on pages 641 to 648 of this issue.

R.A.F. Memorial Fund.—To commemorate the part played by the Wireless Section of the R.A.F. during the War a series of nine pictures was painted by Fl/Lt. E. Verpilleux, M.B.E., and was presented by him to the Officers' Mess, No. 1 (T) Wireless School, Winchester.

The artist was able to obtain first hand information and detail for his subjects, being a Wireless Officer overseas in 3, 22, 9, and 21 squadrons, and, later, the Wireless Officer of the 3rd Brigade R.F.C., and for his services was mentioned in despatches and awarded the M.B.E.

This set of nine "Wireless Pictures" is some of his best work, and in order to let the public have an opportunity of viewing it, reproductions have been made in colour, about 12½" by 9½" suitably mounted 25" by 20".

The title of each picture together with the artist's description of it, is printed at the foot of each.

250 sets only have been made, 150 sets being signed by the artist. The price per set is £4 4s. for signed copies, and £3 3s. for an unsigned set.

All profits are to be given to the R.A.F. Memorial Fund.

All communications *re* these pictures should be addressed to F./O. C.C. Bazell, Electrical and Wireless School, R.A.F., Winchester, Hants.

Wireless Telegraphy and Forestry Fires.—The British Columbia Forestry Branch has recently closed a contract with the Marconi Wireless Telegraphy Company of Canada, Ltd., for the installation of four land stations and five launch equipments for use in forestry fire protection work. One station at the Forestry Office in Vancouver is already installed, and the first installation on one of the small motor boats has been placed. Successful tests have been carried out between these two stations at a distance varying up to 75 miles. On account of the rugged character of the coast country this distance is the limit of the radius to be attempted for the present, although the extreme radius of the wireless telephony sets used is stated to be 300 miles over flat land or over water.

New German Wireless System.—According to the Department of Overseas Trade, it is officially announced, says the *Berliner Tageblatt*, that the German wireless system is to be divided into three distinct systems, viz., the international, home, and the special systems. The international system will consist of the overseas service, which will be transmitted by the large stations of Nauen and Eilvese, and the European service, the messages for which will be forwarded by the central station at Konigs-Wusterhausen. The home communications will be sent by what is actually the German wireless system (Reichsfunknetz), and which is comprised at present of 15 wireless stations. The 13 existing coast stations will serve for communication to and from ships at sea. The special wireless system is very extensive; it includes, (1) The daily European and overseas newspaper service; (2) the wireless press service, which is at present in process of formation, and by means of which a message, sent by one station will be received simultaneously by a large number of receiving stations in Germany; (3) the wireless industrial service for the circulation of industrial and financial reports which is also in course of preparation; (4) the wireless services for the transmission of time signals, warnings of storms for ships at sea, and all other important reports for ships at sea, of weather reports, wireless communications with aeroplanes, etc., including postal aeroplanes; and (5) the receiving stations for receiving foreign Press reports.

A front view of the new building at Nauen Wireless Station. Photopress

Mr. William Le Queux has been elected a member of the Institute of Radio Engineers. He is at present engaged in writing a number of stories of wireless ashore and afloat which will appear in the *Premier Magazine* from February to December next year.

Institution of Electrical Engineers.—On December 15th, at 6 p.m., at the Institution of Civil Engineers, Capt. R. E. Trench, R.E., will give a lecture entitled "The Range of Wireless Stations."

THE PROCEEDINGS OF THE WIRELESS SOCIETY OF LONDON

WIRELESS TELEGRAPHIC PRINTING ON THE CREED AUTOMATIC SYSTEM

By A. A. Campbell Swinton, F.R.S.

AN Ordinary General Meeting of the Society was held at the Royal Society of Arts on Thursday, November 18th, Mr. A. A. Campbell Swinton (President) in the chair.

After the Minutes of the previous meeting had been read and confirmed, Mr. A. A. Campbell Swinton delivered his Paper.

MR. A. A. CAMPBELL SWINTON.

I wish, in the first place, to mention that we are working here under very adverse conditions. There is a telephone pole on the roof of the building, with wires radiating in all directions, and the greatest trouble has been experienced in getting satisfactory signals because of interference. However, last night, at a meeting of the Royal Society of Arts, the apparatus worked remarkably well, and I trust that we may be equally fortunate to-night.

I will now proceed to give a description of the apparatus that we are going to use.

So far as the purely wireless instruments are concerned, they are nothing very special, and you have already seen them before in operation in this room on a previous occasion. We have a small aerial on the roof of the building, and connected to this through the ordinary tuning inductances and adjustable condenser there is a 5-valve resistance amplifier working in connection with a 3-valve transformer note-magnifier, to which the telephones and the other apparatus is connected. This latter consists, firstly, of a low-frequency transformer connected to the grid of a separate single valve, a 15-volt dry battery being connected in the grid circuit so as to make the grid negative. This is for the purpose of reducing the permanent plate-current. Then, in the plate-circuit of this valve we have a special relay, designed by Mr. R. Carpenter, of the Creed firm, which, in turn, is connected to a standard Post Office relay through two resistances, each of about 1,000 ohms. This Post Office relay, in turn, operates a power relay, also of Mr. Carpenter's design. This latter relay has no electric contacts, but its tongue directly operates the pneumatic slide-valve of the Creed receiver. You will see that it is rather a complicated system, and one of the difficulties that we have experienced is due to the effects of the kick-back from these relays. This is very apt to react upon the wireless apparatus and cause a sort of electric-bell continuous action. This is not very easy to get rid of, particularly if a frame aerial is employed, and it is for this reason that we are not using a frame aerial, though such an instrument in the ordinary way works very well in this room. For working these relays, however, an aerial on the roof gives more satisfactory results.

Next, I must endeavour to explain the Creed apparatus. It is somewhat complicated and not very easy to understand, but I will do my best to make it as plain to you as I can.

In the first place, I must explain that the message that we propose to receive on the Creed instruments will be sent automatically by means of punched paper tape, with a transmitter operated on the Wheatstone principle. As will be understood, these Wheatstone transmitters send ordinary Morse alphabet, but they do so by means of punched paper tape. Further, what the Creed receiver does is to take the Morse signals that it rec ives, and from them reproduce an exact facsimile, in punched tape, of the original tape with which the message was sent. Then, finally, this tape, punched by the Creed receiver, is put through the Creed printer, which, from it, prints the message in Roman type.

Fig. 1 will enable you to understand this more clearly. At the top of the figure is represented the letters F L repeated twice over, as received in ordinary Morse code. The middle portion of the figure represents the tape with holes punched therein, corresponding to the signals. The small holes along the centre of the tape are merely for the purpose of regulating the speed, and may be disregarded. The holes that represent the signals are those on the edges of the tape. When two of these holes are vertically above one another this represents a dot, and when they are inclined to one another, they represent a dash. Finally, at the bottom of the figure we have the letters printed by the Creed printer in Roman type, these particular letters having been printed from Paris a few days ago.

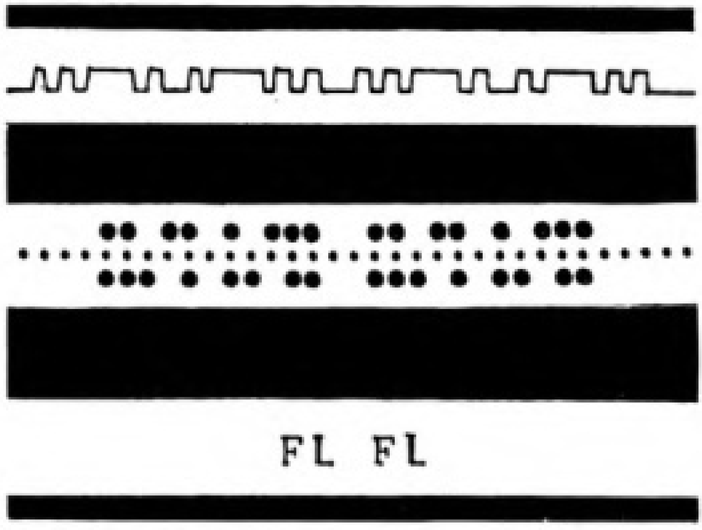


Fig. 1.

Fig. 2 is the Creed receiving instrument,

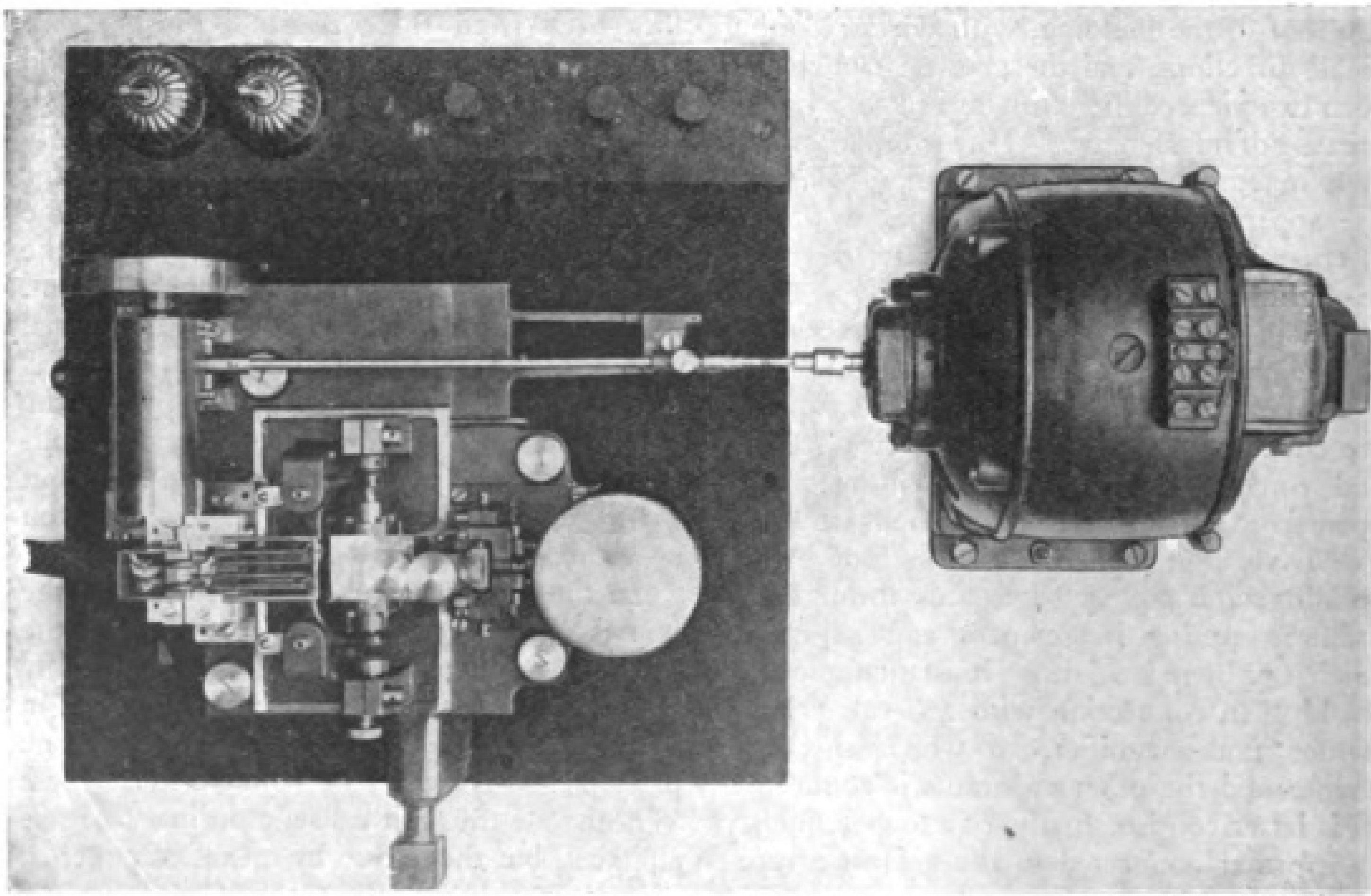


Fig. 2.

and as it is merely a general view of the instrument, together with the electric motor that drives it, it does not show very much.

Fig. 3 shows in diagrammatic form the construction of the apparatus. **A** represents Mr. Carpenter's power relay. This relay has no electrical contacts, but its armature, **b**, is provided with a light tongue, 1, to the free end of which is attached an exceedingly light-balanced slide-valve, 2 ; this is adapted to control the supply of air to the small relay engine, 3, the piston, 3a of which, is thus moved from side to side in accordance with the line signals which actuate the relay tongue. The movements of the piston, 3a, are transmitted by means of the rocking levers, 4, to the piston valve, 5, of the main engine, thus controlling the double-acting piston, 6. From each side of this piston a rod projects through the cylinder cover, and thrusts in either direction the adjacent arms of the three-armed bell-crank levers, 7 and 8. Upon the arms, 10 and 11, are hard steel strikers, 12 and 13, the free ends of which are bifurcated for the purpose of thrusting against the adjacent heads of the rods, 14, and punches, 15. These rods and punches are moun ed and guided in a separate block with the die-plates and the feed-wheel spindle. The correcting rods, 14, have flattened points, 16, terminating in a V-shape (shown separately at bottom right-hand, Fig. 3), and when thrust forward are adapted to enter the slots in the correcting wheels, 17. Retracting springs are provided, as shown, to restore the rods and punches to their normal position against stops. The paper strip, 18, which is previously centre-holed, is led up between the die-plates, pa t the punches, and engages with the feed-wheel, 19, mounted upon the spindle, 20, to which the correcting wheels, 17, are also fixed. When the points, 16, of any correcting rod, 14, are thrust by the striker between the teeth of the wheel, 17, the rod adjusts and holds the latter as well as the feed-wheel, 19, and the tape, in such a position that the corresponding punch, 15, will perforate the paper exactly opposite the feed-holes. Mounted upon an extension of spindle, 20, is a friction disc, 21, driven by the friction blocks, 22, fixed upon the pivoted arms, 23, which are attached to the motor-driven spindle, 24. This spindle rotates the feed-wheel, 19, at approximately the same rate as the feed-wheel

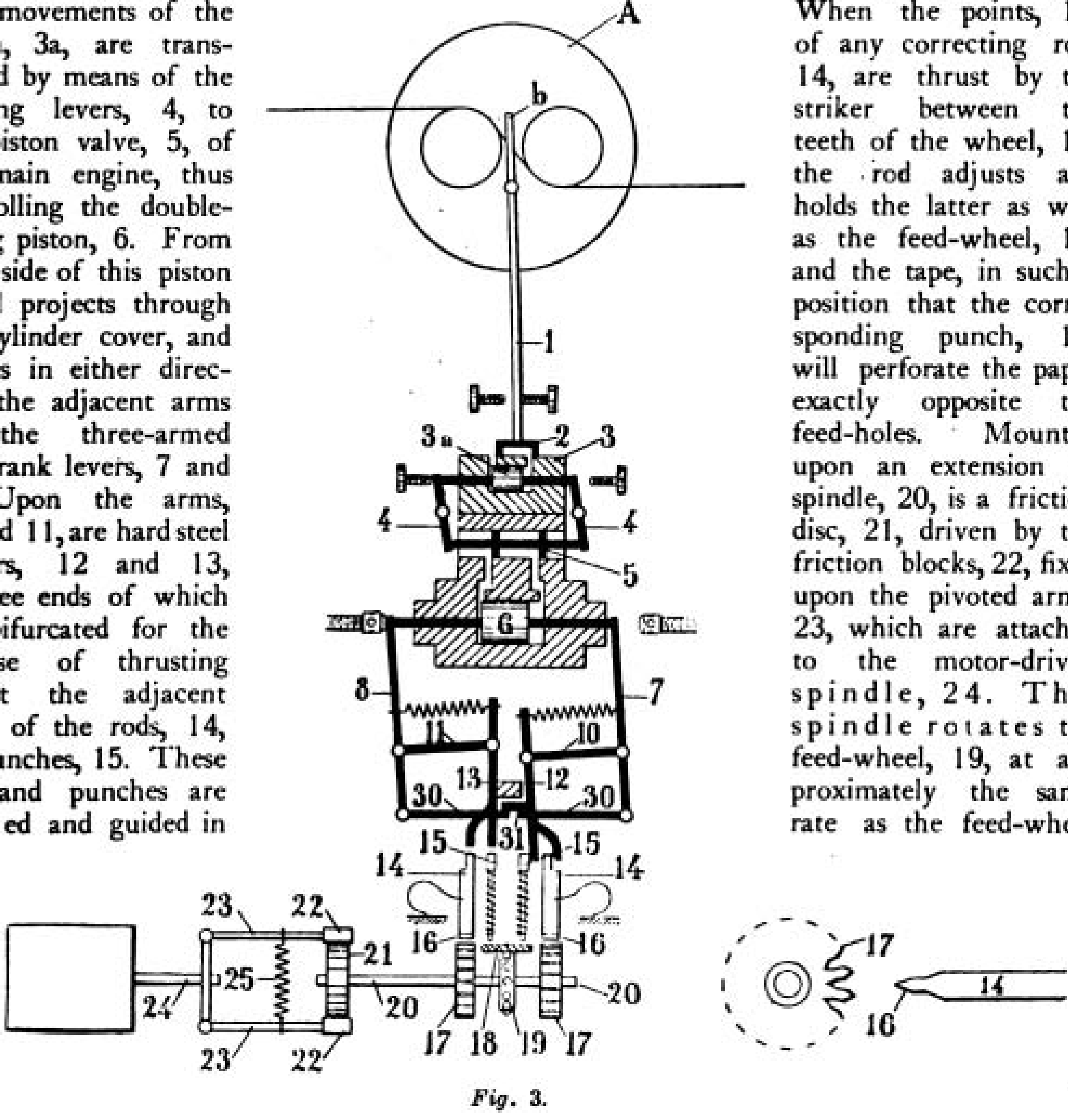


Fig. 3.

of the transmitter. For adjusting the driving tension, the spring, 25, is arranged to slide longitudinally on the rods, 23.

The action of the machine is as follows :—A line marking current in the relay coils moves the armature, **b**, to the right, causing the tongue, 1, to move the valve sharply to the left. The piston, 3a, of the relay engine is thus caused to move to the right, and the valve of the main engine in the opposite direction. This causes the main piston to be driven to the right. The movement is transmitted by means of the bell-crank, 7, and the link, 30, to the bell-crank, 8, which in turn causes the left-hand striker, 13, to thrust the tooth of rod, 14, between the teeth of the wheel, 17, adjusting, if necessary, the position of the feed-wheel and forcing the corresponding punch, 15, through the tape, 18. The tappet piece, 31, formed on the link, 30, now comes in contact with the striker, forcing it from the rod and punch and permitting them to spring back to their normal position. On the reversal of the line-current the relay tongue is moved in the opposite direction, causing a reversal of the engine, when another operation similar to that described is performed by the right-hand striker, 12, upon the right-hand correcting rod and punch. As the complete operation of thrusting and releasing the punches occupies only the 300th part of a second, the time during which the feed-wheel is arrested is practically negligible, and the difference between dots and dashes in the tape depends entirely, therefore, upon the time interval between successive spacing and marking contacts during which the tape is allowed to run on. Even between the marking and spacing currents for a dot, there is an appreciable interval during which the slip has travelled a little. The right-hand punch and the corresponding correcting wheel are given a lead, so that although the spacing punch is actuated later, the spacing perforation appears opposite the same centre hole as the marking perforation.

That is a description, I am afraid, which is difficult to follow, but the result is, as you have seen in Fig. 1, that a dot produces two perforations on the tape, immediately one above the other, and a dash two perforations, which are inclined at an angle.

Fig. 4 is the printer You will understand that in receiving on this system it is first of all necessary to get a punched tape.

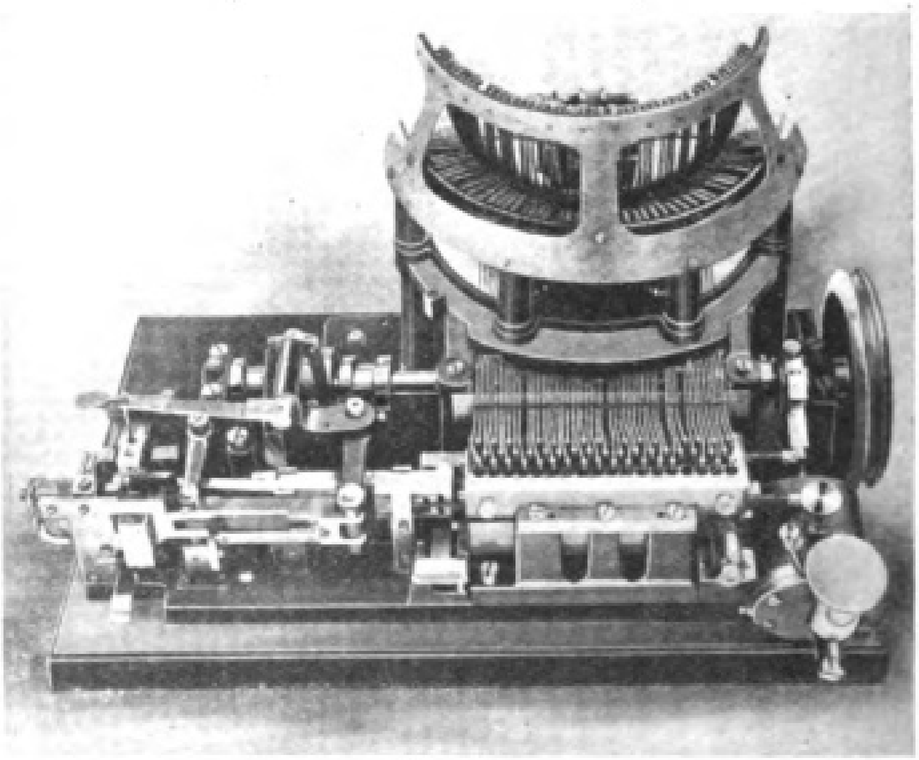


Fig. 4.

This is put through a further machine, which is really a sort of typewriter, and converts the signals as recorded on the punched tape in Morse characters into actual Roman type. The machine is very remarkable, in that it is a machine with what might be termed a memory. My meaning is that, supposing the machine gets, we will say three dots, then it has to remember what it has got. If subsequently it gets another dot, then it has to print the letter H. Supposing, instead of another dot, it gets a dash, it has got to print the letter V. For numbers it has to be able to remember five signals before it knows what to print, and therefore, that is why I say it is an instrument with a memory.

Fig. 5 is a diagrammatic sketch of how this instrument works. Only a small portion of the mechanism is shown, but I hope to give you some idea of how it works. The received perforated slip is passed into the machine at A and out at B, while the slip on which the printing takes place is drawn by a pair of feed-rollers from the roll on the upper left-hand side between the connecting rods of the type bars and over the printing platen.

containing a piston acting on the end of a lever connected to a type bar.

The perforated slip is fed forward by a star-wheel fitted to a spindle carrying a toothed wheel, which is rotated as required by a movement of a rack. The rack is given a vertical motion for feeding purposes, and a sideways motion for acting on any slide-valves that may have been selected. Its movement is obtained from the cam-shaft of the machine, which is belt-driven by a small electric motor. The extent of the vertical movement is limited by the distance to the first space signal, that is to say, the length of a letter. To provide for this limit

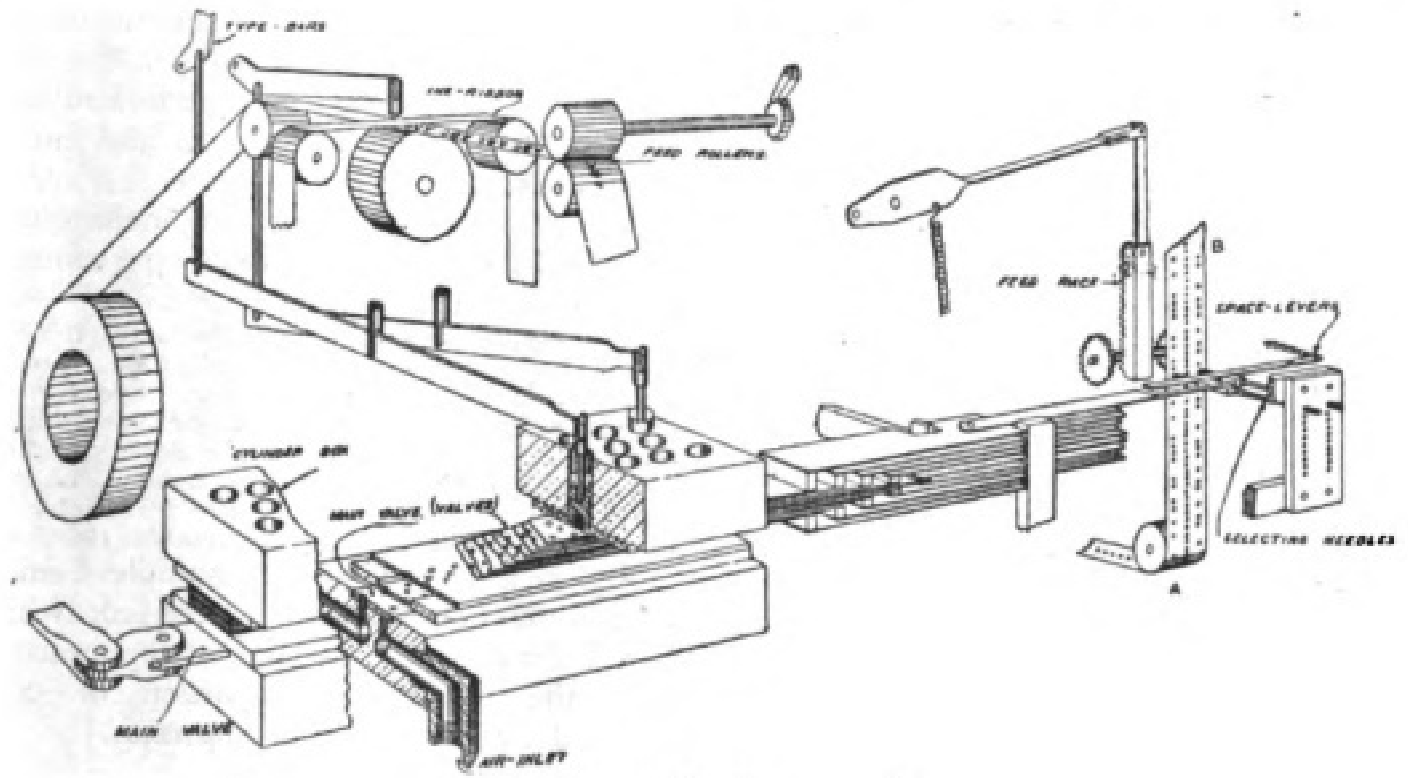


Fig. 5.

The perforated tape is fed forward, letter by letter, in a guide-way in front of a series of ten pairs of selecting needles, one needle of each pair being mechanically connected to a series of ten slide-valve-plates. Each of these valve-plates can be made to occupy one of two positions, thus providing a number of different combinations, every one of which opens one complete and particular passage through the ten slide-valve-plates. Air, under pressure, can thus be admitted to any one of a number of small cylinders, each

there is a group of ten space levers, normally in the path of the rack and preventing its downward movement. Each space lever is also in the path of one pair of selecting needles, and when either needle of a pair passes through a perforation, that space lever is moved out of the path of the rack. Hence, with any letter or figure of the Morse code there is a clear downward path for the feed-rack until it reaches a space signal. A sideways movement is then given to the rack, putting it in gear with the toothed wheel.

Next, the rack is given an upward motion, causing the toothed wheel to turn and the perforated tape to be fed upward by the amount of the particular letter that has just passed. The rack is then moved sideways again, clear of the toothed wheel, ready to descend as far as the next space signal.

The slide-valves, made of thin sheet steel, have each a hinged extension, whose further end is arranged to take up the movement of the corresponding selecting needle in its motion to and from the perforated tape. At the same time, the extension is free to move in a direction at right angles to the needle. Each valve extension is provided with a shoulder which comes into the sideways path of the feed-rack when that particular extension has been selected. At the correct moment, determined by the position of a cam on the main spindle, the rack is moved sideways and, engaging with the shoulders of the valve extensions which have been selected, moves the corresponding slide-valves into their second position. Another cam opens a main valve, admitting air, under pressure, to the slide-valve chamber, whence it passes through the ten valve-plates by the one hole available in that particular setting of the valves, forces up the particular piston and prints the corresponding letter. Another main valve is then opened to allow the air to escape, and the selected slide-valves are returned to their normal position.

Although more than the required number of selecting needles for any particular letter may pass through the tape, only the proper number of slide-valves are acted upon by the rack, on account of the spacing lever preventing the rack descending beyond the required amount.

It will be observed that there are twenty selecting needles, but only ten acting on the lower row of holes in the perforated slip are attached to valves; the other row of needles is not necessary for selecting purposes, but is required for shifting the spacing levers for the first portion of a dash signal.

This instrument is by no means easy either to explain or to understand, but in its main features it is not unlike an ordinary typewriter in which the printing levers, instead of being actuated by the fingers of an individual, are each connected with the piston of a small pneumatic cylinder. There are as many cylinders and pistons as there are characters to be printed, and the wonderful part of the mechanism is that whereby the cylinder connected with any particular letter that has to be printed is connected to the air-supply at the right moment. This is effected by the sliding perforated plates, which constitute a very elaborate form of slide-valve controlling the access of air to the whole of the cylinders, but admitting the pressure to only one cylinder at a time. The motions of these sliding plates are in turn controlled by the little pins, which are all the time feeling for the holes in the perforated tape as it passes by, and working in and out of these holes.

[At this point the following message was received from Paris, the printed tape containing it being thrown on the screen :—

This message is sent by permission of Général Ferrié by automatic perforated tape wireless transmission from the Eiffel Tower, Paris, for the purpose of being recorded on a Creed type printing receiver at a meeting of the Royal Society of Arts and of the Wireless Society of London, on the occasion of an address on wireless telegraphy by Mr. A. A. Campbell Swinton, November, 1920.

Fig. 6 is reproduced in facsimile from a portion of the message as received, while Fig. 7 shows another portion of the message, with the corresponding portion of tape punched by the receiving apparatus.]

Before we close, I think we ought to pass a very hearty vote of thanks to Mr. F. G. Creed and his assistant, Mr. Carpenter, who have taken enormous pains in showing us this wonderful system of printing by wire-

FROM THE EIFFEL TOWER PARIS

RECORDED ON A CREED TYPE-PRINTING

RECEIVER AT A MEETINH OF THE WIRELESS

SOCIETY OF LONDON ON THE OCCASIOD OF

AN ADDRESS BY MR A A CAMPBELL SWINTON

Fig. 6.

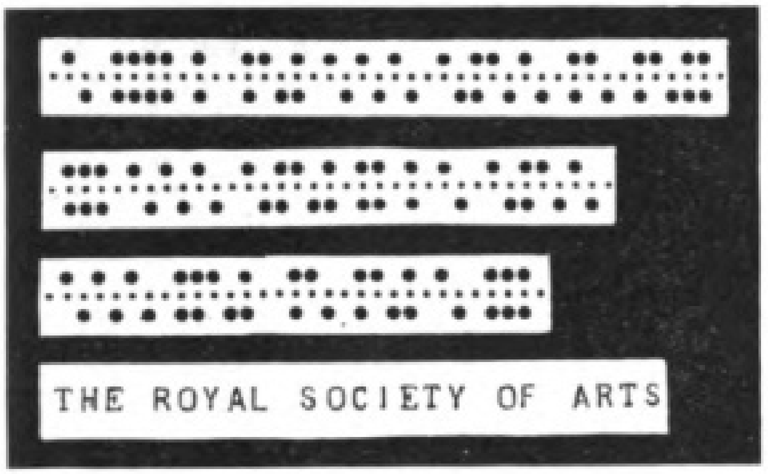


Fig. 7.

less telegraphy. Until yesterday this system of actual printing in Roman capitals by wireless telegraphy had never been previously shown in public.

The actual programme intended for this evening is at an end, but as we happen to have here some wireless-telephone apparatus, which was brought for the purposes of the demonstration last night before the Royal Society of Arts, perhaps you would like to have a demonstration on a small scale of wireless telephony.

Fig. 8 shows diagrammatically the connections at the transmitting station. P is the power valve, while c is the control valve connected with the telephonic microphone on the right through the transformer, T.

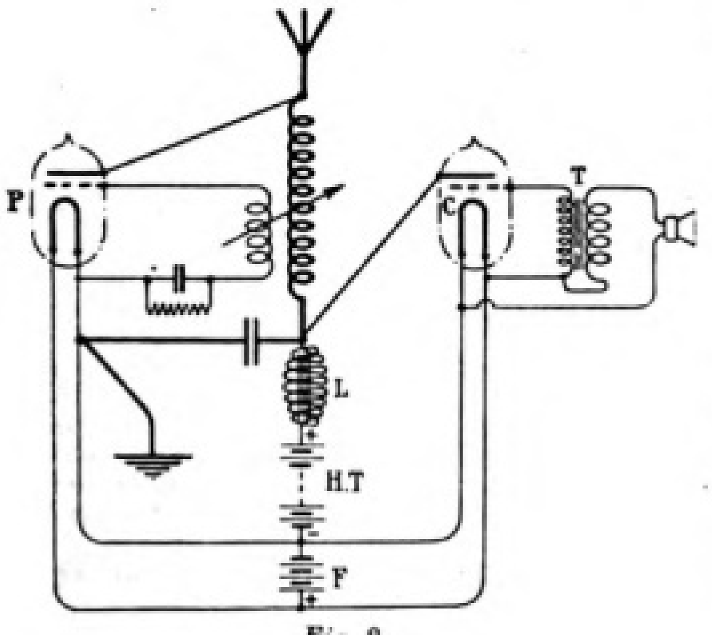


Fig. 8.

The aerial is shown at the top of the figure, and it will be seen that the plate electrodes of both valves draw their high-tension supply of electricity through the choking coil, L, from the 400-volt dry battery, HT, while the 6-volt accumulator, F, supplies current for the filaments. The whole arrangement is one of the forms of wireless-telephone transmitter employed by the Royal Air Force.

Coming now to the receiving apparatus in this room, we are going to employ a short-wavelength 5-valve amplifier, which was made for me by Mr. Sullivan, the well-known telegraphic instrument maker, at very short notice, specially for last night's meeting. The connections are shown in Fig. 9, and as you will observe, the connection between

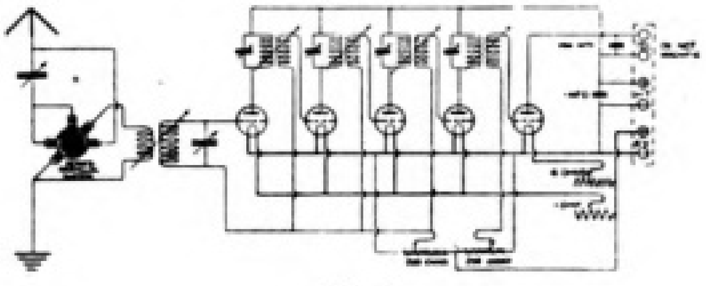


Fig. 9.

the adjacent valves is made by means of transformers. The transformers have no iron cores, and are specially designed to suit the short wavelength. In addition, the primary of each of these transformers is fitted with a separate adjustable condenser by which it can individually be tuned. There are also two potentiometers for the purpose of regulating the grid-voltage on the last two valves, while the current through the filaments of the first four valves can be regulated separately from that through the filament of the last valve.

In connection with the aerial on the left-hand side of the figure there is a series-parallel switch by which the primary tuning condenser can be put either in parallel with, or in series with, the aerial. This instrument, which is not unlike one of the arrangements described at our last meeting, works well on 200-meter waves.

The President: I have to announce that

Dr. J. A. Fleming, F.R.S., will give a lecture on December 10th at 6 p.m., at the Institution of Civil Engineers on "A 4-electrode thermionic detector for damped and undamped oscillation of high or low frequency." I am sure we are very much honoured by a gentleman of Dr. Fleming's eminence giving us the first description of this new important invention that he has made.

I have also to announce that the Annual General Meeting of the Society will be held at the Royal Society of Arts on December 21st, at 8 p.m.

Mr. F. Hope-Jones: I have been asked to make an announcement regarding the trans-Atlantic tests which are to take place for amateurs in February next. The Marconi Scientific Instrument Company are going to award one or more prizes to successful amateurs, though it is, of course, rather early yet for them to specify precisely what these shall be or what the conditions and method of judging the awards will be. An announcement with regard to this will be made in due course, but it is thought desirable to mention the fact that they intend to award prizes to purely amateur radio telegraphists, and perhaps the mere announcement may encourage other bodies or firms to follow the Marconi Scientific Instrument Company's example.

I think whilst I am on my feet I should like to be permitted to move a vote of thanks, which I am sure will be carried with acclamation, to our President for his most excellent lecture.

The vote of thanks was cordially responded to.

The President: I am much obliged to you, and I have now to declare that the meeting is at an end.

The meeting adjourned at 9.40 p.m.

WIRELESS CLUB REPORTS

The Wireless Society of London.

The annual general meeting of this Society is arranged to take place on December 21st, at 8 p.m., at the Royal Society of Arts, John Street, Adelphi, W.C. A Paper will be read by Prof. R. Whiddington, of the Leeds University on "Wireless Valve Circuits applied to the measurement of Physical Quantities," illustrated by experiments. The business of the meeting, which will include the election of Officers and Committee, for the forthcoming year, will be duly announced by letter to members.—Hon. Secretary, Mr. L. McMichael, 32, Quex Road, W. Hampstead, N.

Sheffield and District Wireless Society.

(Affiliated with the Wireless Society of London.)

On November 5th Mr. L. Johnson gave a very interesting Paper on the more recent research work he has been carrying out in wireless telephony.

Mr. Johnson illustrated his Paper with lantern slides, many of them being photographs of his own apparatus.

A demonstration of wireless telephony with transmitting and receiving sets was also given.

On November 19th, a very interesting and instructive Paper was read before the Society by Mr. Walter Burnet on "Small Wireless Transmitters—Spark and C.W. Types."

The lecture was illustrated by lantern slides and also by a varied collection of apparatus. A small portable spark set, which was made before the War for use in connection with a troop of Boy Scouts, was also described. It has since been re-designed to comply with the P.M.G.'s regulations, and even with the very small amount of power allowed is capable of signalling over considerable distances.

Amongst other apparatus described and shown was the Wilson Transmitter and a small C.W. trench set, which, with the modern valve and a small aerial 3 ft. high, is capable of sending messages over a distance of several miles.

A good deal of practical information was given with regard to the design and construction of sets, in order that members might have some data to work upon in building their own transmitters.

The meeting terminated with an interesting discussion and a hearty vote of thanks was given to Mr. Burnet.

This Society has now 125 members, and is doing very useful work. All intending members are advised to communicate with the Hon. Secretary, Mr. L. H. Crowther, 156, Meadow Head, Woodseats.

Bradford Wireless Society.

(Affiliated with the Wireless Society of London.)

A meeting was held on November 5th, the Vice-President being in the Chair.

The minutes of the previous meeting were read and accepted as correct.

A letter was read from Mr. P. R. Coursey, of the *Radio Review*, asking for the co-operation of the members in the scheme for receiving signals from American amateurs. It was proposed by the Chairman and carried, that the Secretary should communicate with Mr. Coursey and intimate to him the willingness of the members to co-operate in the said scheme.

The Chairman proposed that, in order to assist those beginners, who perhaps would not like to ask elementary questions publicly, a box should be prepared into which any questions could be put unsigned; the questions to be discussed and answered at the meetings. This was carried unanimously.

Three new members were elected, making our total membership well above 50.

A Paper was read by Mr. Whitely on "Systems and Circuits of Spark Transmitters" which was both extremely interesting and much appreciated. A vote of thanks was proposed by the Chairman and seconded by Mr. J. Bever.

A meeting was held on November 19th, at 7.45 p.m., in the Club-room, the President, Mr. Wood, in the Chair. After the minutes of the last meeting were read and accepted as correct, the Chairman then called upon Mr. W. C. Ramshaw (Vice-President) to deliver his lecture on "The Adapting of Old Apparatus to meet Modern Requirements." The lecturer had with him a set of apparatus made some 6 years ago, originally intended for long wave crystal work; he showed in a very clear manner the method of conversion.

The Secretary takes this opportunity to state that he would be very pleased to hear from any gentleman willing to read a Paper or give an exhibition.—Hon. Secretary, Mr. John Bever, 85, Emm Lane, Bradford.

Burton-on-Trent Wireless Club.

(Affiliated with the Wireless Society of London.)

At the fortnightly meeting of the Club held on Friday, November 19th, with Mr. A. Chapman (Vice-President) presiding over an attendance of about 25 members, the Hon. Secretary read a letter received from the Wireless Society of London regarding affiliation, and asking whether the Club could send one or two delegates to a Conference of Wireless Societies early in the New Year. It was decided to defer the consideration of the question of sending delegates until further particulars were received as to what was to be discussed at such a Conference.

A letter was read from Mr. Robert Tingey regarding a proposed Wireless College. No action was taken thereon.

It was resolved to apply to the P.M.G. for a transmitting licence.

Four new members were elected, and a hearty vote of thanks was accorded to Mr. Maurice Lloyd for the kind services he had rendered to the Club during his leave.

Mr. F. V. A. Smith read a very interesting Paper on "The History of Wireless Telegraphy and Telephony."

Subscriptions for the year 1920-21 are now due, and are as follows:—For members over 21, 5s.; for members under 21, 2s. 6d.—Hon. Secretary, Mr. R. Rose, 214, Belvedere Road, Burton-on-Trent.

Brighton Radio Society.

(Affiliated with the Wireless Society of London.)

A meeting of the Society was held in the Banner Room, at the Oddfellows' Hall, Queen's Road, Brighton, at 8.30 p.m.on November 11th. Despite the somewhat trying weather the attendance was excellent and included members from towns outside Brighton.

The offer of the Banner Room by the Secretary of the Oddfellows' Institute for future regular meetings of the Society was placed before the members, and it was unanimously decided by ballot that as a temporary measure, this room be taken for weekly meetings on Thursdays.

One new member was enrolled.

Mr. O. G. Sandford was elected to be member of the Wireless Society of London for the ensuing year, and arrangements are being made for this gentleman to attend at the coming meetings of that Society.

An interesting discussion followed concerning the experiences of various members with regard to their sets. A series of Papers will be arranged for, the first of which it is anticipated will be read at the next meeting.

The object of this Society is purely to assist and bring together local amateurs, no technical certificates of any nature being necessary in order to gain admission to membership, keen interest in the science being the main qualification. Any interested reader is invited to communicate with the Hon. Secretary, Mr. D. F. Underwood, 68, Southdown Avenue, Brighton, who will be pleased to furnish full details.

North Middlesex Wireless Club.

(Affiliated with the Wireless Society of London.)

A very successful meeting was held on Wednesday, November 17th, at Shaftesbury Hall, Bowes Park, Mr. G. W. Evans in the chair. After the usual business, Mr. Haines, who had kindly offered to come down for the evening, was called upon to give his lecture on the German Army receiving set, which he had brought with him. Mr. Haines gave diagrams, clearly illustrating the connections of the set, and drew attention to a number of unusual features which it possessed. He then took the set apart, and showed the interior construction, and it was interesting to note that porcelain had been substituted for ebonite in the insulation, which pointed to a scarcity of that article in Germany during the war.

A short discussion then followed during which Mr. Haines replied to questions, after which the set was connected to the Club's aerial and a practical demonstration of the capabilities of the instrument was given.

At the close of the meeting a vote of thanks was passed to Mr. Haines for a most instructive evening.

Those wishing to join the Club may obtain full particulars from Hon. Secretary, Mr. E. H. Savage, Nithsdale, Winchmore Hill, N.21.

Newcastle and District Amateur Wireless Association.

(Affiliated with the Wireless Society of London.)

The weekly course of instructional lectures given by Mr. Dixon has now reached the interesting stage of practical receiving circuits. These lectures are followed by a discussion dealing with circuits brought into notice by members wishing to obtain further information. Such discussion has resulted in a number of interesting and instructive debates.

Intending members apply to the Hon. Secretary, Mr. Colin Bain, 51, Grainger Street, Newcastle.

Halifax Wireless Club.

(Affiliated with the Wireless Society of London.)

This Club continues to make good progress. At our last meeting a full attendance welcomed Mr. Forbes Boyd (late R.A.F.) of the Sheffield and District Wireless Society, who lectured on "The Thermionic Valve." Mr. Boyd treated his subject in a very lucid manner, and his explanations of the functions of the valve were of great benefit and interest to his hearers. The lecturer had prepared large drawings illustrating the points touched upon, and carried out various successful experiments.

At the Royal Halifax Infirmary Bazaar held at the end of October, the Club installed and worked a wireless installation. Permission was obtained from the P.M.G. to do this, and the affair was a great success.

On Wednesday, November 3rd, Mr. P. Denison gave a lecture on the construction of the short wave receiving set used at the Bazaar and outlined its construction. Mr. Denison also dealt with various types of short wave receivers in a very clear manner, and his remarks were very helpful to the large number of members present.

Many other lectures have been arranged for the winter session, and we are looking forward to a very successful season.—Hon. Secretary, Mr. H. L. Pemberton, Clare Hall, Halifax.

Liverpool Wireless Association.

(Affiliated with the Wireless Society of London.)

A meeting was held at the Royal Institution, Colquitt Street, on November 10th. Certain gentlemen were elected to further augment the Committee, and to give new members an opportunity of sharing in the control and work of the Association. Mr. J. Wainwright was elected as Hon. Treasurer, *vice* Mr. C. Wertley who has resigned through pressure of business.

It was decided to commence a course of progressive elementary studies in wireless telegraphy for beginners, and the first lecture dealing with the subject was given on Wednesday, November 24th. Meetings in the future will start at 7.30 p.m., and the first half hour of such meetings will be devoted exclusively to beginners. Messrs. Lewey and Hyde have undertaken the duties of joint lecturers to beginners. Mr. J. Coulton announces that he is in a position to offer members a discount of twenty per cent. on all wireless apparatus.

A substantial sum of money has already been given and promised towards the Association's Apparatus Fund, and further offers of both cash and apparatus continue to roll in; it is anticipated that the Association will very soon have a good collection of apparatus to put before its members.

A meeting of the Association was held at the Royal Institution, Colquitt Street, Liverpool, on November 26th, when a demonstration was given by Mr. S. Lowey (member). By kind permission of the Institution Authorities, two parallel wires had been stretched in the "Byrd Room" on the first floor of the building, each wire being about 45 feet long. The earth connection was made to the heating pipes. The set used was a 3-valve receiver, to which a fourth valve had been added for the occasion. The set has a range of 200 to 20,000 metres, the inductances for same being wound in grooves in cylindrical formers for 2,000 to 20,000 metres, and single layer below 2,000 metres. They are divided into four pair of coils with a total of 19 tappings. With the exception of a portion of the coil used for 600 metres, no wire of larger diameter than No. 36 has been used. A simple four-way single-pole switch is provided for readily changing over from 1 to 2, 3, or 4 valves. A Brown's loud-speaker was connected, and the first signals heard were FL spark at 7.30 p.m., and POZ spark at 7.40.

After various business had been disposed of, Mr. Lowey gave a detailed description of his set, and at 8.30 the loud-speaker again commenced operations. At 9 p.m., UA (Nantes) spark, followed by Malta spark were heard quite loudly.

A cordial invitation is again extended to all interested persons, to join the Association, and full particulars may be obtained from the Hon. Secretary, Mr. S. Frith, 6, Cambridge Road, Crosby.

The Cardiff and South Wales Wireless Society.

(Affiliated with the Wireless Society of London.)

A general meeting of the Society was held at the Wireless Department of the Cardiff Technical College on Wednesday, November 10th, at 7 p.m., the President, Mr. W. A. Andrews, B.Sc., in the chair.

The minutes of the last general meeting were read and confirmed.

Mr. G. C. Hughes, having tendered his resignation as Hon. Secretary, it was proposed that Mr. W. G. J. Howe, of 25, Plasturton Gardens, Cardiff, be appointed.

The proposal being carried, Mr. Howe was appointed Hon. Secretary as from November 10th.

The President then gave a most interesting lecture and demonstration of the 2-Valve Receiver and Direction-Finder manufactured by the British Thomson-Houston Co., of Rugby. The set used was very kindly lent for the demonstration by Mr. Rowlands, of the B.T.H. Co., Cardiff. At the conclusion of the demonstration, discussion took place on the mechanical construction and efficiency of the set and signals were received using both the loop and the outdoor aerials for reception.

The members then adjourned to the Chemistry Lecture Theatre, where a most instructive lecture was given by Mr. E. A. Rudge, B.Sc., A.I.C., on "Some metals and their electrical properties." The lecturer briefly referred to the physical properties of metals and showed how some substances, classed as metals, exhibit extraordinary properties.

The lecture was profusely illustrated throughout by experiments and lantern slides, and at the conclusion a hearty vote of thanks was accorded Mr. Rudge for his kindness in giving such an interesting lecture and for his trouble in preparing the experiments, etc.

Interesting pieces of apparatus were shewn by Mr. A. E. Hay and Mr. Fraser.

The Society cordially invites prospective members to write to the Secretary, and all correspondence should now be posted to Mr. W. G. J. Howe, 25, Plasturton Gardens, Cardiff.

The Wireless and Experimental Association.

(Affiliated with the Wireless Society of London.)

At a meeting of the Association at 16, Peckham Road, on Wednesday, November 10th, Mr. Knight in the chair, a letter was read from the P.M.G. consenting to the Club's aerial being transferred from 16, Peckham Road to the Central Hall, Peckham. The Secretary promised that he would assist our Penge confrères in the formation of their Society, and hoped that a close bond of union would long exist between the two Societies. Two new members were elected. Hon. Secretary, Mr. G. Sutton, Melford House, 16, Melford Road, East Dulwich.

The Wireless Society of Hull and District.

(Affiliated with the Wireless Society of London.)

The Society is still holding its fortnightly meetings at the Marlbrough Room, Metropole. Most of the members, in possession of suitable apparatus, intend endeavouring to their very utmost to make the American amateur trans-Atlantic tests a success. Discussions on Honeycomb coils have recently been held at which two members, Mr. Douson and the Hon. Secretary, showed that the old loose-coupler can still be greatly improved.—Hon. Secretary, Mr. J. Jephcott, temporary address, 79, Freshold Street, Hull.

Preston Scientific Society (Wireless Section).

(Affiliated with the Wireless Society of London.)

This section is now in a very strong position with a membership of about 60.

We are unfortunately not yet in possession of the P.M.G.'s certificate for transmission and reception, but it is expected to arrive shortly.

At our recent exhibition temporary permission for reception was obtained for utilising indoor aerials in conjunction with a 3-valve amplifier. Almost every type of W/T apparatus was on view, dating from the coherer to 7-valve apparatus.

Owing to the resignation of Mr. A. Wilkinson, our Secretary, Mr. W. J. Bryce has taken that office.

All communications *re* membership, etc., should therefore be made to him at 119A, Fishergate, Preston.

Leicestershire Radio Society.

(Affiliated with the Wireless Society of London.)

The monthly meeting of the Society was held on Monday, November 1st, Mr. C. F. Atkinson, Vice-President, in the chair. Four new members' names were submitted for membership.

The Secretary announced that the Annual Business Meeting and election of officers would be held on January 10th, 1921. This meeting to be preceded by a Dinner. Notice was given by a member that at the next meeting of the Society he would move an alteration to the Rules of the Society to provide that before a member be accepted his name shall be submitted to a meeting of the Society.

The Chairman then called on the speaker for the evening to deliver his address. Mr. S. May then introduced his subject, namely, "Electrical Units, their relations and some useful Formula." The speaker explained that his subject was a very comprehensive yet very necessary one to discuss for all who were interested in the study of wireless; he then went on to explain the various units used in electrical measurements. He defined the volt, ampere, ohm, and then dealt with the C.G.S. system of units following on with those of velocity, force, power, capacity, etc.

Altogether the subject revealed the necessity for careful study if it was to be fully understood, and after an interesting debate the Chairman closed the meeting with a hearty vote of thanks to the speaker.—Hon. Secretary, Mr. W. E. Dunt, 45, Baden Road, Leicester.

Three Towns Wireless Club.

(Affiliated with the Wireless Society of London.)

At a meeting of the Club on Wednesday, November 3rd, a lecture was given by Mr. L. J. Voss on the development of the thermionic valve. The lecturer devoted himself mainly to the historical side of the subject. After describing briefly the early forms of detector, the coherer, and the various crystal combinations, he went on to consider the Fleming valve. A hearty vote of thanks was accorded to Mr. Voss at the close of the meeting.

On Wednesday, November 10th, the Secretary being ill no definite programme had been arranged. The members were again kept interested by Mr. Voss offering hints and tips on the making of various forms of inductances, the approximate sizes for various wavelengths and suitable gauges of wire.

Full particulars of the Club may be obtained from the Hon. Secretary, Mr. G. H. Lock, 9, Ryder Road, Stoke, Devonport.

Aberdeen and District Wireless Society.

A meeting of the Society was held on November 16th.

The Secretary gave details of construction of a 2-circuit carborundum crystal receiver which had been constructed at a cost of about £1, without telephones, from such ordinary articles as cardboard jam cartons for the coil formers; a 30-ampere porcelain cut-out as a crystal holder with a portion of hack-saw blade to make contact with the crystal.

To prove the efficiency of the receiver, signals were received from a buzzer in an adjacent room on a very small indoor aerial.

During the demonstration, however, signals were actually picked up from a ship in the North Sea, working with PCH.

On October 23rd the Secretary gave a lecture on the history of detectors from the coherer to the thermionic valve.

The members are showing a keen interest, and are anxious for facilities for the making of their apparatus. To this end we are keenly searching for Club premises in which we are to instal a lathe, drill, etc.—Hon. Secretary, Mr. W. W. Inder, 41½, Union Street, Aberdeen.

The Rugby and District Wireless Club.

Owing to the difficulty in securing suitable accommodation, the above Club has so far done little for the furtherance of wireless work in Rugby. However, a Club-room has now been secured at 11, Albert Street, and the winter session will commence from November 29th. A most attractive programme of lectures, experiments, discussions, demonstrations, etc., has been arranged, and a very successful session is anticipated. Fortunately two members of the Club are ex-telegraphists—Messrs. Hicks and Cave, so that buzzer classes have already been started. The Club-room has been named "The Radio Institute," where meetings are held every Monday evening. Particulars *re* the affiliation with the Wireless Society of London are now to hand.

Mr. R. C. Clinker (President) has kindly promised to give a public lecture and demonstration early in December to assist "recruiting."

The Hon. Secretary, Mr. Arthur T. Cave, will be pleased to give intending members full particulars on application at 3, Charlotte Street, Rugby.

East Kent Wireless Society.

A meeting was held on Wednesday, October 27th, at the Oddfellows' Institute, Pencester Road, Dover. The proposed rules were read before the Society and passed. The revised list of officers will read as follows:—President, Major Martin, R.E.; Chairman, Commander Norfolk, R.N.; Hon. Secretary, Mr. H. Alec. S. Gothard; and Committee, Messrs. Austen, Kelsull, Sargent, and Vaugham.

Before concluding the meeting, it was decided to hold weekly Instructional Lectures, and a meeting the last Wednesday in the month.

A special meeting was held on Wednesday, November 10th, to discuss the future headquarters of the Society. This meeting proved very successful, and it was decided to take over part of the building known as No. 14, Snargate Street, Dover.

A special Committee were elected to inspect the building and report thereon at the next meeting.

The first monthly meeting took place at the Oddfellows' Institute, on Wednesday, November 24th, Major Martin taking the chair.

After the minutes of the last meeting had been read and passed, the Special Committee were called upon to give in their report. This having been discussed the meeting was concluded with a short address from the President.

The Hon. Secretary will be pleased to hear from, or interview anyone interested in the Society. All communications should be addressed to him at 8, Longford Terrace, Folkestone.

Manchester Y.M.C.A. Wireless Club.

On Friday, October 22nd, a meeting of all members of the Manchester Y.M.C.A., interested in wireless telegraphy, was called for the purpose of discussing the formation of a wireless club. With such a subject under discussion there was a good attendance. We were fortunate enough to obtain the services of Mr. Thomason, the Hon. Secretary of the Manchester Radio Scientific Club, to help us in our formation, and in his summing up of the aims of the wireless club likely to be formed, he mentioned that the Manchester Radio Club were willing to give every assistance which lay in their power, both as regards apparatus and experience.

Having definitely decided to form a club, a temporary Committee was elected, Mr. A. Day being appointed Hon. Secretary. Following a general discussion, a vote of thanks was proposed to Mr. Thomason for taking the chair and so ably starting us on our road to success.

On Thursday, October 28th, the second meeting was held, Mr. Thomason again taking the chair. Mr. Day informed us that he had been successful in securing two rooms from the Manchester Y.M.C.A.; these rooms being at the top of the building, are therefore greatly suited to our requirements.

The responsibility of erecting an aerial on the roof has been undertaken by the Y.M.C.A. Authorities and several members have offered to loan apparatus until such time as the Club is in possession of its own.

(The Hon. Secretary's address would oblige.—Ed.)

The Wellingborough Red Triangle Radio Society.

A meeting of amateurs was held on Wednesday, November 10th, for the purpose of forming a radio society for Wellingborough and district.

It was decided to adopt the title of The Wellingborough Red Triangle Radio Society, and the following officers were elected:—Joint Secretaries: Messrs. Horace W. Dunkley and L. G. Fish. Treasurer: Mr. L. Yorke.

It was decided that application be made for affiliation with the Wireless Society of London. It was resolved that membership of the Society should be open to all residents in Wellingborough and district, who have attained the age of 18 years. The subscription was fixed at 5s. per quarter, the entrance fee to be 5s. It was further resolved that classes for Morse practice should be held on Wednesdays and Fridays of each week.

The Joint Secretaries, Messrs. H. W. Dunkley and L. G. Fish, c/o The Red Triangle Club, Oxford Street, Wellingborough, will be pleased to supply all further particulars of the Society to prospective members.

The Walthamstow Amateur Radio Club.

The fifth meeting of the Walthamstow Amateur Radio Club was held on Wednesday, November 10th, at the Walthamstow Town Memorial Y.M.C.A., Church Hill, when all arrangements for the erection of an aerial were completed. The Y.M.C.A. authorities are keenly interested in the proceedings, and have very kindly given permission for the erection of the aerial.

Will those interested kindly communicate with the Hon. Secretary, Mr. K. Hardie, at 58, Ulverston Road, Upper Walthamstow, E. 17.

Wireless Club in North London.

A successful meeting of wireless enthusiasts has been held at which was voiced the great need of a Wireless Club in North London. Sixteen gentlemen were able to be present, and it was decided to form a Club to be known as "The North London Wireless Association." Dr. F. C. Knight was elected President, and the usual officers and Committee were appointed. All those interested please communicate with the Hon. Secretary, Mr. J. W. S. Prior, c/o the Superintendent, Peabody Buildings, Essex Road, N.1., who will be pleased to give full particulars.

AEROPLANE AERIALS

A Review of the Results of some American Investigations.

BY J. J. HONAN.

IN the early stages of aircraft wireless, the universal use of the somewhat clumsy trailing aerial created a pronounced prejudice in the minds of most pilots against wireless sets generally, and went far to handicap the full development of radio work in the air.

The trouble of "dropping" the aerial from the winch, and the quite considerable time and exertion involved in "winding in" before landing, were two of the factors that rendered it unpopular with the airman. In addition the frequency with which either the leaden plummet for weighting the aerial, or else the whole aerial itself, was wrenched away by careless handling of the winch, to fall haphazard to the earth below, formed another objection, the full weight of which was most appreciated by the surplus population on *terra firma*.

In warfare, the trailing aerial was wholly a nuisance without redeeming qualities. To "stunt" with the aerial out involved quite a fair risk of personal and painful interference with the free swing of the plummet; whilst on the other hand, the chance of scoring a bull's eye by "swinging the lead" at the enemy was too remote to be considered as an offset.

In this country apparently, no effective substitute has yet been found for the old type of aerial, in spite of its many defects. This is particularly so in the case of transmission. For reception, the use of sensitive multivalve sets has brought the closed-loop aerial into almost general use for long wavelengths. For ranges below 1,200 metres, however, the airman has still to rely upon the hanging aerial for reception, whilst for any practical range of transmission he is wholly dependent upon it.

The whole question of aeroplane aerials, and the many difficulties that are bound up with the subject, appear to have received considerable attention in America, as is evidenced by the official pamphlet No. 341 recently issued by the Bureau of Standards under the Government Department of Commerce, Washington, U.S.A.

The pamphlet in question, which is published at five cents, is a striking example of the characteristic initiative and thoroughness

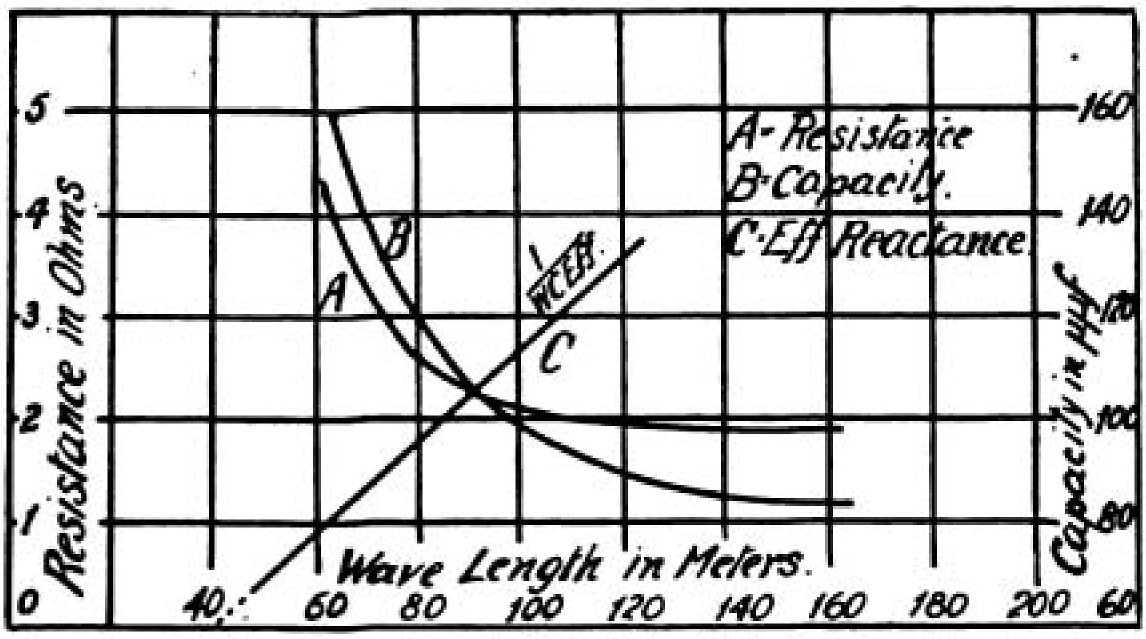


Fig. 1.

Constants of fixed or rigid aerial of type D in Fig. 2.

of our cousins across the Pond, and affords a concrete proof of their faith in the future of wireless in the service of Aviation.

The main objects of the experiments described were to obtain accurate information regarding the effective capacity, effective resistance, true capacity, true inductance, and wavelength, as well as the transmitting directional effects of various types of aeroplane antennæ. Investigations were carried out upon trailing aerials of one, two, and four wires; in addition various systems of fixed aerials were utilized in the attempt to find a satisfactory substitute for the trailing wire.

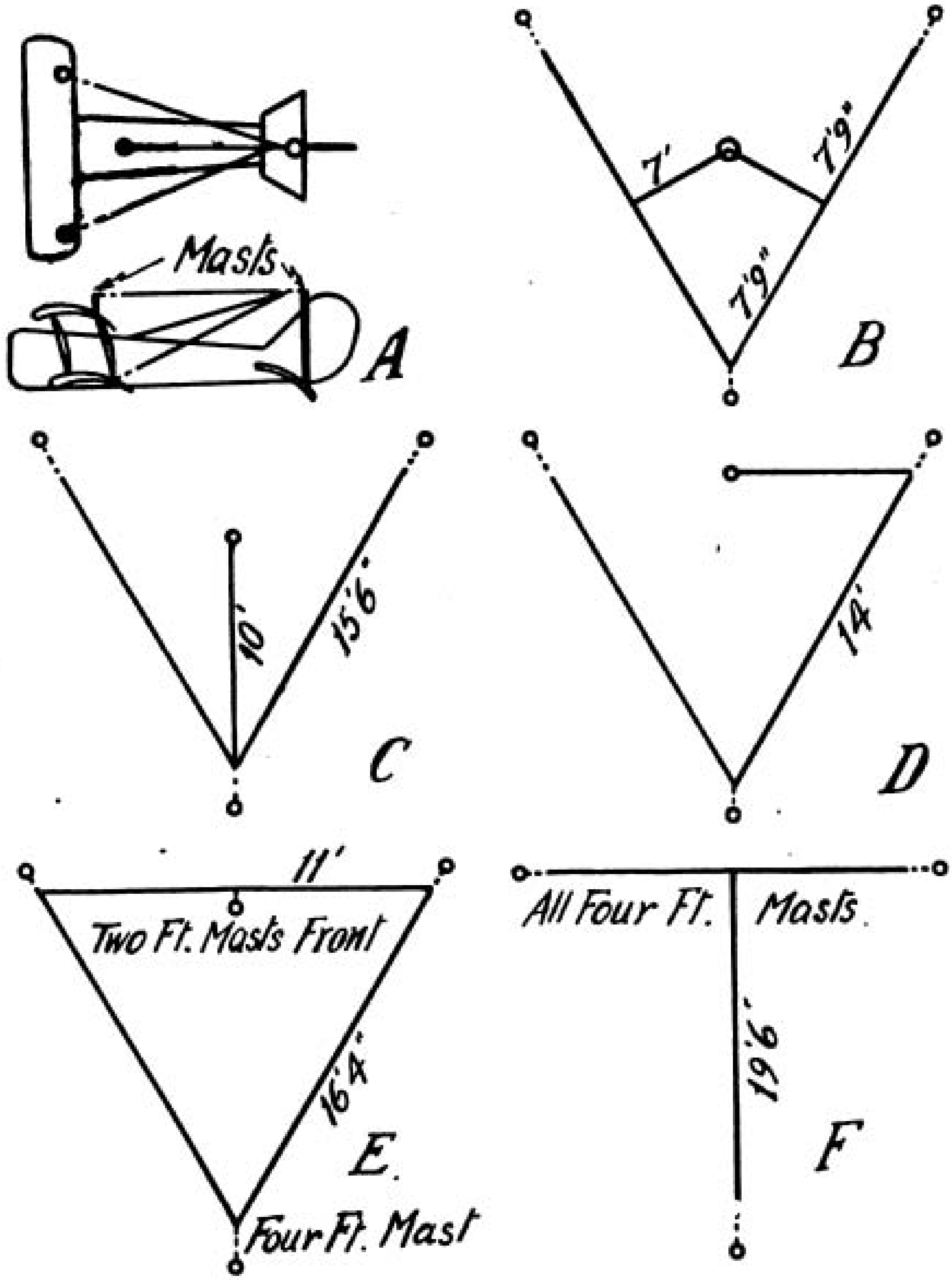


Fig. 2.

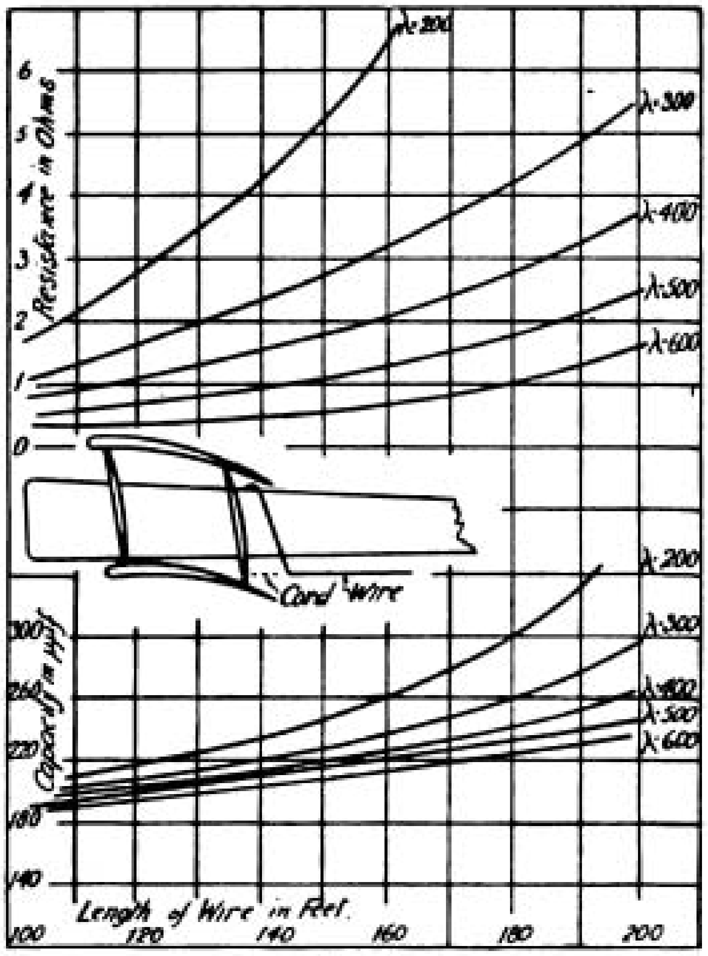


Fig. 3.

Constants for various lengths of single-wire trailing aerials.

Fig. 1 shows the wavelength capacity and wavelength resistance curves for the type of fixed aerial shown at D, Fig. 2, mounted on masts rising two feet above the wings. The height of the masts is, of course, limited by the maximum wind resistance allowable. It was found, however, that increased height, as might be expected, caused a considerable decrease in the natural capacity, but was accompanied by an increase in radiation resistance. Type D aerial is about equivalent in electrical characteristics to a 45-foot trailing wire.

Some of the arrangements of fixed aerials are shown in Fig. 2. These gave wavelengths varying from 60 to 160 metres. In all cases the flying and landing wires were bonded together to give the earth.

Fig. 3 shows the aerial constants for various lengths of a single trailing wire over a range of wavelengths varying from 200 to 600 metres, the upper portion of the figure showing the resistance variation, and the lower half indicating the corresponding capacity values. The aerial was attached by an insulator and a 40-inch cord to the inside strut of the plane. It was found that the position of the lead-in wire played an important part in determining the total capacity of the aerial; it should preferably be kept as far as possible from the wire network of the machine.

Fig. 4 is a similar diagram for a double aerial of two trailing wires attached to the plane in the manner shown in the inset sketch. The wires are in parallel with the bonded wires of the machine as earth.

An attempt to utilize one wire as "earth," against the other as the aerial proper, gave greatly reduced capacity and also a decreased radiation resistance.

In Fig. 5 is an interesting comparison of the characteristics (capacity and resistance against wavelength) of a single 100-foot

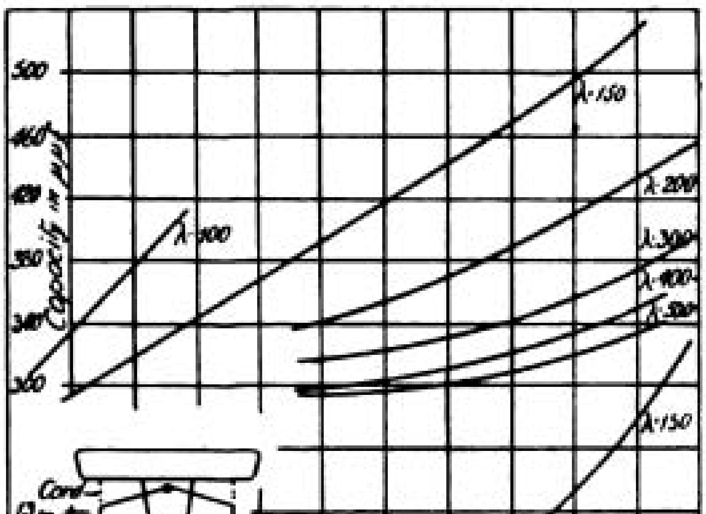


Fig. 4.

Constants for various lengths of two-wire trailing aerials.

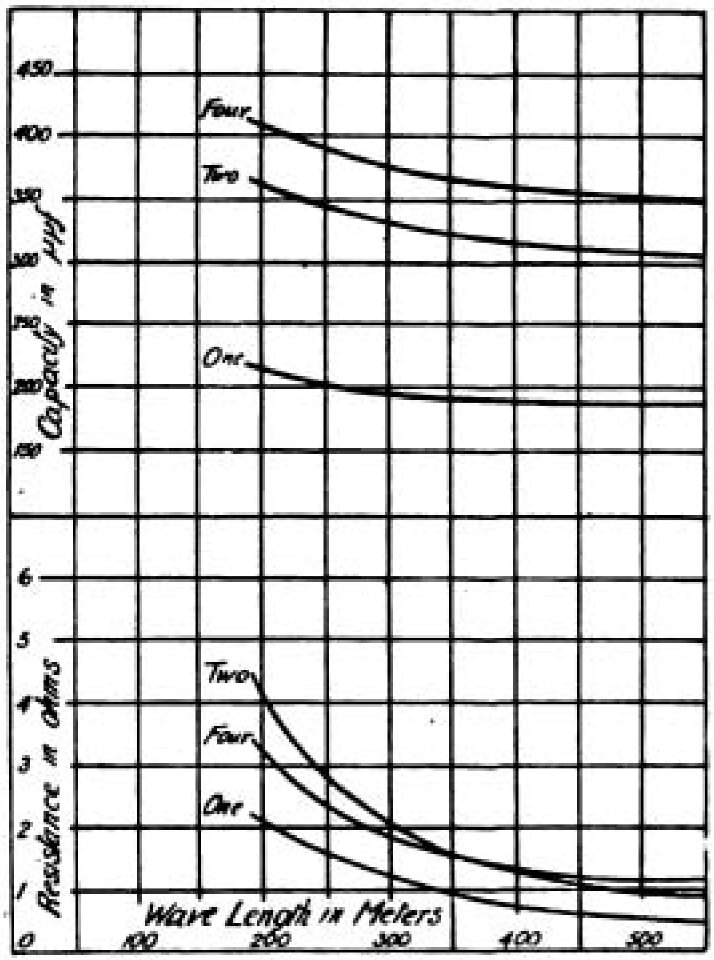


Fig. 5.

Constants of 100-ft. trailing aerials of one, two and four wires.

trailing aerial compared with a two-wire and four-wire arrangement of identical length.

In Fig. 6 is shown the directional transmitting effect of trailing aerials as determined by a multivalve receiving-set connected to a symmetrical vertical-wire land antenna. The effect is found to be quite pronounced, showing about twice the radiation in the direction of motion of the plane as it does in the opposite direction.

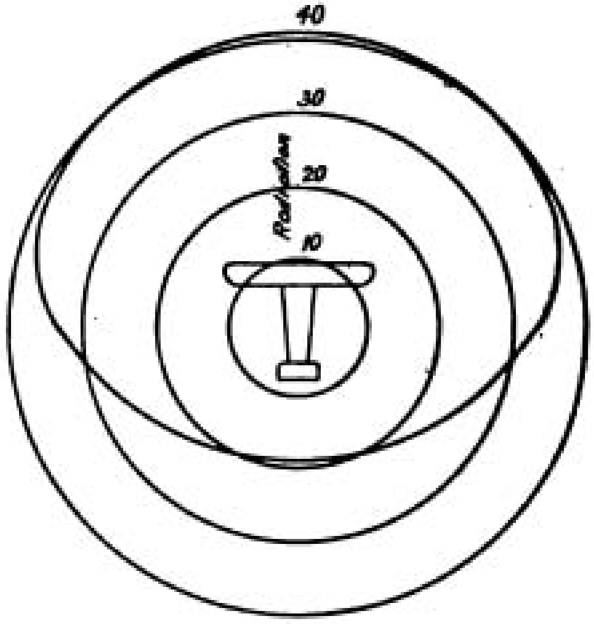


Fig. 6.

Directional effect of a two-wire trailing aerial.

Similar experiments in the case of fixed aerials failed to show any decided directional effect.

In all the experiments a continuous wave set was used for transmission, feeding directly into the aerial.

PILOTING AIRCRAFT BY WIRELESS

According to the *Radio News* for November, electric lights operated by wireless placed on the front of the machines will guide the planes at night on the Cheyenne—Salt Lake—San Francisco air-route.

These lights will be tuned to the wireless apparatus of the three cities in such a manner that they will glow only when the machines are within a certain radio path about 200 feet in width. When a plane strays from the path the lights will cease to glow, and the pilot will be obliged to determine from the wind on which side of the route he is travelling. Approach to the destination will be signified by a flashing on and off of the lights. The process has proved a success in tests, and is owned by the U.S. Government.

PAGES FOR BEGINNERS

Under this heading we publish COMPLETE *instructional articles, forming a series specially designed and written for beginners in wireless work. Hardly any mathematics will be introduced, and we hope to present the fundamental facts of wireless in such a manner as will prove attractive to a much wider range of students than that for which this series is primarily intended.*

AMPLIFIERS.

THE term *amplifier* is almost self-explanatory. By it we mean any arrangement of apparatus which will magnify signals received on an aerial. In late years the term *amplifier* has grown to mean an arrangement of valves, so connected as to render weak signals more audible in the telephones.

It is possible to employ magnifying valves in two ways,—we can either increase the amplitude of the received oscillations before rectifying them, thus rendering them more audible in the telephones, or we can increase the magnitude of the rectified current.

If the incoming oscillations are increased before rectification, the valve is adjusted so that the alteration in plate current exactly corresponds to the variations in the grid-circuit potential. It is then said to act as a high-frequency amplifier.

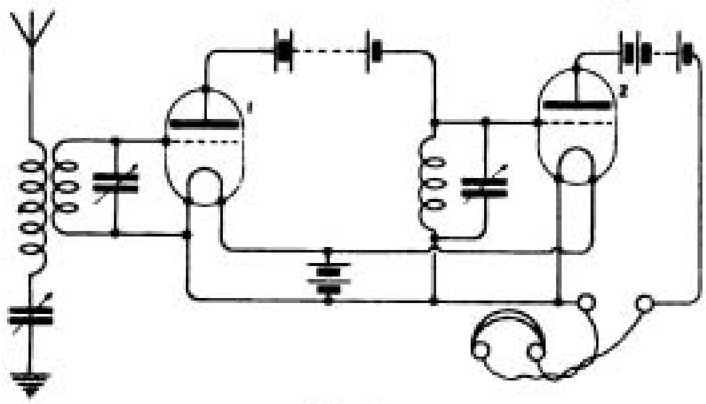


Fig. 1.

Where the valve is simply used to increase the current flowing in the telephone circuit, the process is known as low-frequency amplification, or *note-magnification.*

Further, it is possible to combine high-frequency amplifying and note-magnifying valves in one set. For instance, a six-valve amplifying set might comprise one rectifying valve, three high-frequency amplifying, and two note-magnifying valves.

High-Frequency Amplifiers.—For the purpose of magnifying the high-frequency oscillations the valve is usually adjusted to work at about the middle point of its characteristic.

With this arrangement any variation in grid-potential due to incoming signals, will be accompanied by corresponding variations in the plate current of exactly the same frequency and waveform, but of greater amplitude.

These oscillations in the plate-circuit can be utilised in two ways. They may either be led through a coil coupled to the aerial inductance, and so increase the amplitude of the incoming oscillations, (a diagram of this arrangement was given in the last issue), or the plate may be coupled direct to a secondary tuned-circuit. A second valve could then be connected in the circuit to act as a rectifier. A diagram of this arrangement is shown in Fig. 1.

Valve No. 1 simply serves to increase the amplitude of the received oscillations, which flow in the secondary tuned-circuit, and are rectified by the valve No. 2. That part of the characteristic curve on which the valves are working is shown in Fig. 2. The circuit could further be improved by the introduction of a potentiometer in the grid-circuit of the second valve, thus ensuring that the grid would work at the best potential for rectifying.

It is possible to use a number of valves "in cascade," as it is termed, each valve amplifying the oscillations of the one before it.

The plate-circuit of one valve is connected to the next grid by means of a transformer, which usually takes the form of an ebonite tube or rod, over which is wound the primary and secondary coil.

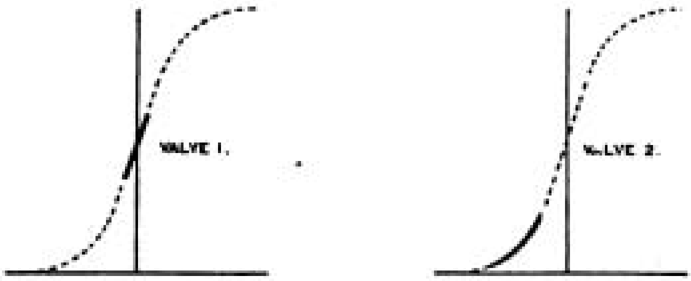


Fig. 2.

Fig. 3 illustrates such a circuit. The filament battery and telephone connections are the same as in Fig. 1, and are omitted for the sake of clearness.

In designing transformers for high-frequency work some trouble is usually experienced in the loss of efficiency due to self-capacity of the windings. Each turn of the coil behaves like a small condenser, adjacent wires forming the two conductors, and the insulation acting as the dielectric.

In order to make a high-frequency amplifier as efficient as possible on short-wavelengths, this self-capacity must be reduced to a minimum. The reason for this will be discussed more fully when we come to consider the effect of high-frequency amplifiers on short-wave circuits.

For the present it is sufficient to note that there is usually one particular wave-length at which the high-frequency amplifier will be operating at its best efficiency. For general purposes the reaction amplifying circuit (Fig. 5 in the preceding article) will be found to give good results over a wide range. For greater selectivity it is possible to couple two valves in cascade by means of a second tuned-circuit.

When long-distance stations are being received on small sets, the energy in the aerial circuit is so small that it is very often completely lost in the rectifier. In this case

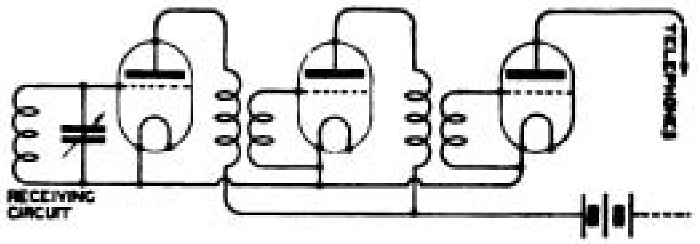


Fig. 3.

the addition of an amplifying valve would increase the range of reception of audible signals.

The CONSTRUCTION *of* AMATEUR WIRELESS APPARATUS

A FRAME AERIAL RECEIVING SET—IV.

The Amplifier (contd.)

When the clips are finished they should be mounted on the panel. It is intended that the valves be placed on the front of the panel and the resistance on the back. The anode resistances are mounted immediately behind the valves and the grid-leak resistances between the successive valves, but so arranged as to leave room for the intervalve condensers mounted on the anode and grid-clip fixing screws. Fig. 8 shows the relative positions of the various parts, the back of the panel being shown dotted, and from this figure, together with Fig. 7—the latter showing the drilling of the ebonite panel—the worker will be able to understand where the clips are to be placed. It should be noted that all clips, with the exception of those for the valve-filaments, have their bases turned inwards.

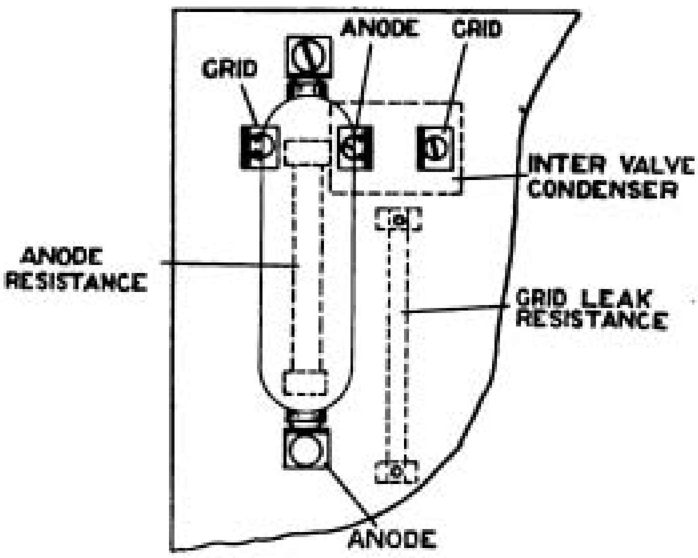


Fig. 8.

The clips on the front of the panel should be secured by means of 5BA cheese-headed brass screws about 1″ long, fastened by 5BA brass hexagon nuts, while those on the back should be held by 5BA counter-sunk brass screws about ¾″ long.

The three intervalve condensers should next be made. Each condenser is mounted in a small ebonite clamp. These latter, which should be made first, should be of $\frac{1}{16}$″ ebonite, cut to size 1¼″ × 1″, fitted with small fixing screws, one at each corner, as shown in Fig. 9. The two holes in the middle should be ⅛″ diameter and their centres exactly ¾″ apart.

These clamps are to be on the grid and anode clip screws, one clamp between the anode of the first valve, from the left, and the grid of the second valve, and so on. They should be tried in their positions to see that they clear the resistance lugs. These condensers should have a capacity of ·001 mfd. and should be made very small. The condenser plates should be of thin copper foil, cut to the shape and size, as shown at the top of Fig. 9. Each condenser will require 10 foils, and small sheets of mica ·001 to ·002 inch thick shou'd be made to size ⅝″ × ¾″.

The condensers are best moun ed in position on the valve screws in the following manner: After first placing the bottom of the clamp in its position, lay the first foil on one of the screws, followed by a mica separator, then a foil on the other screw, another mica, and so on. The mica separators need not have holes punched in them, as it is sufficient for them to cover the area between the two screws.

When the 10 foils are mounted, put the top clamp in position and screw tightly. The lugs of each half of the condenser should be soldered together and tests made to see that the condenser is not shorted. Finally, secure the condensers to the panel by means of nuts and washers.

The intervalve resistances are the next consideration. For the anode circuits three 50,000 ohm resistances will be required and three 2 megohms resistances for the grid-leaks. Much has been said about the utility of graphite lines on ebonite, but reliable resistance values cannot easily be obtained.

Those not familiar with actual valve work cannot estimate by the action of the receiver itself when the proper resistance values have been obtained and apparatus to measure the resistances is not always available.

In view of this we recommend that the required resistances be purchased from one of the firms advertising in this journal.

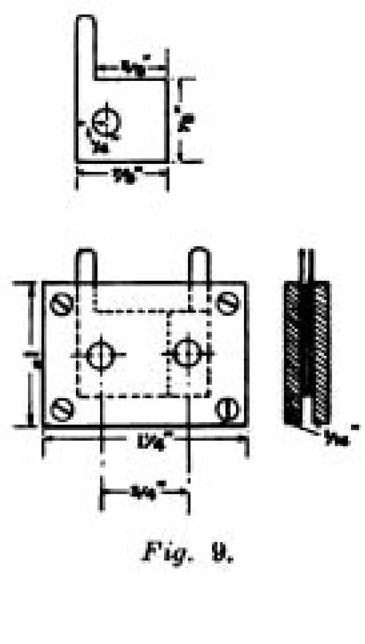


Fig. 9.

The resistances used in the preparation and testing of this amplifier were carbon rod resistances, fitted into small ebonite tubes and provided with terminals at each end, as shown in Fig. 10,* the distance between

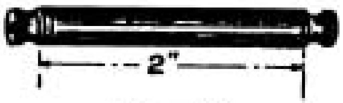


Fig. 10.

the terminal shoulders being 2". The position of the resistance clips has been made suitable for this type of resistance rod and if other types are used their position should be altered to suit.

The variable resistance for the filaments and the potentiometer are the next to receive attention. The filament resistance should have a maximum value of 2·5 ohms approximately, whilst the potentiometer should be about 200 ohms.

The filament resistance should be wound with No. 22 S.W.G. Eureka or Manganin wire, about 72" of which should be closely wound round a lead pencil, so that when the wire is removed from the pencil the turns will remain touching each other. If the wire is pulled out about 6" long it will form a helix, with the turns about $\frac{1}{16}$" apart.

* These are made by the Marconi Scientific Instrument Co.

Next, make a hard-wood block about $2\frac{3}{4}$" diameter, $\frac{3}{4}$" thick, and turn out a groove or ledge about $\frac{3}{8}$" deep. Drill a $\frac{1}{4}$" hole through the middle of the block. The extended helix should be mounted in the groove and the wire secured by means of two wood screws, one at each end of the wire. Mount the wood base to the back of the panel, in the position of the triangular three holes at the bottom left-hand of the panel. Make a contact arm of springy strip brass, suitably bent and shaped so that it makes contact on two turns at a time. Make also a $\frac{1}{4}$" brass spindle, threaded at both ends, the spindle being about $1\frac{3}{4}$" long. Screw one end of the latter into a small ebonite or hard-wood knob, passing the spindle through the ebonite top and wood base. The latter should have a brass washer fixed to its end, so that it will act as a rubbing surface for the spring washer on the spindle and also permit of connection to the rubbing arm.

A spring washer should be placed on the spindle, followed by an hexagonal nut, the contact arm and another hexagonal nut. When the tension is properly adjusted the nuts should be tightened and the contact arm firmly locked to the spindle.

In the next instalment we will describe the potentiometer, telephone transformer and also the wiring of the panel.

WIRELESS CLUB REPORTS.

With the ever-increasing number of Amateur Wireless Clubs sending their reports for publication, considerable pressure is being brought to bear upon our columns. Every endeavour is made to keep the date of publication as near to the dates of reports as possible, and to this end Hon. Secretaries would greatly assist by making their reports as brief as is compatible with a record of their Club's proceedings and sending each report as early as possible after the date of their meetings. Photographs of officers, members, or apparatus accompanying reports will, whenever space permits, also be published as early as possible.

BOOK REVIEWS

TELEPHONIC TRANSMISSION. THEORETICAL AND APPLIED.

By J. G. Hill,

London: Longmans, Green & Co., pp. 398, illustrated, (21s. net.)

THIS book is one of a series of Manuals of Telegraph and Telephone Engineering.

The field covered is obviously far too extensive to be dealt with in one volume or by one individual, since the expert knowledge of a specialist is required to deal with each of the branches of this series in its division. The volume *Telephonic Transmission* is written with the intention that it should completely cover the ground implied by its title.

The book probably covers the ground more fully than any other text-book yet published. Numerous other books have dealt with the subject, but nearly all of them in a general or more elementary manner, because they have not specialised and have tried to embrace too much in one volume.

The book under review will be found invaluable to any student of this subject, or of wireless telephony, for the one forms an essential introduction to the other.

The problems of wireless telephony transmission cannot be properly studied without a knowledge of the theory of line transmission as a foundation.

Many of the controlling factors in speech production are identical, whether wireless or wired systems are the mediums employed for transmission.

Many of the obstacles which crop up in the path of the wireless experimenter will disappear if he is in a position to tackle them armed with a good knowledge of line telephony, even though his knowledge be confined to theory.

If *Telephonic Transmission* is on the shelf of your bookcase you can dispense with other reference books on the subject, for the volume embraces its subject thoroughly.

GERMAN AND ENGLISH COMMERCIAL CORRESPONDENCE.

By N. Sadezky and William Chevob-Maurice, A.I.L.

London: Published by Marlborough & Co., 1s. 9d. net; cloth, 3s. net.

This book, which adds yet another volume to the Marlborough Series of English and Foreign Commercial Correspondence, is a practical and reliable guide to German Commercial Correspondence. It contains model phrases, letters, circulars and business documents; commercial terms and abbreviations; tables of money, weights and measures: all set out in German and English in parallel form, so that the correct translation can be seen at a glance. A perusal of the book shows that considerable care has been taken to lose nothing, by translation, of the style and phraseology generally employed in German business correspondence. With this end in view the authors have avoided the system, so often adopted by other handbooks, of always giving a literal translation at the expense of style. The little book is to be highly recommended, especially at the price.

SLIDE-RULES, AND HOW TO USE THEM.

By Thos. Jackson, M.I.Mech.E.

London: Chapman & Hall, Ltd., pp. 30, illustrated (1s. 6d. net).

One of the most striking developments in modern technical methods of calculation has been the increase in the use of the slide-rule. In the book under review the various makes of these instruments are fully described and their operation explained. When the general instructions given are properly understood, no difficulty whatever should arise in applying the slide-rule to the special calculations which occur in one's business or professional work. To the wireless amateur the slide-rule affords a speedy method of arriving at the result of the various calculations which come his way, and a careful study of this little book will give him the required skill.

QUESTIONS AND ANSWERS

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

NOVO (Tottenham) *asks* (1) *For criticism of a receiving circuit.* (2) *What modifications would be necessary to enable him to receive 6,000 ms.* (3) *Should he fit a jigger and a condenser across aerial and across the telephones.* (4) *Is an electrolytic detector any good.* (5) *What would be the capacity of the variable condenser shown in his diagram.*

(1) Set is practically useless as shown as nearly every piece of apparatus is wrongly connected. Connections should be as shown in Fig. 1.

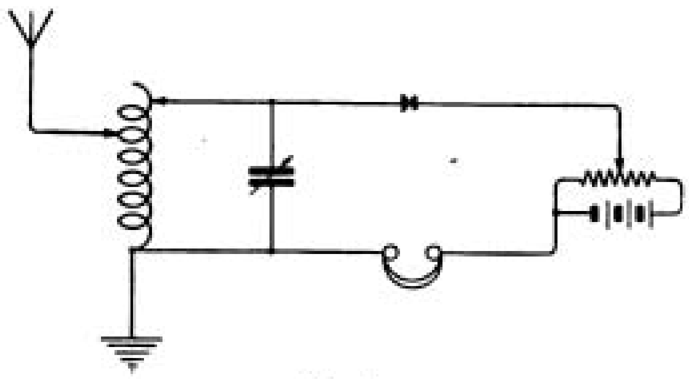


Fig. 1.

Your maximum wavelength with apparatus you specify would probably be about 800 ms. A potentiometer should be wound with finer wire than No. 22.

(2) A set of this type is not efficient with a small aerial at more than 4,000 ms. This could possibly be reached by making coil about 12" × 8" of No. 24 wire.

(3) Jigger is not necessary. Condenser in parallel with A.T.I. would be useful. Blocking condenser across telephones can be added if desired, but it is not important.

(4) Quite good in skilled hands but we do not recommend it to a beginner.

(5) We cannot say, as you do not state distance between neighbouring plates.

H.S.W. (Hastings) *asks* (1) *For a diagram of the simplest valve set with which he could receive FL easily.* (2) *For the name of a book which tells one how to make the apparatus for a valve set.* (3) *If he could improve a set sketched.* (4) *If a 40 ft. twin wire aerial suspended from two chimney stacks be suitable, and what would be the farthest station he could receive with it.*

(1) Fig. 2 shows as simple a circuit as is consistent with fairly good results.

(2) We do not know of any suitable book. Consult constructional articles in *The Wireless World.*

(3) We are afraid your apparatus is not of much use as shown. The connections are quite wrong and the inductance is too small. For suitable dimensions to receive FL see recent replies, or the constructional article in December last.

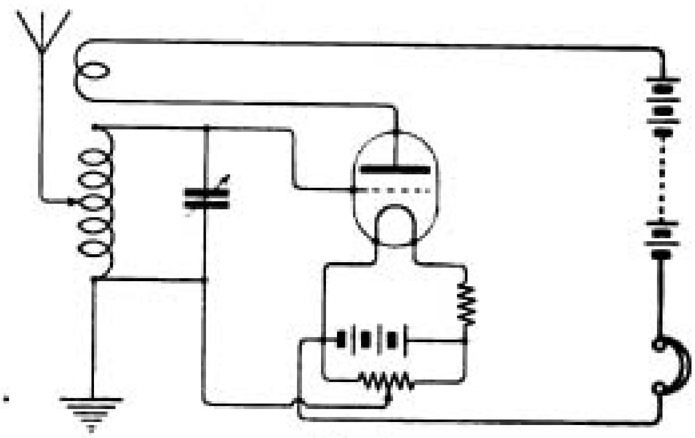


Fig. 2.

(4) Aerial should be fairly suitable. As often explained we cannot say what is the most distant station any set will receive.

BEGINNER (Dunstable) *asks* (1) *What are the necessary instruments for a receiver and a transmitter.* (2) *What symbols are given to each instrument or part of an instrument.*

(1) This depends on the type chosen. For receiving the only things absolutely necessary are an aerial, a tuning inductance, a detector (preferably a crystal) and telephones. For information on transmitters consult a book such as Bangay's Elementary Principles.

(2) The most common are shown in Fig. 3.

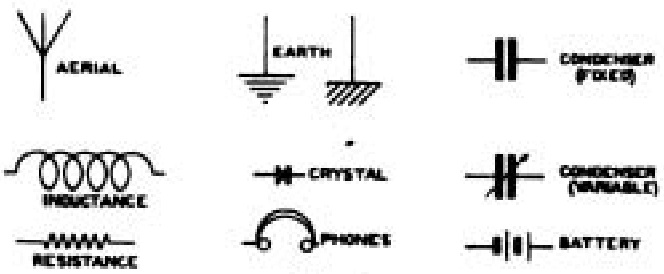


Fig. 3.

T.H.W. (Norwood) *is using the "Crystal receiver with valve transformer" described in the*

April 17th issue and wishes to add another valve. He asks (1) *For a diagram of this circuit plus one valve and an intervalve transformer for further amplification.* (2) *If this set will receive signals with a frame aerial as well with two valves, as with P.M.G. aerial and one valve.*

(1) Circuit is not a very convenient one for adaptation in this way, but Fig. 4 should be fairly suitable.

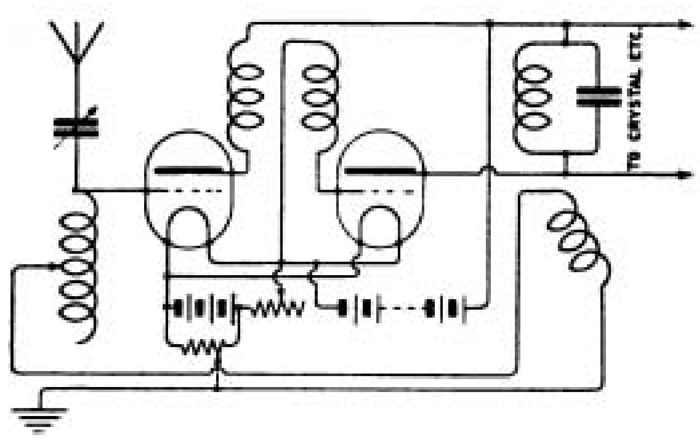


Fig. 4.

(2) No, the results with a frame aerial are hardly likely to be as good as with a P.M.G. aerial, and one valve less.

N.B.—Inter-valve transformer in this case is iron-less, for H.F. amplification. Results with L.F. amplification by extra valve would be very poor with a frame aerial.

MULTILAYER (Parkstone) *refers to the article on "Multilayer Coils," in the October 2nd issue. He asks* (1) *Why he can receive Lyons, using a coil 11" long and 5" in diameter, wound with No. 30 wire, whereas the article refers to a coil 8' in length.* (2) *Using a receiver consisting of a standard P.O. aerial, directly coupled to a high-frequency valve amplifier with a crystal detector, the coil referred to in (1) being used as primary, and a coil 7" long by 4½" in diameter, wound with No. 28 wire in series as a loading coil, he asks for any suggested improvements.* (3) *Is it likely this receiver will pick up* **NSS** *time signals?* (4) *Would an extra 6" on the primary enable* **NSS** *to be tuned?*

(1) The difference in the dimensions arises from two causes—(*a*) you are using a finer wire and, therefore, a larger number of turns per inch length of coil, and (*b*) you have a condenser in parallel with the winding, whereas in the article the inductance stated was required to tune up a standard aerial directly, without any parallel condenser. From the dimensions quoted, assuming an average thickness for the glass (as this dimension is not stated), the maximum capacity of your tuning condenser would be about 0·0024 mfd. this, with your coil, which should have an inductance of about 30,000 microhenries, would enable you to tune up to over 15,000 metres. This explains the reception of **YN.**

(2) Connect your condenser C_1 across both the primary and the aerial tuning inductance. This will increase your tuning range. It is best to keep C_1 as small as possible and the inductance large to obtain loud signals.

(3) Yes.

(4) Increase length by at least 6", or more if possible.

W.M.B. (Ancona) *asks* (1) *Why it is that when in the Mediterranean he could hear* FFU (*Ouessant*), *quite strong while* BYW (*Gibraltar*), *who was much nearer and no doubt using higher power, was only fair.* (2) *If it is safe to use, when not possessing a special unit for valve work, the standard shipboard accumulator battery, giving 24 volts, with a valve rated at such a voltage.* (3) *If, when employing the above battery the life of the valve would not be much shortened.*

(1) It is difficult to say; so many factors being uncertain. Freaks of this kind often happen, and moreover, BYW may not have been using full power while probably FFU was on high power.

(2) and (3) If a valve is rated at 24 volts H.T., it will work off any battery delivering that voltage with equal safety and efficiency. (We presume you have no intention of lighting the filament with all the above battery, otherwise the life of the valve would be very considerably shortened.)

C.U.L. (S. Croydon) *gives a specification of a receiving circuit with a reaction-coil coupled to the aerial circuit and asks* (1) *For details as to winding the reaction-coil.* (2) *If a grid-condenser of* ·0003 *mfds. is good.* (3) *If leak for such a condenser is necessary, if so, what value should it have.* (4) *Should the reaction-coil above-mentioned be variably coupled to the tuning inductance.*

(1) and (4) This depends on so many factors that we cannot answer with certainty. We recommend you to try a coil about 6" × 3" wound with No. 30 S.W.G., with a blocking condenser of ·0003 mfds. across your telephones and H.T. The latter is absolutely necessary, as otherwise you may get no oscillations, or what is worse, very strong ones. The coupling between the two coils must be variable.

(2) and (3) ·0003 mfds. and 3 megohms have been recommended by a well-known experimenter, though a smaller value of capacity is generally preferable. The leak is necessary to prevent the grid acquiring too large a negative charge.

BORG (Newcastle) *asks* (1) *If an* A.T.I. *wound with No.* 22 S.W.G. *on a former* 6" × 6" × 4" *in four layers with suitable tappings would be all right for a single-valve receiving set, not using a coupled tuner, and what wavelength it should reach.* (2) *Will a pair of* 1,000 *ohms. telephones be any good with a valve-set, using a telephone transformer.* (3) *What resistance is needed for a grid-leak.* (4) *What is the capacity of a tubular condenser, the outside tube being 4" long by 1½" diameter and the dielectric being 1/16" ebonite.*

(1) This coil will be unsatisfactory if layer wound. If, however, it is pile-wound it should give good results.

(2) 1,000 ohm telephones could be used, but a higher resistance would be preferable.

(3) From 1 to 5 megohms, according to circumstances.

(4) ·00016 mfds.

T.S. (Seaham Harbour) *encloses diagram and particulars of a crystal receiving set which he proposes to make, employing certain coils of specified dimensions. He asks* (1) *If the primary and secondary windings are correct.* (2) *What size of variable condenser would be suitable for open and closed circuits respectively.* (3) *What stations would he be able to pick up on a standard aerial 35 ft. high.* (4) *Where he can obtain "The Wireless World" from April 3rd last to September 11th inclusive.*

(1) You do not state the wavelength you wish to receive, so it is impossible to advise you. The inductance of your primary coil is 6,800 mhys. and of your secondary 51,000 mhys. The latter would seem to be very high relative to primary.

(2) Open ·0003 mfds., closed ·01 mfds.

(3) Your wave-range is only up to about 2,300 ms. though your secondary circuit tunes to 7,800 ms. Further considerations depend on the construction of the set and the skill of the operator.

(4) The Wireless Press, Ltd., 12-13, Henrietta Street, W.C.2. Price 6d. each, postage 1s. 6d.

H.G.BK. (Brighton) *refers to the set described in the issue of September 18th, 1920, pages 444 and 445, and asks how the distance between the coils alters the tuning. He suggests that it would merely alter the coupling between the two coils.*

We quite appreciate your difficulty as no diagram of the circuit is given in the article. There is, however, a well-known method of altering the tuning of a circuit by means of a pair of coils, viz., a variometer. If the two coils in question are connected in series or parallel, the inductance of the combination varies with the coupling between the coils. It is fairly clear that a variometer arrangement of some kind is used in the above set.

L.W.B. (Romford) *asks* (1) *If we could suggest any reason for the fact that he fails to get any signals. He believes it to be due to the fact that his aerial* (P.M.G.) *is screened by trees.* (2) *For dimensions of a loading-coil to increase wavelength of his Mark 3 tuner.* (3) *If he should get ships with this instrument.*

(1) We do not think the trees screening your aerial should entirely prevent your getting signals. In any case failing the obvious remedies of either (*a*) cutting the trees down or (*b*) putting the aerial somewhere else, we are afraid that the only thing you could do would be to install valve-amplifiers (H.F.) to make up for diminution of signal strength by the trees.

(2) You will not be able to get increased wavelengths on a Mark 3 tuner by the use of a loading coil only. See several recent replies on this point. 6,000 metres is too high for a set of this type. For dimensions of a more suitable coil see replies referred to.

(3) Yes.

H.T.L. (Beckenham) *encloses specification of crystal receiver and asks* (1) *What will be its range of wavelengths.* (2) *For information regarding* KAV's *programme.* (3) *If we advise any particular crystal for speech frequencies.* (4) *If he should hear* EGC, *using above receiving set with 100 ft. aerial 25 ft. high, and if so, what are his times.*

(1) Up to about 3,200 metres Lower limit uncertain. We have assumed ordinary P.M.G. aerial.

(2) See *The Wireless World* of May 1st last.

(3) No; there is no essential difference between spark and speech reception.

(4) We think it very unlikely with your aerial; anyhow EGC works at most hours of the day and night.

W.H.G. (Par) *says* (1) *He encloses diagram of a circuit using* V24 *valves. Would we suggest the necessary modifications for substituting a* Q *valve for one of the* V24's. (2) *He has tried the wiring shown on page 290 of the July 10th issue, but without success. The circuit submitted works best on 600 to 2,000 ms. What modifications do we suggest for longer wavelengths.* (3) *He requires a criticism of circuit.*

(1) The circuit shows grid-condenser, tuned H.F. amplification, followed by resistance amplification. H.T. battery 50 volts. A Q valve could be used for first valve by considerably increasing its H.T. Failing the latter, do away with grid-condenser in first valve Q and apply a suitable potential between grid and filament by means of a potentiometer.

(2) The circuit referred to should be quite satisfactory if only V24 valves are used. Our statement that one Q valve might probably be used for rectification was not strictly accurate as results would be poor with only 30 volts on the H.T. To increase wavelength, increase the dimensions of all your coils—circuit otherwise unaltered.

(3) Circuit is somewhat clumsy, as it involves 2 H.T., and 2 L.T. batteries, one of the latter being at a high potential above earth. Moreover, the practice of not earthing the filament, as in your first valve, though giving strong signals at times, is conducive to "flukey" signals, and not to be recommended. We would certainly advise you to earth this filament.

F.B.T. (Mapperley).—See advertisement pages of this magazine.

E.F.B. (Chelsea).—Any of the schools advertising in this magazine will be able to help you.

A.R. (Lancashire).—Midland Railway; Great Eastern Railway; S.E. & C. Railway; Lanc. & Yorkshire Railway; Lindsay, Swan and Hunter, Ltd.; Messrs. F. R. Lucas, London; Eastern Telegraph Company; L.B. & S.C. Railway; Western Telegraph Co.; General Steam Navigation Co.; Federal Steam Navigation Co.

J.F.K. (Galway) *asks how to adapt a Type 31 receiver for use with valves, one for H.F. and the other for L.F. amplification after the crystal.* (2) *What type of valve do we recommend.* (3) *If a 24-volt battery will be suitable.* (4) *What would be the cost of a two-valve amplifier, and what would be its advantages.*

(1) The questions of H.F. and L.F. amplification adaptations of the Type 31 have been dealt with quite recently.

(2) V24's should be quite suitable.

(3) Yes.

(4) Cost depends on the type chosen, consult various advertisers in this magazine. A complete amplifier unit might be handier to use than the arrangement you propose to make, but the results obtained would otherwise be very suitable.

R.A.L. (Glasgow) *encloses specification of his receiving set and asks whether it will be efficient for wave-lengths approximately between 600 and 3,000 ms.* (2) *What are the capacities of two semi-circular condensers of certain dimensions—(a) and (b).* (3) *Would condenser (b) above be suitable for a blocking condenser in his set, or should he make one with 12 quarter plates and tinfoil.*

(1) Your circuit is incomplete in that we cannot make out your aerial and earth connections. The closed-circuit itself, tunes to 1,400 metres; if the aerial and earth leads are connected direct to it, it will attain about 1,800 ms., but in this case would probably not tune as short as 600 ms. We cannot judge of the general efficiency of the circuit until we have further particulars. See also remarks in (2) below, as capacity of (a) comes in to this question.

(2) (a) ·00047 mfds., (b) ·00053 mfds. You state in your specifications that the air spaces between vanes are 1/16″ and 1/32″. We have taken this to be the air space between a fixed plate, though your drawing implies that it is the distance between two fixed plates and a moving plate. If the latter is the case we shall require to know the thickness of the vanes, as the capacities would be more than doubled. Further, you do not state whether the dimensions given of the moving vanes of (b), given as 2 5/32″, are radii or diameters. We have assumed that this is a misprint for 3 5/32″, as otherwise the plates would not overlap.

(3) Taking the dimensions of a quarter-plate as 7¼″ × 4¼″ × 1/16″, 12 plates (*i.e.*, 13 sheets of tinfoil), should give you a condenser of the right value. We do not recommend you to use the condenser (b) which is too small. We would point out that the capacity of the glass-plate condenser is critically affected by the thickness of the plates, which you do not specify.

C.W.P. (Southampton) *sends diagram and description of his crystal receiver and asks for criticism and suggestions for improvement.*

It is a two-circuit receiver. The aerial inductances should be wound with coarser wire than No. 26 and 28, say No. 22 or 24. With windings as you suggest, your maximum wavelength will be about 1,200 ms. We cannot say anything about the capacity of the condensers without knowing the thickness of the dielectric and its nature. You had better compare your condensers with others, of which we have given capacities recently. You show telephones and crystal in parallel, and blocking condenser in series with the pair. This is quite wrong, as we have pointed out in almost every issue. For proper connections see any crystal circuit diagram.

A.E.S. (Lee) *encloses specification of his crystal receiving set and asks* (1) *For faults and remedies.* (2) *For inductance values of* A.T.I. *and loose-coupler, primary and secondary.* (3) *For maximum wavelength.* (4) *If condenser of ·0005 mfds. in the aerial-circuit would enable the number of tappings of coupler primary to be reduced, if so to what extent.*

(1) Circuit is diagrammatically correct, but a condenser of ·0003 mfds. maximum capacity is ample for the secondary. Further, your blocking condenser is too small for best results, it should be ·003 mfds.

(2) A.T.I. is 14,500 mhys. L.C.P. is 6,970 mhys. L.C.S. is 20,300 mhys.

(3) About 4,000 metres.

(4) No, too small. Better to use a series condenser of ·01 mfds. in the aerial circuit. This will enable you to dispense with the tappings for L.C. primary, altogether, provided you have other means for varying the coupling between the primary and secondary.

R.H.T. (Spalding) *asks* (1) *For an adaptation of a crystal receiver circuit with valve-magnifier, for use with two valves.* (2) *With reference to a German transformer which he has recently acquired, what do we think it is for. He states that the apparatus is similar in design to an intervalve transformer of a L.F. amplifier, but that the primary is wound with about No. 14 or 16 S.W.G. cotton-covered wire and the secondary with about No. 38 S.W.G. silk-covered wire.*

(1) See reply to **E.J. (Sutton)** in issue of October 30th.

(2) Possibly a transformer for lighting filaments from A.C. for transmission work.

F.E.C. (Eton College) *encloses specification of a crystal receiver and asks* (1) *If his diagram of connections is right, and if not, why not.* (2) *If he will be able to tune to 4,000 ms.* (3) *If a 20 ft earth-lead is too long.*

(1) Your diagram is all right, though we prefer the arrangement in which one end of the closed circuit is earthed. The wire used (No. 28) is rather fine for good reception, and your blocking condenser is too small; it should be ·003 mfds.

(2) Yes.

(3) No.

R.S. (Bexhill) *says* (1) *His present aerial is 70 ft. long of No. 14 copper twin-wire separated by 3 ft. spreaders, and is 30 ft. high; would a single 100 ft. span of 7/22 wire be better.* (2) *Would there be any advantage in joining up the twin-wire aerial at the far end.* (3) *He has a pair of 4,000 ohm Brown telephones;—is it advisable to allow the reed to drop against the magnet to act as a keeper.* (4) *Is 4,000 ohms a suitable resistance for use with a crystal receiver.*

(1) If your spreaders are only 3 ft. long you will probably get better results with a full length single wire.

(2) No: probably a slight disadvantage.

(3) This is unnecessary and is not usually done, but it can do no harm.

(4) Yes.

G.W. (Preston).—(1) Try the Radio Communication Co., Ltd., Norfolk Street, London, W.C.2

(2) You do not say how high your aerial is to be. If it is below the level of the houses, screening will probably be too bad for useful results. If, however, it is several feet above the tops of the roofs it will probably be O.K.

G.R.E.C. (Felsted) *encloses a diagram of a circuit and asks* (1) *For criticism of the circuit.* (2) *If a transformer is necessary for amplification.* (3) *What is the correct value for grid-leak.*

(1) Your arrangement of a crystal in the grid-circuit is useless. If you connect direct to the

grid you will probably get good rectification for 50 volts H.T.

(2) No; not for single stage amplification.

(3) It depends upon the value of the grid-condenser. ·0003 mfds. and 3 megohms have been recommended, but other widely differing combinations are also suitable. Your Q valve should rectify and amplify with a grid-condenser and leak at 230 volts H.T.

BIGLI (St. Austell) *asks* (1) *If he can use a coupler consisting of a spherical coil inside a cylindrical one as reactance, in a valve circuit of which he gives a diagram.* (2) *If a grid-condenser and leak is necessary in the above circuit.*

(1) Reaction-coil will probably be all right, though your information is insufficient.

(2) Not necessarily; it depends on the valve used and the point on the characteristic at which it functions. The best results can be obtained by using a grid-condenser and leak.

J.L. (Harrowgate) *wishes to make a coupling-coil and secondary unit as described in "The Wireless World" for April 17th, but wants it to receive up to 7,000 metres. He asks* (1) *For details of formers and amount of wire required.* (2) *For capacity of variable condensers required.*

(1) The following formers should be satisfactory A.T.I. 18″ × 10″ wound with No. 24. Closed-circuit coil 9″ × 6″, No. 28, say six tappings increasing in size from beginning up to the end. Coupling-coil 5″ × 4″ of No. 24, say three equally spaced tappings. Wire required, about 2¼ lbs. of No. 24 and about ¾ lb. of No. 28.

(2) Condensers should be as in original circuit.

E.S. (East Kirby) *asks what are the capacities of three condensers* (a), (b), *and* (c), *specifications of which are given.*

(a) ·00014 mfds. (b) ·0011 mfds. (c) ·003 mfds.

A.G.E. (Coventry) *asks* (1) *If a tuning-coil of 6″ diameter wound with 80 turns of No. 18 wire would give good results.* (2) *Would an iron-pipe 25 ft. high make a suitable earth.* (3) *Up to what distance would he be able to receive.*

This coil would be of too low inductance; to give you satisfactory results use a coil about 8″ long and 6″ diameter wound with about No. 24.

(2) Yes, fairly, if it is a water-pipe and goes to earth without any joints packed with, more or less, insulating material.

(3) We are afraid this is impossible to say.

I.L.D.H. (Hove) *sends diagrams of two receiving sets and asks* (1) *For criticism of both, and which is the better.* (2) *Will they tune wavelengths between 600 and 4,000 ms. or more.* (3) *Are the condenser capacities correct.* (4) *What ought to be the resistance of H.R.,* R_1, R_2, *and should telephones be 4,000 or 8000 ohms.* (5) *For a suggestion for an indoor aerial to pick up 600 to 4,000 ms. or more.*

(1) These sets are a variation of the audion type, which would probably work fairly well, but be less simple and convenient in operation than the more usual types. Set (1) should be fairly satisfactory as it stands. Set (2) will work only if the grid-condenser is arranged as in set (1). Set (1) will probably be somewhat insensitive.

(2) With suitable loading coils, yes.

(3) Yes, except that grid-condensers might profitably be somewhat smaller.

(4) H.R. (grid-leak), 3 megohms. R_1 (grid-leak), 3 megohms. R_2 (filament-resistance), 3 ohms.; telephones preferably 8,000 ohms.

(5) 6 ft. frame with 70 turns, spaced ¼″. A much smaller frame could be used if you use a loading coil.

Four questions, please.

L.H.L. (Smethwick) *wishes to increase wavelength of a Mark 3 tuner up to about 5,000 metres, and asks* (1) *If he could do this by adding an A.T.I. 8″ × 5″ wound with No. 22 wire.* (2) *Whether a sketched valve-circuit could be used.* (3) *If a twin-aerial 27 ft high and 30 ft. long, wires separated 2 ft., should give ships and telephony with a Mark 3 tuner.*

(1) This size A.T.I. would tune aerial-circuit to about 2,000 ms., but your tuned-circuit would also have to be altered before you could get stations on this wavelength. See various replies in the last two or three months. 5,000 ms. is rather too high for a set of this type.

(2) Circuit is inefficient, as it uses 2 L.T. and 2 H.T. batteries. It would not give very good results. See various valve-circuits given recently.

(3) Aerial is very poor—much too short—and two wires only 2 ft. apart are little better than a single wire. We doubt if you would get ships, and most telephony concerts are on a wavelength considerably above your present maximum.

H.E.R. (London, N.W.) *finds that he can adjust for most sensitive reception point on a single valve C.W. receiver, either on filament brightness or on reaction coupling. He prefers the former on the ground that this leads to economy in gear and convenience in arranging, the result being similar in either case, he asks for an opinion on the relative advantages of these methods.*

Within limits either method is quite good. As you say, the filament brightness method is simpler and in some ways handier, but it is not so flexible as the reaction coupling method. The latter is more useful, and gives better adjustment, under wider variations of receiving conditions. Unless the batteries are quite reliable, filament control is somewhat liable to give unsteady operation with variations in the battery voltage.

Dr. E. J. P. Stuer, 28, Rue Jourdan, Port Louise, Brussels, is unable to obtain No. 46 S.W.G. copper wire and No. 47 Eureka resistance wire. He would be glad to hear where these may be obtained.

SHARE MARKET REPORT.

The market is looking distinctly better. Prices as we go to press (December 3rd) are :—

Marconi Ordinary	£2 - 13 - 9
,, Preference	£2 - 12 - 6
,, Inter. Marine	£1 - 16 - 8
,, Canadian	7 - 9

The WIRELESS WORLD

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(See page 24 for details.)

THE WIRELESS WORLD

THE OFFICIAL ORGAN OF THE WIRELESS SOCIETY OF LONDON

VOL. VIII. No. 20. DECEMBER 25TH, 1920 FORTNIGHTLY

HIGH-FREQUENCY CURRENTS—
THEIR DETECTION AND MEASUREMENTS

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

THE study and the practical application of high-frequency currents both introduce difficulties and problems not encountered in experiments using only direct current sources. In general laboratory work the standard instrument for all bridge measurements and other similar tests, involving either the detection or quantitative measurements of very small currents, is the "moving-coil" galvanometer in one of its many varieties, or, in special cases, a modernised development of the earlier patterns of "moving-needle" instruments. Although considering the difficulties truly remarkable results have already been achieved, it cannot be said that the instruments for effecting the corresponding measurements of alternating currents have been developed to the same extent as the ubiquitous mirror galvanometer. The lack of appropriate measuring instruments has undoubtedly retarded the progress of some researches in connection with radio apparatus, so that it may be of interest to discuss briefly the most important methods of measurement that have been devised in this connection.

The ordinary type of galvanometric instrument cannot be used for work on low-frequency alternating current circuits, much less in high-frequency ones, owing to the complete inability of the mechanical system to follow changes of force occurring with such extreme rapidity. It is possible to design instruments—vibration galvanometers they are usually termed—which are capable of responding to regular changes of current having a frequency of a few hundreds per second, but beyond this value the difficulties seem insuperable for this type of construction. With such instruments the indicating means, which is generally a spot of light reflected from a small mirror, vibrates in synchronism with the current variations, so that the instrumental readings must be gauged, not by a steady deflection from the zero position, but by the amplitude of the vibration on either side of zero. These instruments require to be mechanically tuned to the frequency of the alternating current, and this generally precludes their use with accuracy in circuits in which the currents are much divergent from the uniform sinoidal form.

The chief reason for the sensitiveness of d.c. instruments, as compared with a.c. ones, is to be found in the fact that usually their indications result from a force arising from the *product* of the current to be measured and some other constant factor (such as the magnetic field of the magnet in a moving-coil instrument), which may be made large.

Since with alternating currents it is necessary to measure the *square* of the currents, in order to obtain a steady deflection (since the squares of negative currents are positive quantities like those of currents in the positive direction), this mode of procedure cannot usually be adopted.* The result is an instrument whose indications are proportional to the *squares of the currents* passing through it, which means that *small* currents give rise to still smaller indications—the square of a small quantity being less than that quantity.

Speaking generally, there are three main effects depending upon the second power of the intensity of the current which may be employed in building measuring instruments. These are :—

(1) Thermal effects, since the heat liberated by a current I flowing through R ohms. is proportional to I^2R ;

(2) Electrostatic effects, since the force between two conductors between which there is a potential difference of V volts is proportional to V^2 ; and

(3) Magnetic effects arising from the interaction of two magnetic fields both of which are set up by the current to be measured.

This last class includes the electrodynamometer type of instrument, in which the force producing the indication arises from the interaction of the fields of two coils, both of which carry the current to be measured; and also the "moving-iron" type of instrument, in which one magnetic field is that due to a coil through which the current circulates, while the other is an induced magnetic field in an iron needle or plunger under the influence of the field due to the coil. In some varieties of these instruments both fields are induced in iron parts under the influence of the main coil.

For high-frequency work practically only thermal and electrostatic instruments are employed, the latter being customarily arranged as voltmeters and the former as ammeters. Provided proper precautions are taken in their construction these instruments may be used for the measurement of large currents and high voltages, but greater difficulty is experienced in adapting them for low ranges. For the accurate measurement of large H.F. currents the actual ammeter should either be coupled inductively to the main circuit, or, if shunted, it should be so arranged that the proportion between instrument current and shunt current remains constant at different frequencies. If the shunt and the instrument wires are made of the same form and material, and are arranged symmetrically with respect to the terminals and connecting leads, this condition will be satisfied, as has been pointed out by Dr. J. A. Fleming. This last form of instrument is most conveniently adapted for giving indications, not directly by reason of the expansion of the wires, but by means of a thermo-junction (connected to an indicating galvanometer) mounted upon one of the wires so as to indicate its rise of temperature when the current is flowing

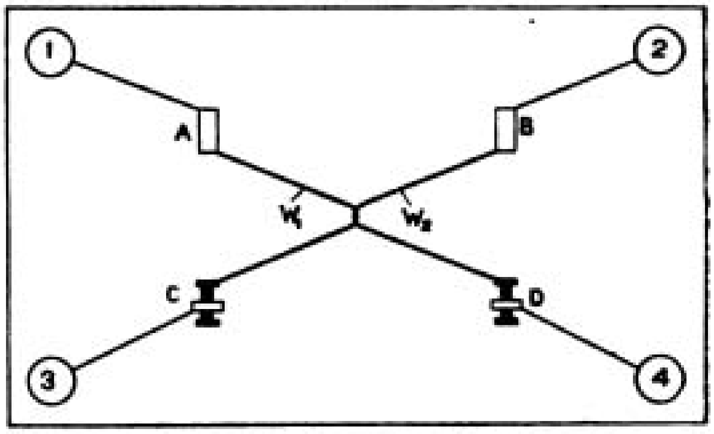


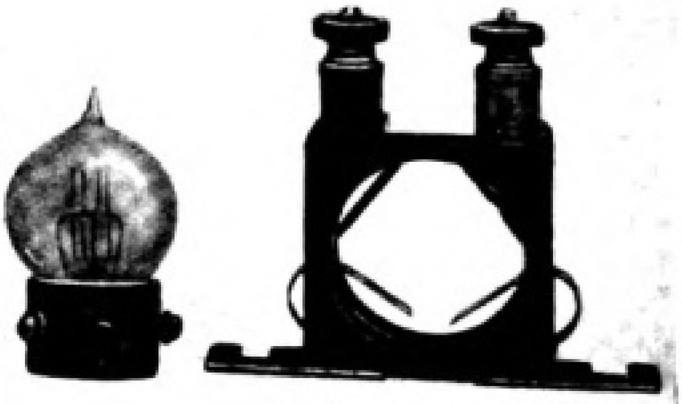
Fig. 1.

This same principle may be applied to instruments for measuring H.F. currents of the order of a fraction of an ampere, using a single fine heater wire with a thermo-junction attached to it. For simplicity in construction only two wires may be employed, forming what is often called a "thermo-cross," Fig. 1. In this diagram A and B are two rigid metal supports connected to the terminals 1 and 2 ; C and D are brass springs fitted with tension adjusting screws as indicated. These are joined to terminals 3 and 4 respectively. Two fine wires W_1 and W_2 are each soldered to a support and to a spring, so as to loop round one another in the centre as indicated. These wires are made of materials having the greatest difference in thermo-electric power, so that a given rise of temperature produced by the passage of

* It may be of interest to note here that a very similar principle is made use of in heterodyne receivers—a fact which indicates at least a partial reason for the great sensitiveness of such apparatus.

the high-frequency current through the wires will yield the largest possible indication on the galvanometer to which the thermo-junction is connected. Instruments of this type cannot easily be calibrated with direct currents, but must be compared with a standard instrument using alternating current. Apart, however, from this disadvantage, this type of instrument (Fig. 2) has the advantage of being easily constructed, and being very readily suitable for a current *indicator*—as, for example, to indicate resonance in a wavemeter circuit.

The sensitiveness of these thermo-ammeters may be increased by enclosing the heater wires in an exhausted glass bulb. Fig. 3 illustrates one of this type, as manufactured by the Cambridge and Paul Instrument Co. A holder for the bulb is also shown in the photograph.



(Photo—Cambridge and Paul Instrument Co.

Fig. 3. Vacuum and Thermo-Ammeter with holder.

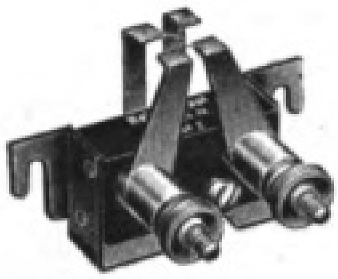


Fig. 2. Cambridge and Paul Thermo-Ammeter Attachment.

An enormous advance in the measurement of small H.F. currents was made by the invention of the thermo-galvanometer by W. Duddell. In this instrument the current to be measured is passed through a fine heater wire near which is suspended a small thermo-junction, forming part of a moving coil galvanometer. The general arrangement of the instrument has already been described and illustrated in these columns.* Although by the use of very fine wire heaters these instruments can be made very sensitive, they do not approach the sensitiveness of some direct current instruments, since the energy expenditure in the high resistance heater wire is relatively large. In the measurement of small currents, too, the presence of the high resistance instrument in the oscillating circuit is generally very detrimental to the tuning qualities of that circuit.

The measurement of small H.F. currents is of importance, not only for laboratory research work, but has a valuable practical application in the measurement of received signal strength over long distances, the accurate investigation of this quantity being of great importance in the design of high-power stations for working over long ranges. In connection with this problem, however, there are other methods available. For instance, any well-known form of rectifying detector may be employed in conjunction with a sensitive direct current galvanometer for measuring any H.F. currents that are ordinarily perceptible to that detector. If the intensity of the H.F. currents does not vary rapidly, any sensitive form of moving coil galvanometer may be used as the indicator in such an arrangement, but for measuring the strength of received signals cut up into Morse characters, a much more rapidly acting galvanometer must be employed. An Einthoven galvanometer, which consists of a single very fine conducting thread (through which the current to be measured is passed)

**The Wireless World*, 8, pp. 181–183, June 12th, 1920.

stretched in a powerful magnetic field, is very frequently used in such cases.

For still greater sensitivity a two or three electrode valve arranged for rectification may be used to replace the crystal rectifier, but with these it is essential to provide a means for balancing out the normal flow of valve-plate current through the galvanometer—such as by an appropriate potentiometer—so that the galvanometer may normally indicate zero, and only give a reading when a high-frequency P.D. is impressed upon the detecting valve. As a further step in sensitivity, one or more stages of amplification may be used before the rectifying valve.

The greatest difficulty experienced with all these arrangements lies in their accurate calibration, so that their readings may be truly quantitative. For the more sensitive ones, it becomes essential to employ some indirect means, such as by coupling them to a circuit in which larger currents may flow through a less sensitive standardised instrument. The ratio of the currents in the two circuits must then be determined by an independent experiment.

Amongst the class of instruments suited for measuring H.F. currents of the order of milliamperes must be mentioned the Bolometer, which, if suitably arranged, provides a reasonably sensitive current-measuring instrument suitable for radio frequency bridge measurements, resonance curve plotting and the like, while, at the same time, it is comparatively easily constructed. The principle of the Bolometer bridge is shown in Fig. 4. It consists essentially of a Wheatstone bridge arrangement fed from a battery B_1 of a few volts, and provided with a sensitive galvanometer G to indicate balance. Two of the bridge arms are made up of the loops of fine wire A B C D, and A′ B′ C′ D′ arranged as shown, with the bridge wires connected to opposite corners. The length and resistance of each of these wires A, B, C, D, etc., are made equal, so that in effect each of these closed loops is a little balanced wheatstone bridge. The remaining arms of the main

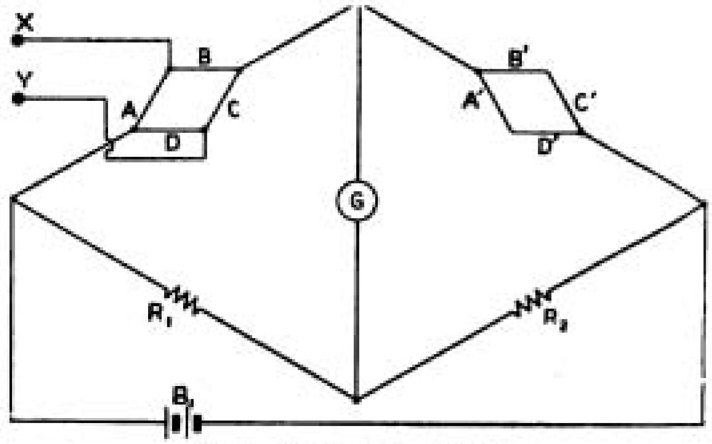


Fig. 4. Bolometer Bridge.

bridge are made up of the balancing resistances R_1 R_2, by means of which the bridge can be balanced and the normal galvanometer deflection brought to zero.

Suppose now that the terminals marked X and Y are connected up to a source of high-frequency current. This current will flow through the four wires A B C D, and since this loop is balanced no H.F. current will flow through the remainder of the main bridge. This high-frequency current will, however, warm up the fine wires and so increase their resistance, throwing the bridge out of balance and giving an indication on the galvanometer G

In place of the closed loop arrangement of the two bridge arms, a similar separation of the D.C. and H.F. currents can be effected by inserting low resistance choking coils in series with the main bridge arms, thus confining the high-frequency current to them, while not impeding the flow of the steady bridge current. Short single lengths of fine wire, either exposed to the air or enclosed in a bulb in the form of small lamps, may then be used to form the bridge.

An entirely different class of instrument—the cathode ray oscillograph, by means of which the wave forms of high or low-frequency currents or voltages may be delineated—may also be employed to obtain the effective values of these currents or voltages, but it does not lend itself to giving direct readings as do those described above.

2 PF.
AN AMATEUR WIRELESS STATION

By F. Foulger.

THE receiving station described herein consists of two distinct units, one whose range is from 200 to 900 metres, and the other whose range is from 600 to 30,000 metres. The long-range set will be dealt with first, every portion of which is home-made.

The set is composed of two loose-couplers connected in series, and an aerial loading coil, a short circuit stud being provided to each switch, so that any portion of the inductance can be shorted. Fig. 1 shows the main tuning unit of the long-range set. The primary is wound with 2 lbs. of No. 24 enamelled wire on a tube 6″ in diameter and 14″ long : the secondary is wound with ¼ lb. of No. 32 enamelled wire brought out to 10 studs.

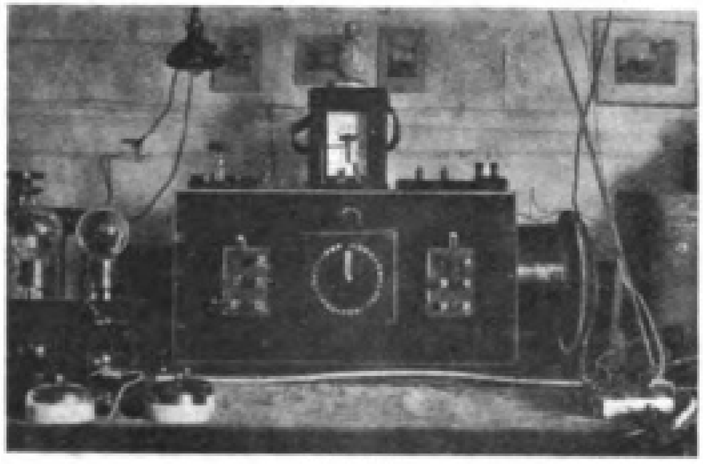


Fig. 1.

It will be seen that two D.P. throw-over switches are mounted on the tuner ; these are switches C and D in the diagram of connections, Fig. 2, and perform the following functions : C puts the detector circuit across either the primary or the secondary of the tuner, while D puts a 3-valve amplifier in the place of the telephones in the detector circuit for simple audio-magnification, or across the secondary when it is required to use No. 1 valve as a rectifier. This unit will just reach 5,000 metres.

The second unit of the long-range set is seen in Fig. 3, the A.T.I. being made to slide inside the C.C.I. The aerial tuning inductance is wound with 1 lb. of No. 26 enamelled wire, while the secondary is wound with ¾ lb. of No. 32. The loading-coil is seen in Fig. 4, and is wound with 1 lb of No. 26. When the three units are in series it is possible to reach the 15,000-metre stations with a 70′ double-wire aerial 25′ above the ground, without using any additional capacity. The set is used with perikon or carborundum detectors, and it is quite possible to tune to ships by shorting the two big units and receiving on the main unit, with the secondary circuit open and fairly loosely coupled. Quite accurate tuning can be obtained in this manner, which is, after all, the same as using the secondary and primary windings as a small capacity variable condenser.

Across the secondary of this set is a Telefunken condenser of 2,300 cms. maximum capacity, with air dielectric This latter is a piece of German apparatus from the Disposals Board, and was purchased for the sum of £2 5s. It gives excellent results and with oil as a dielectric gives a maximum capacity of about ·0056 mfds. With the primary is used a home-made variable condenser, which can be put either in series or in parallel : it consists of seven fixed and six movable plates, separated by paraffin-waxed paper, its maximum capacity being about ·006 mfds.

For a short-wave set a Marconi 50-watt trench set is used, which set is of a most interesting design. The aerial tuning inductance serves the dual purpose of A.T.I. for both reception and transmission ; the coils being basket-wound, are not only compact, but accurate tuning for transmission can be obtained by means of varying the A.T.I. and the coupling between the transmitting coils.

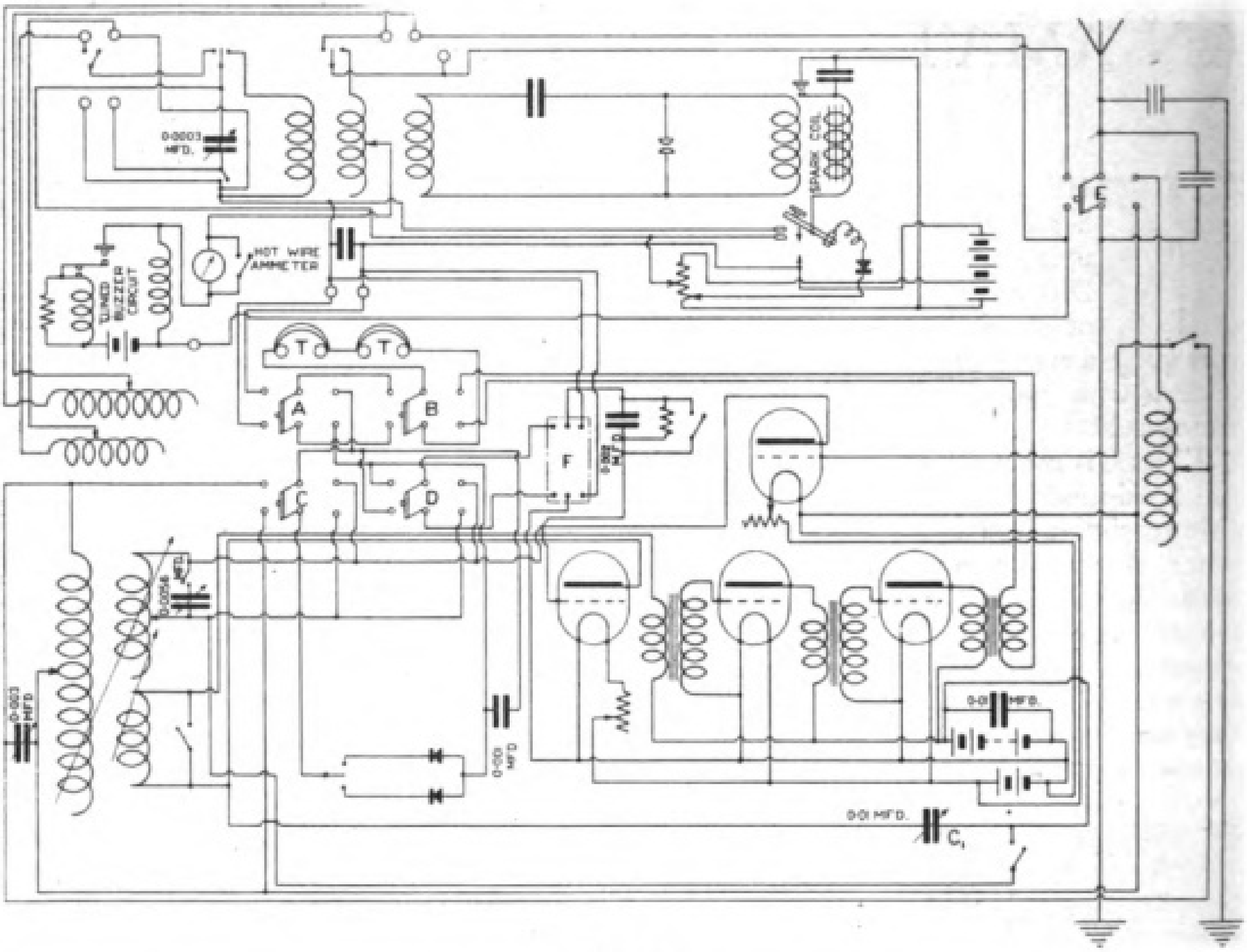


Fig. 2.

The secondary of the receiving circuit has a small variable condenser across it, which enables the wavelength to be changed from 300 to 600 metres. In the set being described the aerial and secondary circuits have been broken and brought out to terminals, thus permitting extra inductance to be nserted if required. It will be seen that there is a tuned buzzer in the aerial circuit; this can be used to emit oscillations, and it is found that by depressing the buzzer it will heterodyne the louder C.W. stations, thus enabling their reception without a valve.

The transmitting portion consists of a 2½" spark coil, to take 5 amps. at 10 volts, and gives a very fine musical note.

For amplifying an A Mark IV 3-valve amplifier is used, and for the benefit of the several correspondents of *The Wireless World*, who have enquired for such, Fig. 5 is a diagram of connections.

The peculiarity of this instrument is that

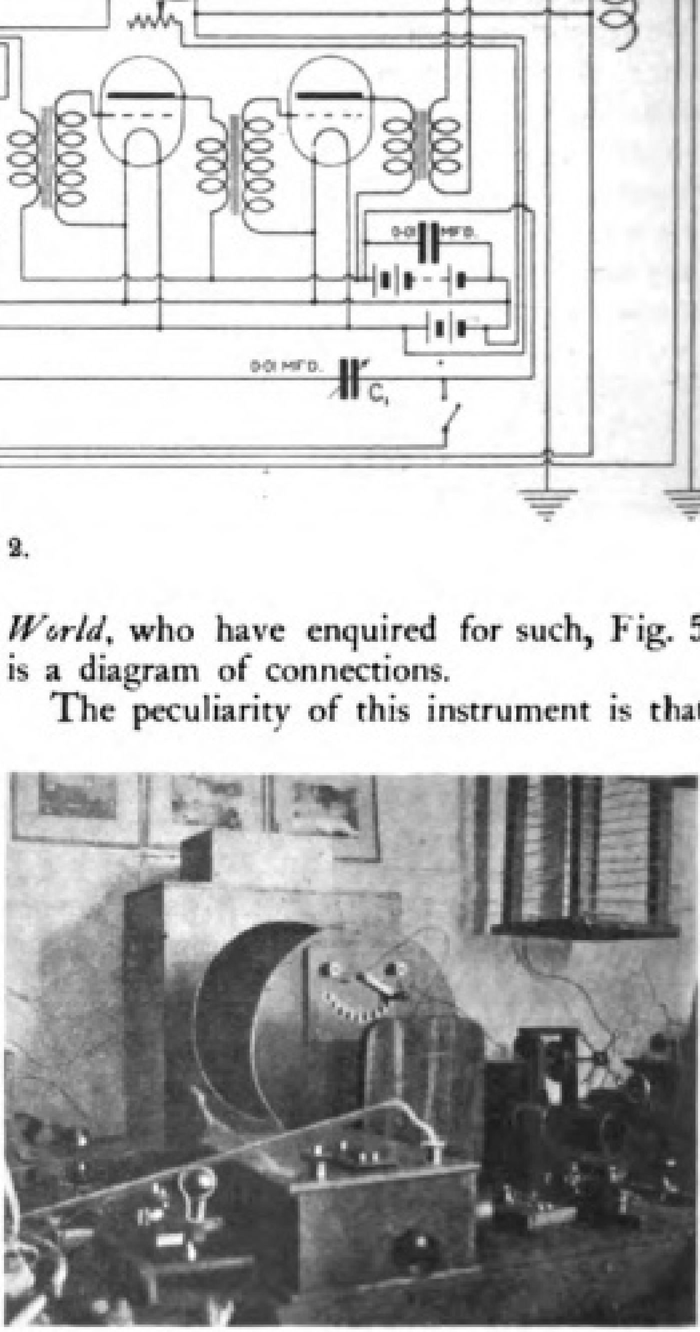


Fig. 3.

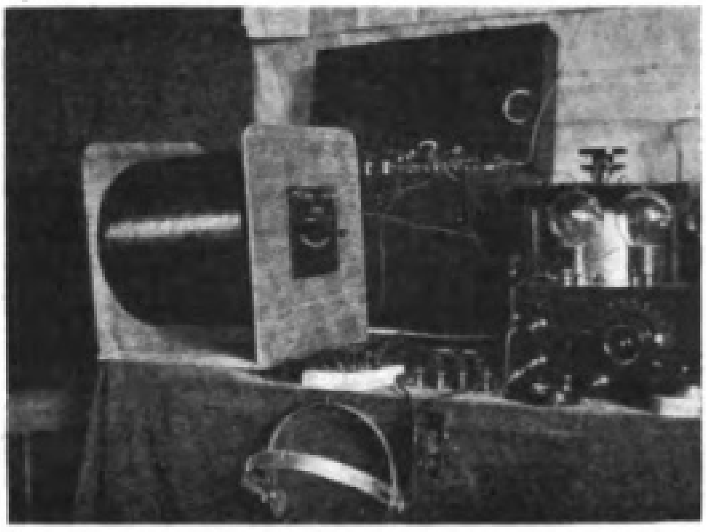


Fig. 4.

a condenser of ·002 mfds. capacity is shunted across the primary of the first transformer. With this amplifier I find that the selection of valves makes a great deal of difference in the strength of signals. To use the first valve as a rectifier the terminals C D are left open, thus connecting the grid-leak and condenser. In my own amplifier I have broken the sheath circuit of the first valve and brought out the ends to terminals mounted near the first valve; a reaction coil is connected to these two terminals and a large variable condenser across the transformer and H.T. battery. Loud C.W. stations are received in this way, but the difficulty is to get the first valve to oscillate on wavelengths of more than 5,000 metres. I have now abandoned this method of C.W. reception and substituted a 1-valve H.F. magnifier, which will oscillate at almost any wavelength between 300 to 25,000 metres. The connections used are as shown in Fig. 6: they can be adapted to any loose coupler, and the circuit gives very good results. The advantage of this circuit is that spark signals can be received on crystal by merely switching off the filament current of the valve. When the coupling is loosened the valve operates as an H.F. magnifier.

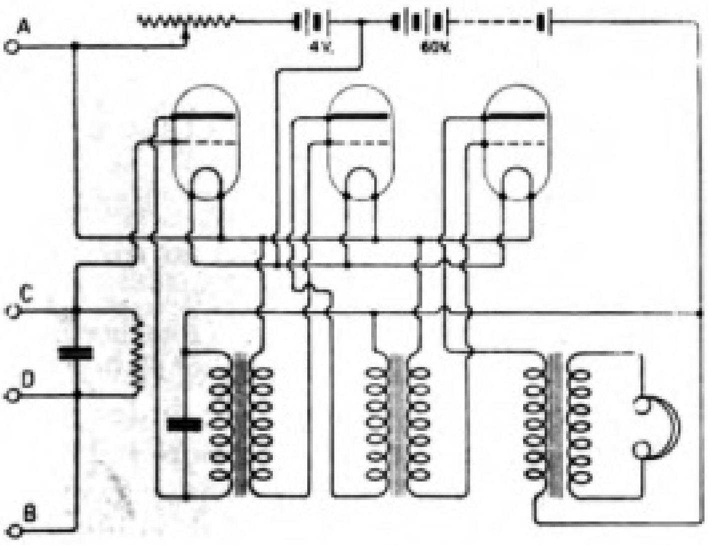


Fig. 5.

I have recently been carrying out experiments in wireless telephony, as far as my licence will allow me, and the circuit which has given the greatest success is that of Elmer Bucher. The circuit (Fig. 7) is made up with a loose-coupler, A B; B is the exciting coil, and placed outside the aerial inductance, A. B consists of No. 26 enamelled wire,

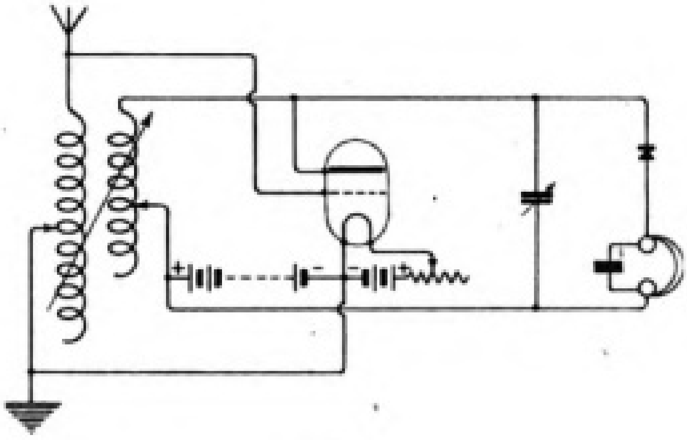


Fig. 6.

wound on a 3½" diameter former, 3½" long, while the aerial coil is wound with No. 24 D.C.C., on a 3" former, 3½" long. The position of the slider is found by experiment. The plate and grid circuits are thus auto-coupled and are tuned by means of a variable condenser, C_2.

It is quite a simple circuit to work, and when properly designed will give a range of approximately 1 mile for each ⅜ of a watt absorbed from the H.T. battery, this, of course, when using one valve as an H.F. magnifier. The circuit must be carefully adjusted, as the least touch of the variable condenser is enough to throw the whole apparatus out of resonance. The size of the condenser, C_1, must be found by experiment, as it varies for valves of different characteristics, and also depends on the microphone transformer. I find that by using an ordinary B type French valve and a 3" induction coil as a microphone transformer, a telephone blocking condenser will serve the purpose. Valves for transmission of speech should be carefully selected, as one is apt to get "gurgling" effects when talking. Using 5 volts on the filament and 120 volts on the plate, the current taken from the H.T. battery is 2½ milliamps, and gives audible signals at 400 yards without a valve receiver.

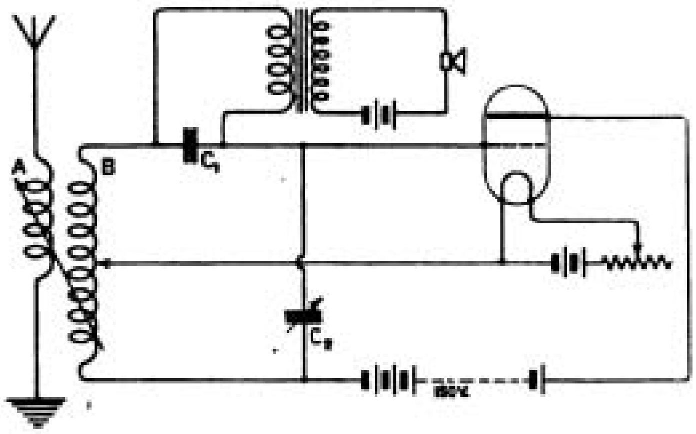


Fig. 7.

A very interesting experiment for amateurs is to obtain magnification of signals by means of a microphone. The signals are first brought to maximum strength by means of one valve used as an H.F. magnifier, as described in the circuit (Fig. 7), and the telephones then placed against a microphone, whose circuit is completed through the primary of an induction coil (without the contact breaker); another pair of telephones is then connected across the secondary of the coil. I have received Paris in this manner quite as loud as with a 3-valve L.F. amplifier, but only the loudest of signals can be magnified in this way.

The telephones used in the set described are of the Brown reed-type, and are wound to 4,000 ohms. It is found that they work quite well with the 3-valve amplifier, and show good all-round results. The aerial is 70' long, and has an average height of 25'.

In conclusion, I must explain the reason for my using single layer-coils for the reception of long wavelengths. I am of opinion that they are decidedly more efficient than multilayer coils, and I think it advantageous for the purpose of calibration to keep capacity effects out of receiving inductances as far as space will permit.

This description is of necessity brief, but I hope in a future article to enlarge upon the construction of some of my apparatus, such as variable condensers and inductances.

AIRCRAFT IN PEACE AND THE LAW*

By J. M. SPRAIGHT, O.B.E., LL.D.

This book, though not of the type usually treated in these pages, is one that may be read with a considerable amount of enjoyment by those whose interest is excited by the relationship of air and law. The book opens with a quotation taken from a Report of the Sub-Committee of the Civil Aerial Transport Committee, dated January 2nd, 1918. The quotation implies that one country may dispute the principle of air sovereignty in spite of the fact that the rest of the world may recognise that right.

The part played by Germany in point of disregarding the neutrality of the air frontiers of certain countries during the war is both interesting and clearly written. The book is one of law from an aircraft point of view, and though perhaps our readers are little concerned with such matters, *Aircraft in Peace and the Law* will do much to pass away a quiet evening by the fireside, both enjoyably and instructively.

*London: Macmillan & Co., Ltd. New York: The Macmillan Co. Pp. 233. (8s. 6d.)

NOTES AND NEWS

Mr. H. J. Nierstrasz.—We regret to have to announce the death, on December 5th, of Mr. H. J. Nierstrasz, Inspecteur b.d. dienst der Kusten Scheeps-radiotelegrafie, Knight of the Oranje-Nassau Order. The deceased was one of the pioneers who set in order the wireless system of Holland, and in recognition of his efforts was, in 1906, appointed to the position of Chief of the Technical Service of the Wireless Service in Holland. In his official capacity Mr. Nierstrasz was a delegate at the International Radiotelegraphic Conferences of London and Berlin, and was also present at the Conference for the Safety of Life at Sea which was held in London in 1913. He was born at Roermond on April 11th, 1864.

The Naval Exhibition.—One of the most interesting exhibits at the Naval Exhibition held at Bradford from November 29th to December 11th was the wireless receiving station installed by the North Eastern School of Wireless Telegraphy, Leeds.

The installation consists of a 6-valve receiver with a frame aerial, together with several other wireless instruments of interest.

During the opening ceremony by H.R.H. the Duke of York, a message addressed to H.R.H. from Admiral the Hon. Sir E. E. Fremantle was sent from the Marconi demonstration station at Crewe by means of wireless telephony, and afterwards news items were read, being rendered audible to the large crowds of people present by means of a loud speaking trumpet.

Longitude by Wireless.—With reference to our paragraph in the October 30th issue the following extract from *Nature* is of interest :— The scheme for linking up the observatories of the world by utilising wireless time-signals was referred to in *Nature* for May 20 last (vol. cv., p. 370). It must be understood that no appreciable increase of accuracy over the older method by cable signalling is claimed ; indeed, where the observers are not interchanged the precision is less. But the gain in convenience, expense, and wide distribution of signals is considerable, and it is known that where the travelling-wire method of observing transits is adopted, personality is greatly reduced ; what remains is of the same order as the small local deflections of gravity, which can be eliminated only by extensive geodetical operations.

Mr. Dodwell, the director of Adelaide Observatory, has communicated the longitude which he deduces by the reception of the Lyons and Annapolis signals at Adelaide and Greenwich. It is 9h. 14m. 19·95s. using Lyons signals, and 19·78s. using Annapolis ones. The Nautical Almanac value is 20·30s. Allowance has been made for time of transmission, assuming a speed equal to that of light.

Many of the Australian boundaries are defined as meridians east of Greenwich by a specified number of degrees. They were determined by lunar observations and are known to be in error by some miles. It is not, however, expected that any change will now be made in them.

M. H. A. Madge, Principal Technical Adviser on the Wireless Telegraph staff at H.M. Signal School, has been appointed to the rank of Commander of the British Empire (C.B.E.) to be dated June 5th, 1920.

Wireless Telephony Demonstration.—The following report upon a demonstration of wireless telephony recently held in Australia is indicative of its popularity and possibilities in that continent :

A demonstration of the value and possibilities of wireless communication was given in the Queen's Hall at Federal Parliament House, Melbourne, on October 13th. With the aid of an aerial erected on the roof of the building and a set of instruments, songs which were being sung in a house at Brighton were heard very clearly by a very interested audience of Federal members.

During the rendering of a violin solo the Melbourne wireless station in the Domain was transmitting a weather forecast, yet, the violin solo was relatively undisturbed. Nothing could have demonstrated more effectively the efficiency of modern wireless apparatus and the degree of perfection which has now been reached in selectivity.

Reference to the demonstration was made subsequently in the House of Representatives by Mr. Gregory (W.A.) during the budget debate. He said they had had a marvellous exhibition of wireless telephony, and he could see enormous possibilities in connection with the provision of facilities in the back country. It would be a magnificent thing if the men in the remote districts could get into touch with the centres of civilisation in this way.

An Electric Photometer, recently described by Mr. A. H. Compton in the Transactions of the Illuminating Engineering Society, contains a device which is known as a "photo-electric cell." This piece of apparatus contains an electrode, which when subjected to illumination, emits a stream of electrons, and thereby enables a current to pass across the space between it and another electrode, mounted inside the same containing vessel. An ordinary type of three-electrode valve is used to magnify the feeble currents which can pass through such a photo-electric cell. When light falls on the sensitive surface of the cell a galvanometer causes a reading which is dependent upon the illumination of the cell, and in this manner comparisons can be made between the lamp under test and a standard comparison lamp. Photo-electric cells are more sensitive to blue and ultra-violet light than to red light, but this inequality, it is claimed, can be allowed for by means of suitable colour screens permanently interposed between the sensitive cell and the source of light.

Wireless on Motors.—A wireless telephone set operated with current from the batteries of a motor-car and transmitting and receiving with an aerial wire stretched from the top of the wind screen to the radiator cap, is described by Reuter's New York correspondent as the latest equipment provided for the modern motor-car or truck.

THE PROCEEDINGS OF THE WIRELESS SOCIETY OF LONDON

A FOUR-ELECTRODE THERMIONIC DETECTOR FOR DAMPED OR UNDAMPED ELECTRIC OSCILLATIONS OF HIGH OR LOW FREQUENCY

By J. A. Fleming, M.A., D.Sc., F.R.S.

An Ordinary General Meeting of the Society was held at the Institution of Civil Engineers, on Friday, December 10th, Mr. A. A. Campbell Swinton (President) in the chair.

After the minutes of the previous meeting had been read and confirmed, Dr. J. A. Fleming, delivered his Paper.

Dr. J. A. FLEMING, M.A., D.Sc., F.R.S.,

The thermionic valve, which was devised and first suggested by me in 1904 as a detector of high-frequency electric oscillations, comprises a hot and a cold electrode in a highly-exhausted glass bulb. These electrodes are connected by a circuit external to the bulb, which contains a source of high-frequency oscillations and some form of current-reading or detecting instrument. *

If this latter instrument is a galvanometer or other device for detecting a feeble unidirectional current, as shown in my patent specification, the arrangement can detect the presence of either damped or undamped electromotive forces in the external circuit.

If the current-detecting appliance is a telephone receiver, as generally used, then the receptivity becomes limited to damped oscillations, with train frequencies lying within the limits of audition. Since the magneto-telephone *plus* a normal human ear is a highly-sensitive detector for feeble unidirectional intermittent currents, this thermionic rectifier so used was found to be a very sensitive detector of damped oscillations, the train frequency of which lies within the limits of audition by the ear, as these are converted by the thermionic valve into intermittent gu hes of electricity in one direction. I originally mentioned a galvanometer as the current-detecting instrument, because we are not then limited to detecting damped oscillations.

The combination of the two-electrode valve with an Einthoven galvanometer gives us a possible arrangement for detecting radio-telegraphic signals by undamped waves when the movements of the image of the silvered quartz fibre of the galvanometer are recorded by photography.

The Einthoven galvanometer and photographic recorder is, however, an appliance not suitable for use on board ship, or indeed for any except large radio-telegraphic stations, on account of the complexity of the apparatus.

Although the three-electrode valve in its many designed circuits provides an arrangement of extraordinary sensitivity for the detection of undamped waves, yet the scheme of c'rcuits employed is not in general adapted for the reception of both damped and undamped waves without some alteration.

The various forms of wave generator now in use, viz., (1) high-frequency alternators, (2) Poulsen arcs, (3) valve generators, (4) timed-spark, and (5) ordinary intermittent high-frequency and low-frequency spark generators give us three types of wave radiation with a great range of wavelength, which are cut up as required into periods to make the signals.

It seemed to me, therefore, some time ago that it would be interesting to endeavour to

* See J. A. Fleming "On the Conversion of Electric Oscillations into Continuous Currents by Means of a Vacuum Valve," *Proc. Roy. Soc., Lond.*, 1905, Vol. 74, p. 476; or British Patent Specification, No. 24,850, Nov. 16th, 1904, of J. A. Fleming.

design a simple thermionic detector and receiv ng arrangement which should be quite independent of the nature of the transmitter, and detect without change of apparatus or circuits, undamped as well as damped waves of any wavelength, and also be heterodyne in the sense that the energy absorbed in making the signal is not derived solely from the energy of the incident waves.

The following is a description of a construction I have found efficient for this purpose, which although as yet not approaching the cascaded three-electrode amplifier in sensitivity, has yet some special advantages of its own.

It is a four-electrode thermionic detector, made as follows :—

In a glass bulb 3 inches in diameter there is a rather wide inset tube, with broad "pinch" at the inner end, through which are sealed five wires. Five copper wire leads pass down the inset tube and terminate in five pins set in the insulating base of a nickel collar.

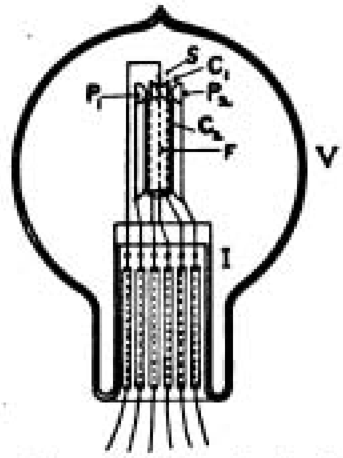


Fig. 1. Four Electrode Thermionic Valve. I Inset Tube, P_1, P_2 Potential Plates, C_1, C_2 Collecting Plates, F Filament, S Spring.

One pair of these wires form the lead and return of a straight vertical tungsten filament about 1¼ inches long. This filament is kept tight and straight by a small spiral spring S, attached to its upper end and to the vertical lead wire (see Fig. 1). The object of this spring is to take up the slack of the tungsten wire as it expands when rendered incandescent, and keep it quite straight at all temperatures. This filament is rendered incandescent by about 8 volts, and takes about 0·85 ampere to bring it to bright incandescence. Around this filament are arranged four narrow curved nickel plates about 1¼ inches long and ¼-inch wide, slightly curved about their long axis and set with convex faces towards the filament and 2 or 3 millimetres from it (see Fig. 2). One pair of these plates on opposite sides of the filament are carried on separate wires, sealed through the "pinch."

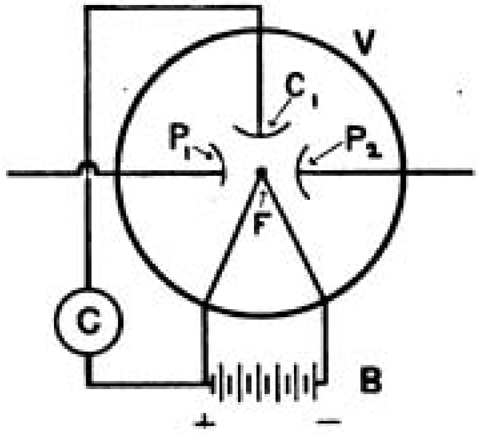


Fig. 2. Four Electrode Valve in plan. F End-on view of filament, B Filament-heating battery, C_1 Collecting plate, P_1, P_2 Potential plates, G Galvanometer or relay.

These I call the potential plates. They are connected to one pair of pins on the collar base. The other pair of plates are connected together, and both connected to the fifth inset wire. These plates are called the collecting plates. The bulb is exhausted. and the electrodes freed from gases in the usual manner employed in making "hard" valves.

If then the filament is incandesced by the proper voltage using, say, 6 storage cells and a sliding rheostat in series, and if the terminal of the collecting plates is connected by an external circuit with the positive terminal of the filament, we find the ordinary thermionic current flowing through this circuit as in the "Edison Effect" experiment. In the samples of this detector I have had made by various makers, this current will vary from 150 to 400 micro-amperes or more, depending upon the exact position of the collecting plates.

I may here say that in making these detectors, great care must be taken to place the four metal plates symmetrically round the filament, and at equal distances and with the convex surface not more than 2 or 3 millimetres from the filament at their nearest point.

Also it is convenient to mount each detector on a base-board, with five terminal screws marked $+F$, $-F$, P_1, P_2 and C for the filament, potential plates and collecting plates respectively (see Fig. 3).

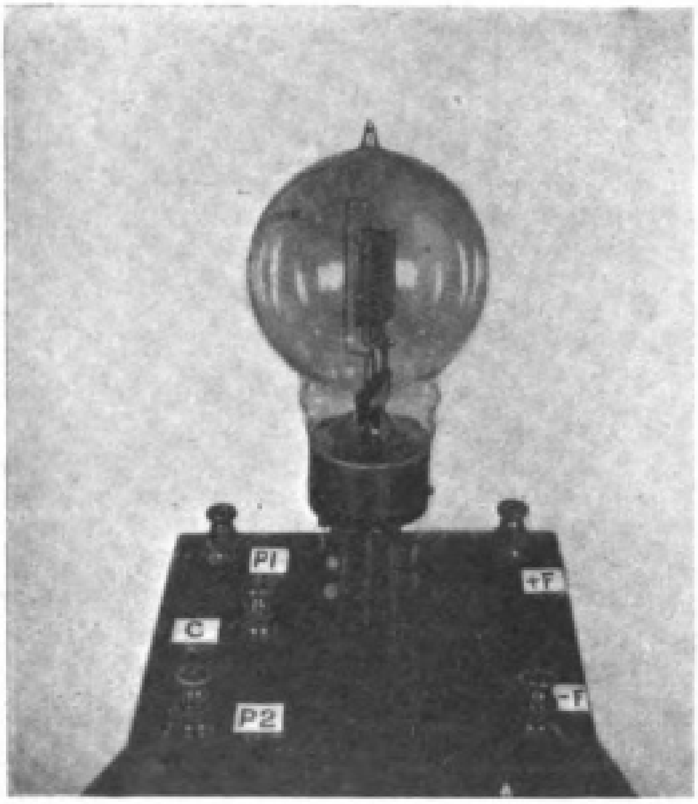


Fig. 3. Perspective View of Four-Electrode Valve.

Let us assume, then, that the filament is incandescent, and that a galvanometer is placed in the external circuit connecting C with $+F$, and that we find a thermionic current, say, of 150-200 micro-amperes. The peculiar property of this thermionic detector is, that if a small difference of potential, whether high frequency, low frequency, or steady, is created between the plates P_1 and P_2, the thermionic current at once falls to an extent determined by this potential difference (see Fig. 4).

We can, therefore, describe a characteristic curve by measuring the thermionic current corresponding to a measured P.D. of the potential plates.

Such a curve is shown in Fig. 4, taken for one valve in my stock.

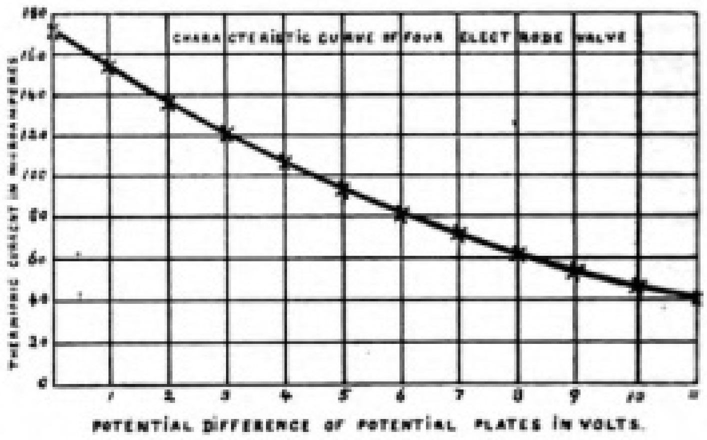


Fig. 4. Characteristic Curve of Four Electrode Valve.

If the potential difference of the plates P_1 and P_2 is direct, and is about equal to that of the filament terminals, the thermionic current falls to somewhere near half its value when the potential plates are at zero potential.

If P_1 is at the positive potential, and P_2 is negative, the characteristic curve will slightly differ from that taken with P_1 negative and P_2 positive, because the plates can never be set at exactly equal distances from the filament.

If a low-frequency alternating potential is employed the characteristic curves takes a midway position.

The explanation of this effect seems fairly obvious. When one of the potential plates is made positive it attracts some of the electrons in the electron stream proceeding to the collecting plates, and as the total electronic emission per second is determined by the temperature of the filament and by the voltage of the collecting plate, this displacement of part of the electron stream means a reduction of the thermionic current moving to the collecting plates. When the potential plates are subjected to a high-frequency electromotive force, the electrons moving from the filament are deflected first to one potential plate and then to the other, and as a consequence the thermionic current to the collecting plate is reduced to an extent which depends upon the ratio of the alternating potential difference to the potential drop down the filament.

To use this device as a detector in wireless telegraphy we need only connect the potential plates to the terminals of the tuning condenser in the closed receiving circuit, and insert in the external plate-filament circuit of the valve some current-detecting instrument which will indicate a drop in the thermionic current (see Fig. 5).

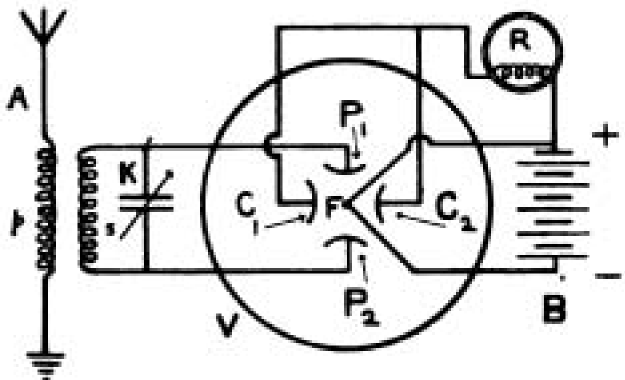


Fig. 5. Four Electrode Valve used as a detector in Wireless Telegraphy. A Aerial, K Tuning Condenser, V Valve, R Relay, F End-on view of filament.

If we are receiving damped-wave trains, a magneto telephone can be employed, and then corresponding to the impact of each wave train there is a drop in the thermionic current and a sound in the telephone of the pitch of the train frequency.

So used the arrangement is about as sensitive as a simple crystal detector.

We can use it with another arrangement, which makes it equally receptive for damped or undamped waves as follows :—If we insert in the plate-filament external circuit an ordinary balanced telegraph relay, the thermionic current will hold the contacts of this relay closed. If the potential plates are connected to the tuning condenser terminals of the receiving aerial circuit, then at the impact of each signal, whether dot or dash, damped or undamped, the potential plates are impressed with an alternating high-frequency potential difference. The thermionic current, therefore, drops and the relay contacts open, and remain open whilst the signal lasts and close again when it finishes.

We can make the opening of these relay contacts close another circuit, in which is placed a battery and telegraph instrument, whether sounder, inker, syphon recorder, chemical recorder, or buzzer. The second relay is made as follows :—On a board is mounted an electro-magnet, M, which attracts an armature, A, pulled away by an adjustable spring, S (see Fig. 6). The coils of this magnet are connected through a few dry cells with the contacts of the first relay. To the armature of the second relay is attached a thin rod of celluloid, tipped with a gold wire, G, which is connected by a fine wire spiral with a terminal. This gold wire when pushed forward by the detachment of the armature of the electro-magnet makes contact with an adjustable gold plate, S_1. Hence the opening of the relay contacts by the drop in the thermionic current can be made to close another circuit, which actuates a signal-making instrument (see Fig. 6).

In connection with metallic contact relays it may be well to draw attention to some facts perhaps not so generally known as they ought to be.

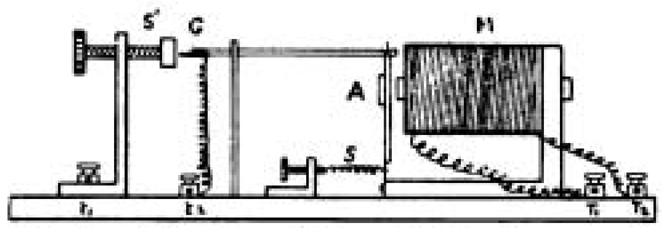


Fig. 6. Reversing Relay. M Electro-magnet, A Armature, G S¹ Gold-Carbon Contacts, S Spring Control.

The trouble with all such relay contacts is that they require a certain pressure between the contact points to give a sufficient electrical contact to pass a current sufficient to work some telegraphic recorder, say, a Morse inker, syphon recorder, sounder, or other device. Metals differ very much in the amount of pressure per square cm., which must be applied to give this good contact.

If the pressure is too small the required current does not pass. If, on the other hand, we raise the e.m.f., or increase the pressure, the contacts are apt to stick and then refuse to open.

Instrument makers have continued to perpetuate old ideas on this subject by making the contacts generally of platinum, which is not at all a good metal for this purpose, because though non-oxidisable it is a cohering metal, or perhaps I should say a non-automatic decohering metal, in a wireless sense of the words. A far better metal is gold, because it has a less contact resistance than platinum, and this metal is used in Dr. Muirhead's cable relays, I believe, for the contacts.

I find, however, that an improvement can be made by using gold and graphitic carbon as contact surfaces, and connecting across the contacts a capacity of a fraction of a micro-farad, say, 0·5 in series, with an inductive resistance. This greatly reduces the contact resistance.

What happens, then, is this: When the contacts are open the impressed e.m.f. charges the condenser. When the contacts close with very light pressure the condenser discharges *with oscillations* across the contact and causes them to cohere, so that the e.m.f. drives the required current through the instrument to be actuated. If, however, these contacts are of self-decohering materials, such as gold and carbon, then when the relay current ceases, the contacts open without sticking. †

Returning, then, to the description of this four-electrode valve when used as a wireless detector in the circuit shown in Fig. 5, it is to be noticed that the impact of waves upon the aerial creates a difference of potential between the potential plates, and operates the above-mentioned appliances and makes a signal no matter whether those waves are damped or undamped.

It will be evident, then, that what is required to create sensibility in the arrangement is that the potential difference of the potential plates shall be as large as possible.

We can achieve this to some extent by arranging the receiving circuit so that its capacity is small and inductance large conditionally on their product agreeing with that required by the wavelength.

We can also amplify to some extent by the u e of resonance spirals as follows :—

† See British Patent Specification, No. 112,544, of May 7th, 1917, to J. A. Fleming "Improvements in Telegraphic Relays."

We connect to the terminals of the receiving condenser, K, two spirals of wire, S_1, S_2, consisting of a single layer of closely-wound turns of silk-covered No. 36 wire on an ebonite rod about 5 cms. in diameter, and we adjust the length of these spirals to resonate to the frequency or wavelength employed. We then connect the potential plates, P_1, P_2, of the valve to the outer ends of these spirals. The resonance of the spiral will then exalt the potential difference of the condenser terminals, and, in fact, amplify it at least in the ratio of 1, 2, or more (see Fig. 7).

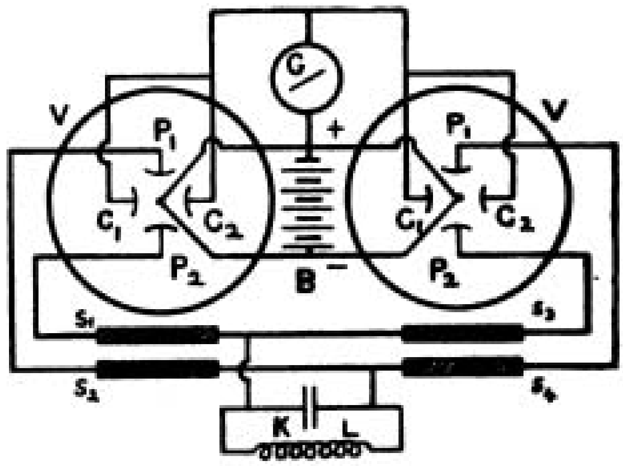


Fig. 7. Two Four Electrode Valves used in parallel with Amplifying Spirals S_1, S_2, S_3, S_4 *on terminals of the Receiving Condenser* K. G *Galvanometer or Relay.*

It is not quite easy to pre-determine the length of spiral required, because the small capacity of the potential plates of the valve virtually increases the resonance length of the spiral to an unknown extent.

We can easily determine a maximum possible length of spiral required for any given received wavelength as follows :—

The velocity with which a wave of potential travels along such a spiral is numerically equal to the reciprocal of the square root of the product of its capacity and inductance per unit of length.

Hence, for spirals of the same diameter, and wound with the same kind of wire in a single layer of closely adjacent turns, the fundamental resonance frequency is inversely proportional to the length of the spiral employed.

We can determine the resonance frequency of any given spiral in the following manner :—Set up an oscil ation circuit consisting of a variable inductance and condenser and spark gap. Excite oscillations in it in the usual way by means of an induction coil. Connect one end of the spiral under test to one terminal of the condenser and the other terminal of the condenser to a large sheet of zinc placed a couple of feet or so away from the spiral.

Then hold a Neon vacuum tube near the outer end of the spiral and adjust the capacity and inductance of the oscillation circuit until the brightest glow is secured in the tube when held near the outer end of the spiral. If we take obvious precautions to secure that, we have excited the fundamental oscillation on the spiral and not a higher harmonic, we can determine at once by the observed capacity of the condenser and inductance associated with it the frequency we are employing. Hence, if the measured length of the spiral is l, and its fundamental resonance frequency is n, we know that for a different length, l_1, of the same spiral the resonance frequency will be n_1, with the relation, $l/l_1=n_1/n$.

If we are receiving a wavelength W metres on the aerial then we know that its frequency is $n_1=3\times10^8/W$, and hence one might suppose the required resonance length of the spiral should be,

$$l_1=\frac{ln}{3\times10^8}W$$

Thus, for instance, I have some spirals of length 50 cms., and their resonance frequency has been determined to be 860,000. If, then, I wish to receive a wave of wavelength 1,000 metres, the proper resonance length of this spiral might appear to be 143 cms. when employed as an amplifier with the above-described four-electrode valve. As a matter of fact, it would be very much less, owing to the capacity of the potential plates to which the ends of the spirals are attached.

The best way to determine it is experimentally, and by trial. If a metal curved saddle is fitted to the spiral, and so made that it can be moved along the spiral, we can arrange this contact so that it alters the effective length of the spiral in use. We can then find by trial what length when connected in between the potential plates and the receiving condenser is most effective in reducing the thermionic current.

We can also attach to the terminals of the receiving condenser two pairs of such spirals and connect them to the potential plates of two valves worked off one common filament-heating battery, both valves sending their thermionic currents through the same relay. We can conveniently add an additional electromotive force by inserting four or five dry cells in series with this relay.

We can, of course, also amplify the P.D. at the terminals of the receiving condenser by means of a cascaded series of ordinary three-electrode valves inductively coupled, but then we require the high-potential plate-voltage battery and another filament-heating battery, and we make the arrangement much more complicated.

It is, however, quite easy to employ a couple of the four-electrode valves, each with appropriate resonance spirals, to receive ordinary not very feeble undamped waves, and make them operate an ordinary telegraph sounder as signal-making instrument (see Fig. 7).

It may be convenient to give a few hints as to the construction of these amplifying spirals.

In the first place, they should be wound on ebonite tubes of about 1 or 2 inches in diameter. Wood rods cannot be employed on account of the energy dissipation which then takes place. Glass is too fragile for practical use. In the next place, they should be wound with very fine silk-covered copper wire of not greater diameter than No. 36 S.W.G., and preferably No. 40. If a larger size of wire is used, the resonance seems to become much less sharp.‡ The spirals should be supported on insulating stands, raised above the level of the table about 2 feet, and the two spirals should not be very near each other. In

‡ For the reason for this see section 4, chapter IV. of the author's book, "Principles of Electric Wave Telegraphy and Telephony," 4th edition.

place of sliding saddles it is better to remove the silk covering off a narrow longitudinal area, and have a sliding contact which enables the effective length of the helix to be varied quickly. The use of such resonance spirals for amplification of potential is not altogether new. They were employed by me in 1904 in the construction of a cymometer or wavemeter, and they have recently been employed as amplifiers in transmission of high-frequency oscillations along wires in the so-called "wired wireless telegraphy."

This system was described by Major-General George O. Squier in *The Electrician* for June 11th, 1920, under the title "Multiplex Telephony and Telegraphy Over Open-Circuit Base Wires."

The adjustable resonating helix shown in Fig. 3 of this last-named paper closely resembles the helix cymometer described by the author in a paper to the British Association in 1904, and figured in the 2nd edition of the author's book, "Principles of Electric-Wave Telegraphy," where also will be found an illustration of Slaby's Variable Length Helix Wavemeter.§

I may say I have not yet had time to determine the effect of a slight reduction of the vacuum upon the performance of this valve.

By slightly lowering the vacuum the thermionic currents would be increased, and since the potential of the anode plate is only a few volts, the force tending to drive back the positive ions produced by any gaseous ionisation is not large. There would not, therefore, be much danger of shortening the life of the filament by positive ion bombardment.

It is possible that such rather soft valves might have some advantages, provided that the potential difference of the potential plates required to make a given percentage decrease (say 50 per cent.) of the normal thermionic current is not thereby increased.

§ See "Principles of Electric Wave Telegraphy," 2nd edition, 1910, pp. 486 and 493. See also *Phil. Mag.*, October, 1904, p. 435, J. A. Fleming "On the Propagation of Electric Waves along Spiral Wires."

This, however, must be the subject of experiment.

In connection with this subject I should like to exhibit a very simple type of bell-call I have devised which is free from any complications.

It depends upon the principle utilised in nearly every time-limit relay in power stations for opening switches and cutting out feeders in case of short circuits which are not spontaneously removed directly.

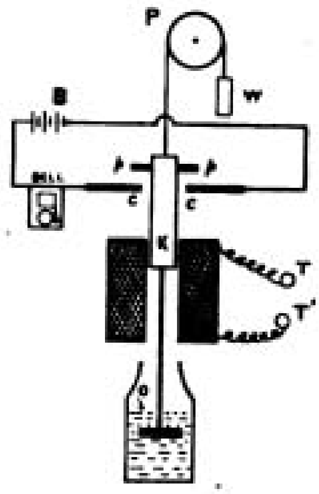


Fig. 8 Bell Call Apparatus. K, Iron Core drawn down into a solenoid when a current passes. O Oil damping vessel. W Counter balance weight p p c c Contacts closing circuit of electric bell.

It comprises a solenoid with a movable iron core, K, sucked into it. This core is suspended by a string passing over a pulley, P, and is balanced by a weight, W, which just keeps the core elevated with its end in the entrance to the solenoid. The core also has a brass wire attached to the bottom, ending in a disc immersed in a bottle of viscous oil, O. The core is rather heavy and is about 0·5-inch diameter and 2 or 3 inches long (see Fig. 8).

Hence, it possesses considerable inertia and viscous resistance to motion. When the core is sucked into the solenoid to a certain extent it makes a contact (*pc*), which closes an electric circuit and rings an electric bell. This contact, however, cannot be made unless the current through the solenoid is kept going without interruption for a couple of seconds or so. The intermittent currents due to Morse signals will not depress the core sufficiently to ring the electric bell.

I use this arrangement as follows :—I employ a pony sounder to receive the Morse signals by ear, connected to my four-electrode valve, as above described. The pony sounder makes and breaks contacts by the movement of the magnet armature, and this contact closes the circuit of the solenoid in the bell-call apparatus through a few dry cells. Hence, when the sounder is receiving ordinary Morse signals, the contact in it is closed intermittently, and the current which passes through the bell-call solenoid does not cause the bell to ring. If, however, the key at the transmitting end is held down for a couple of seconds, making, as it were, a very long dash signal, the bell will ring.

In this manner the receiving operator can be called up and receive signals sent by C.W. on an ordinary pony sounder of G.P.O. pattern. The bell can be replaced by a buzzer or an electric flash-up lamp if desired.**

In place of the sounder one can employ an ordinary Morse inker or a syphon recorder as the signal-making instrument, and make continuous waves record on any ordinary telegraph instrument. It would not be difficult to make the arrangement work a Hughes printing telegraph.

I have not attempted as yet, from want of opportunity, to make comparisons between this four-electrode valve and other detectors as regards sensitivity, but from a few tests which have been made for me by others, it appears to be about as sensitive as a good crystal detector. Even if it does not invade the field at present occupied by the three-electrode valve, it may prove to be a useful adjunct, and in connection with the simple bell-call I have described above, may provide for the needs in this respect of practical radio-telegraphy and telephony without introducing any complicated appliances.

The valve will also have some laboratory uses. Since it is affected by low-frequency alternating potential, we can use it to construct an alternating current capacity bridge or potentiometer in any mode of test in which we desire to find out when two points are at the same potential. Thus, for instance, if we arrange four condensers C_1, C_2, C_3, C_4, in Wheatstone's bridge fashion, and supply the system with H.F. oscillations, by a generator A, we can connect the potential plates of the valve across one diagonal *b d* of the bridge, either directly or through a transformer, and use it to find when the ends of the diagonal are brought to equality of potential by varying the capacity of one of the condensers. For if we connect the potential plates to these two points, and place a sensitive galvanometer G in the collecting-plate filament external circuit, then the thermionic current will be diminished if these potential plates have any sensible difference of potential (see Fig. 9).

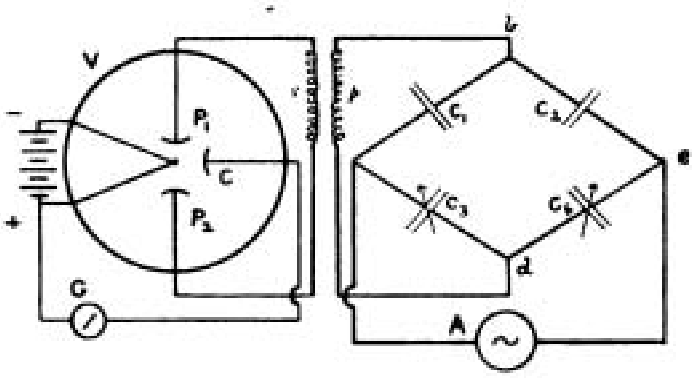


Fig. 9. Four Electrode Valve used as a potential detector in Capacity Bridge measurements.

Again, we may use this valve to make an alternating-current ammeter. For if we connect the secondary terminals of an induction coil to the potential plates, and then pass any small alternating current of low or high frequency through the primary coil, the thermionic current will be diminished to an extent which depends upon this alternating current.

I think, therefore, that this four-electrode valve will prove to be of use in our laboratory measurements in addition to any application in radio-work.

** Another arrangement of Call-bell is described in my British Specification, 149,442, of 1919.

WIRELESS CLUB REPORTS

The Wireless Society of London.

A General Meeting of this Society was held on December 10th, at the Institute of Civil Engineers, when Prof. J. A. Fleming, F.R.S., delivered a most interesting lecture on his new 4-electrode thermionic valve—this lecture is reported fully elsewhere. The President at the close of the meeting voiced the feelings of those present in a few well-chosen remarks, and the Society are to be congratulated that Prof. Fleming chose the Wireless Society of London to act as a medium for making public his most recent invention. It was announced that the Annual General Meeting would take place at 8 p.m., on December 21st. at the Royal Society of Arts, John Street, Adelphi, when the election of Officers and Committee will be considered for the forthcoming year, and a lecture is to delivered by Prof. R. Whiddington, of Leeds University, on "Wireless Valve Circuits Applied to the Measurement of Physical Quantities," illustrated by experiments. Hon. Secretary, Mr. L. McMichael, M.Inst.I.R.E., 32, Quex Road, West Hampstead, N.W.6.

Manchester Wireless Society.

(Affiliated with the Wireless Society of London.)

At the first Annual General Meeting, held on November 10th, 1920, the Chairman, Mr. J. Griffin (Vice-President), called upon Mr. J. McKernan to make a few remarks on the work of the Society during the past twelve months.

Mr. McKernan responded with a brief description of the way the Society had been built up and of the many little difficulties that had been met with, explaining that these were unavoidable, and that wherever a business of any kind was commenced, these same obstacles were met with, but were easily overcome if only the members stood firm and pulled together.

Following Mr. McKernan, the Hon. Secretary, Mr. Y. W. P. Evans, went through the business of the Society, with details as to membership, etc. Mr. Evans explained that the chief difficulty had been the cutting of expenses to meet the funds available, but was very pleased to say, that, owing to the ever increasing membership and the generous support of the members, this little cloud was gradually being dispelled.

Mr. Evans announced the total membership to date to be 77, comprising 68 members and 9 associate members.

The Chairman, Mr. J. Griffin, then announced the following vacancies for Officers and members of the Committee, adding that the resigning members did not seek re-election :—Vice-Presidents (4), Chairman, Hon. Secretary, Hon. Treasurer, and Committee (7).

Proposals were then invited and the following Officers and Committee Members were elected :—Vice-Presidents: Mr. A. Marr. Mr. E. Blake, Mr. A. Parkinson, and Mr. M. Proctor-Gregg. Chairman: Mr. J. McKernan. Hon. Secretary: Mr. Y. W. P. Evans. Hon. Treasurer: Mr. W. Lamb. Committee: Mr. D. J. Davies, Mr. H. A. Blackburn, Mr. A. Couyoumdjian, Mr. A. E. Siddons-Wilson, Mr. R. Walton, Mr. E. Samuels, and Mr. A. G. Gregory.

At a Special General Meeting held on November 24th, the Chairman, Mr. J. McKernan, addressed the meeting, explaining that the object in calling another general meeting so soon was to deal with one or two very important matters which had been brought forward.

He regretted to inform the members that owing to business extensions their present room was required, and therefore the Committee were compelled to accept the usual notice which would ordinarily expire on November 25th, but a further extension had been granted until December 20th, to enable the Society to find other accommodation.

He had much pleasure in announcing that the post of President had been accepted by Capt. J. Hollingworth, of the College of Technology, Manchester, and that Vice-Presidency's had been accepted both by Mr. M. Proctor-Gregg and Mr. E. Blake.

A very important point which had to be put before the meeting was relating to the annual subscription.

It had been found insufficient to cover expenses, and therefore it had been suggested that the annual subscription be doubled as from January 1st, 1921.

Several views were expressed by the members, the majority being in favour of the increased subscription. It was therefore proposed by Mr. Reid (Vice-Chairman) and seconded by Mr Hanstock that the motion be adopted This was carried unanimously.

It was decided by a huge majority to continue with the present entrance fee.

Hon. Secretary, Mr. Y. W. P. Evans, 7, Clitheroe Road, Longsight, Manchester.

Three Towns Wireless and Model Engineering Club.

(Affiliated with the Wireless Society of London.)

At a meeting of the Club held on November 17th, the business of the evening was a discussion of the proposed Club-set. It was eventually decided, for the benefit of the less experienced members, to begin with a simple crystal set. The specification having been drawn up, various members eagerly promised to undertake the manufacture of the different parts. A definite winter programme was also drawn up, and the Club has now a series of weekly lectures lasting up to April next.

At the meeting of November 24th, the first half-hour was devoted to buzzer practice, after which the Secretary demonstrated his home-made 2-valve portable set. Unfortunately no practical results were obtainable as the lecturer had the misfortune to break the filament of one of the valves on his journey to the Club. It was decided to extend the activities of the Club to embrace all branches of model engineering and to hold for that purpose as soon as possible two evenings a week.

Full particulars of the Club may be obtained from the Hon. Secretary, Mr. G. H. Lock, 9, Ryder Road, Stoke, Devonport.

Plymouth Wireless Society.

(Affiliated with the Wireless Society of London.)

On Friday, November 12th, a most interesting and instructive lecture was given by Mr. L. Bucchini on the French Type Valve. (Mr. J. C. Andrewartha in the Chair.)

After introducing the filament, plate, and grid, and showing their characteristic curves, Mr. Bucchini thoroughly explained the general working of the valves; he then went on to explain its use as a detector of Spark and C.W. signals.

Everyone present thoroughly appreciated the lecture, and passed a vote of thanks to Mr. Bucchini in the usual manner.

On Friday, November 19th, it was with regret that we learnt of Mr. J. C. Andrewartha's wish to resign his position as Chairman of the Society. His resignation was accepted, and the Society as a whole is extremely indebted to the most excellent services he has rendered during his period of office. Mr. R. S. Menhennet has since been elected in his stead.

On November 26th Mr. Menhennet in the chair, we were unfortunately unable to obtain a lecture for this date, and as we have in our Society a number of members shortly to take the examination for the P.M.G. Certificate, it was decided that these members should in turn ask other members who had already obtained their Certificate any questions regarding wireless telegraphy. This proved a splendid opportunity to clear any query not already grasped.—Hon. Secretary, Mr. H. P. Mitchell, Municipal Technical College, Plymouth.

Birmingham Wireless Association.

(Affiliated with the Wireless Society of London.)

A meeting was held on Thursday, November 18th, at the Birmingham and Midland Institute, with Mr. J. B. Tucker in the chair; present, 68 members.

Mr. F. Johnson, of the Sheffield Wireless Association, delivered a lecture on Wireless Telephony.

The lecturer gave various diagrams, and explained his experiences when trying the different methods of connecting up. He also very kindly went into details as to capacities, inductances, gauges of wire, etc., which those present thoroughly appreciated.

A general discussion then took place as to the best all-round connections to use for a wireless telephone receiver and transmitter, and the power necessary for transmission.

At 9 p.m. Mr. Johnson gave a practical demonstration of Wireless Telephony, the transmitting station being situated at a member's house in Harbourne.

A gramophone concert was first given, followed by a speech from the operator, both of which were distinctly heard by all present.

A hearty vote of thanks proposed by the Chairman and seconded by Mr. J. J. Shaw was accorded.

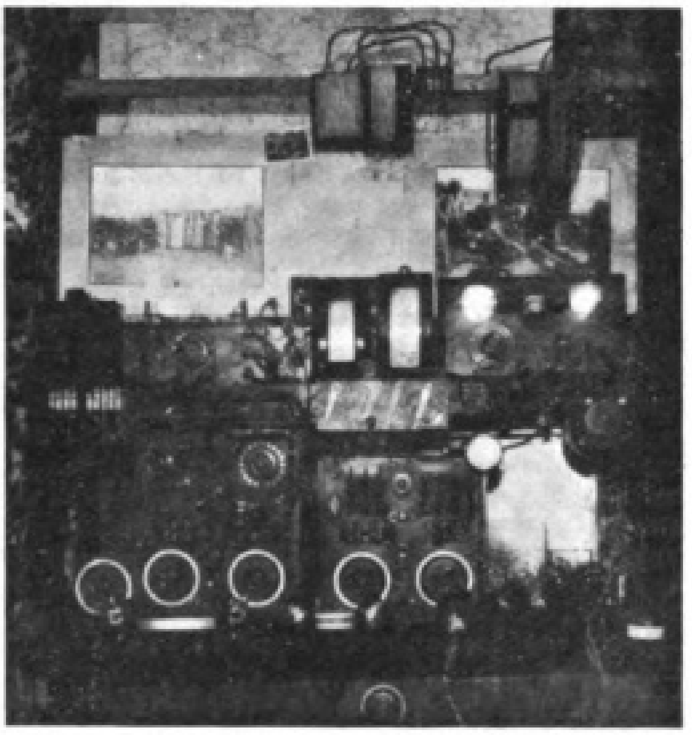
A meeting was held on Thursday, November 25th, at the Birmingham and Midland Institute, with Mr. J. B. Tucker again in the chair; present, 22 members.

Mr. Clinker, of Messrs. British Thomson-Houston Co., Ltd., Rugby, gave a lecture and demonstration on the B.T.H. portable set. By means of a portable cinematograph, which the lecturer had brought with him, he demonstrated some of the fundamental principles of valve apparatus and waves.

The lecturer explained that the B.T.H. set contained a small frame aerial, about one foot square, and the case mounted on a swivel stand, constituted not only a receiving set complete, but also a direction finder. Quite loud signals were heard by all present without the instruments being connected to the Club's aerial.

Mr. Tucker proposed a hearty vote of thanks, and complimented the lecturer on getting such excellent results in spite of the obvious difficulties presented by the building.

All those interested in wireless subjects are requested to write to the Secretary for particulars of membership, Mr. A. H. Handford, 188, Hamstead Road, Handsworth, Birmingham.



A portion of the apparatus used by the Sheffield and District Wireless Society.

Wireless and Experimental Association.

(Affiliated with the Wireless Society of London.)

The Association took possession of its new quarters at the Central Hall, High Street, Peckham, at 7.30 p.m. on December 1st. A very attentive audience listened to Mr. Langley's description of the design and construction of alternating current machinery. Several members showed short wave receiving apparatus of home construction, that of Mr. Foord compelling universal admiration with its micrometer adjustment of the reaction coil.—Hon. Secretary, Mr. G. Sutton, A.M.I.E.E., 18, Melford Road, E. Dulwich, S.E.22.

Preston Scientific and Wireless Telegraphy Society.

(Affiliated with the Wireless Society of London.)

The reception licence is now to hand, but the transmission permit has not yet been sanctioned by the P.M.G.

Our rooms are open to members three evenings a week, Tuesday, Wednesday and Thursday; reception on Society's apparatus by members will take place on Tuesday and Thursday evenings;

Wednesday evening being allotted to buzzer practice from 8 p.m. until 10 p.m.

We have also a series of lectures arranged for every alternate Monday evening (*i.e.*, first and third of every month) at 8 p.m.

Our membership is rapidly growing, but there are still vacancies for wireless amateurs on application to the Hon. Secretary, Mr. W. J. Bryce, 119a, Fishergate, Preston.

Glasgow and District Radio Club.

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

On November 10th, at a meeting in the Clubroom, Mr. E. Snodgrass gave an interesting lecture on "The Theory and Care of Accumulators." The lecturer fully described the construction of the various types of accumulators, and explained with the aid of symbols shown on the blackboard the chemical actions which take place during charging and discharging. The necessary precautions to be taken were emphasised, and many valuable hints on the proper care of accumulators were given.

For those privileged to listen to Mr. Snodgrass, there should be no excuse for having their accumulators in anything but first-class condition.

On the call of the Chairman, Mr. W. K. Dewar, a hearty vote of thanks was awarded Mr. Snodgrass.

At a meeting held in the Natural Philosophy Building of Glasgow University, on November 24th, Dr. G. E. Allan delivered a lecture on "Sound," with special reference to analogies in wireless telegraphy. The room was placed at the Club's disposal by the courtesy of Professor Andrew Gray, one of the Patrons of the Club, and between 50 and 60 persons were present. The Chair was occupied by Mr. Eric Snodgrass, one of the Club's Vice-Presidents, who, on introducing the lecturer, apologised for the absence of the President, Mr. R. Watson, the latter being confined to his room through illness.

The lecturer demonstrated how the pitch note depends upon the frequency, the volume, or degree of loudness, upon the amplitude of the vibrations, and the quality or richness of the sound upon the number of harmonics in a single wave. The limits of audibility were explained, these being between 30 and 25,000 per second, but vary with different persons and ages.

Reflection and Refraction having been dealt with, the lecturer proceeded to explain Interference, including "Beats." The beat phenomenon was illustrated by several methods which demonstrated clearly how two sounds of different frequencies produced audible beats. The beat-frequency in one case was adjusted by a sliding tube which was analogous to the variation of inductance in an oscillating valve circuit of a wireless receiving set. This, to many present, was the most interesting part of an excellent discourse.

Dr. Allan concluded his lecture with remarks on Resonance, after having spoken for an hour and a half.

A very enjoyable and instructive evening was spent, and on the motion of the Chairman, Dr. Allan and his assistant, Mr. Cochrane, were accorded a very hearty vote of thanks, which was passed by acclamation.

The Club's membership is growing steadily, 15 new members having been enrolled recently.

Intending members can obtain particulars of the Club from the Hon. Secretary, Mr. Robert Carlisle, 40, Walton Street, Shawlands, Glasgow.

Burton Wireless Club.

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

The ordinary fortnightly meeting of the Club was held at the offices of *The Burton Daily Mail* on Friday, December 3rd, Mr. A. Chapman presiding.

The question was raised as to whether it was not desirable to extend the studies of the Club to other branches of science and engineering, instead of simply specialising in the study of wireless. It was thought that if such a suggestion were adopted the membership of the Club (at present between 40 and 50) would be greatly increased. The consideration of the matter was deferred for the present.

Mr. T. W. Parkin, B.Sc., gave a very interesting lecture on "A Few Technical Terms used in Wireless Telegraphy and Telephony," which was followed by a discussion.—Hon. Secretary, Mr. R. Rose, 214, Belvedere Road, Burton-on-Trent.

Members of the Glevum Radio and Scientific Society.

Glevum Radio and Scientific Society.

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

The lecture arranged for Friday, November 26th, at the Royal Hotel, was postponed on account of notice being received respecting the Wireless Telephony demonstration on that date.

A temporary portable aerial was erected in conjunction with a 6-valve amplifier and loud speaker, and exceptional results were obtained.

Signals were so good that many of the guests residing in the hotel were attracted to the meeting, and became so enthusiastic that three new applications for membership were received, which brings our total senior membership well above 50, a most gratifying and encouraging result for such a newly-formed Society.

The meeting terminated by the Chairman, Mr. Courtenay Price, proposing a cordial vote of thanks to the Hon. Secretary, Mr. J. Mayall, for so kindly bringing the apparatus. Messrs. Hayward and Reynolds were also thanked for the use of a very good inductance.

We regret to lose the services of Mr. C. Smith who was on our Committee, and who has left us to take up an important position outside the neighbourhood. He leaves us with best wishes for his future welfare.

F. H. Corson, Esq., A.M.I.C.E., General Manager of the Gloucester Corporation Light Railway and Electricity Dept., has kindly agreed to accept the Vice-Presidency of the Society.

A highly interesting programme has been arranged for the winter session including demonstrations, practical and theoretical, on the following subjects: Wireless Telegraphy, and Telephony, Radiography, Tesla Coils, Microscopy, Photography.

We are fortunate in possessing a complete X-Ray and high-frequency apparatus, and this, together with highly sensitive recording instruments, places us in a very favourable position for the study of Science. In addition to the above, interesting social events have been arranged.

For particulars of membership and any information appertaining to wireless subjects will be furnished gratis to intending members.—Hon. Secretary, Mr. J. Mayall, "Burfield," St. Paul's Road, Gloucester.

Edinburgh Wireless Club.

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

At a Business Meeting of the Club, held on 1st December, a number of interesting questions were discussed in regard to our future policy.

It is particularly desired to raise the membership by a considerable number in order to extend the scope of the Club and to make its use more general both to the advanced experimenters and to beginners.

The Club apparatus at present available at its headquarters consists of long and short wave valve reception sets, a seven-valve H.F. amplifier, and a large assortment of instruments suitable for carrying out experiments with both valves and crystals.

While in every way satisfied with the progress which has been made, the members hope shortly to carry out further plans for the improvement of the Club. The Hon. Secretary would be glad to hear from gentlemen in Edinburgh and district interested in wireless and other relative scientific subjects, who would give the Club the benefit of their knowledge and experience.—Hon. Secretary, Mr. W. Winkler, 9, Ettrick Road, Edinburgh.

The Greenwich Wireless Society.

A meeting was held on Saturday, November 20th, at the Royal Observatory, Greenwich, the Astronomer Royal, Sir Frank Dyson, in the chair, for the purpose of forming a local wireless society. Owing to the rapid growth of wireless it was felt that Greenwich should, in company with other districts, have its wireless society. The meeting was attended by about 40 gentlemen, and it was agreed to form a society to be known as The Greenwich Wireless Society. It was decided that the annual subscription should be £1 1s., and the following officers were elected:—President, Sir Frank Dyson (The Astronomer Royal); Vice-Presidents, Prof. Fortescue and Mr. William Le Queux; Joint Secretaries *pro tem.*, Arthur F. Bartle, 27, Kidbrooke Park Road, Blackheath, S.E.3, and W. W. Burnham, 18, Blackheath Rise, Blackheath, S.E.; Hon. Treasurer, W. Fergusson, 15, Ulundi Road, Blackheath, S.E.3; Acting Sub-Committee, H. Fergusson, Inst.-Commander Ainslie, R.N. The meeting closed with a hearty vote of thanks for the great kindness shown by the Astronomer Royal in allowing the meeting to be held at the Observatory, for taking the Chair, and for consenting to act as President.

The joint Secretaries will be pleased to hear from gentlemen desirous of joining the Society.

Exeter and District Wireless Society.

A meeting took place at the Franklin Hotel, Fore Street, Exeter, on Friday, November 12th, when the above Society was formed and the officers elected. The rules of the constitution of the Society were drafted subject to ratification at the next meeting.

The co-operation of all members is earnestly requested and the benefits of membership cannot then be overestimated.

Months of hard work have resulted in perfect sets being made in our district, and we trust these experiences will be brought forward at some future meeting enabling experimenters to begin their work where others have left off.

After the general work at the next meeting the Hon. Secretary will exhibit a 7-Valve High and Low Frequency Amplifier and show the astounding results which may be obtained by coupling-valves in cascade.

Applications for membership are invited, and all interested should communicate with the Hon. Secretary, Mr. H. E. Allcock, 11, Richmond Road, Exeter.

Luxembourg Radio Club.

A meeting of the Club was held at 3 p.m. on November 7th. The meeting was opened by the President, Dr. R. Weckering, in the presence of 40 members.

After various business had been put before the meeting, Dr. Weckering was unanimously re-elected President.

Mr. Jean Lagrance then gave a discourse entitled "An Historical Record of Wireless Telegraphy." After the meeting, the members visited the station at the Ecole Industrielle et Commerciale, and also the private station of Mr. J. Wolff, the Hon. Secretary.

York Y.M.C.A. Wireless Club.

A very enthusiastic meeting of members of the York Y.M.C.A. and others interested in wireless telegraphy and telephony was held at the Y.M.C.A Headquarters, Clifford Street, York, on Wednesday, November 17th. The occasion was the opening of the "Polaris" apparatus which has recently been installed. An address was given by Mr. Alfred Cooper, one of the keenest of local amateurs, and the liveliest interest was taken in the proceedings, particularly in the receipt of messages which came through with great clearness. It was unanimously decided to form a wireless club and to organise classes for tuition. Offers of help were received from a number of wireless men with considerable experience, and the club promises to be one of the most successful in the country.

Tynemouth Y.M.C.A. Amateur Wireless Society.

An auspicious gathering was held on November 16th, at the Y.M.C.A., in connection with the official opening of this newly-formed Amateur Wireless Society.

Among those present were the President, Ed. Burnett, Esq., the Vice-President, Wilfred Hall, Esq., J. Stanley Todd, Esq., and a large number of members and friends.

In his remarks, the Chairman drew attention to the value of such a Society in fostering the experimental spirit, quite apart from the fascination of the science. Before calling upon Mr. Burnett to declare the Society open, the following messages of congratulations which were received by wireless from Poldhu, immediately before the opening, were read by the Chairman:—

"Her Highness Princess Helena Victoria sends her cordial congratulations to the Borough of Tynemouth Y.M.C.A. on their newest development, and trusts that the after-war work will increasingly represent the full programme of the Y.M.C.A. in reaching the largest number of boys and young men."

"Greetings and congratulations to the men of Tynemouth through the new Wireless Society of the Y.M.C.A. May this section strengthen the unseen fellowship of the movement.—Kinnaird."

The Hon. Secretary, Mr. Leslie Sims, gave in a few words a brief outline of the proposed programme for the coming months, which includes lectures, demonstrations, etc.

All communications to the Hon. Secretary, Mr. L. L. Sims, Y.M.C.A., Bedford Street, North Shields

Loughborough Technical College Wireless Society.

The Society will shortly be organised for evening classes in Morse and lectures.

A wireless house is being built on the roof of the College.

It is proposed to spend £100 on the first installation of apparatus; all firms are therefore invited to send catalogues, etc., to the Hon. Secretary, Capt. F. Pamment, addressing him at the College.

Croydon Wireless and Physical Society.

The Society proposes a resumption of its activities, suspended during the War. All communications to Acting Hon. Secretary, Mr. C. Harrison, 11, Carlyle Road, East Croydon (please enclose stamped addressed envelope).

The Society invites offers of demonstrations from manufacturers, etc., to include in their 1921 programme which is now being arranged. Meetings first Saturday evening each month.

Chiswick, Acton and District Amateur Wireless Association.

The above Society which unfortunately has been held back owing to lack of a convenient meeting room, has at last obtained accommodation in the district.

On and after Thursday, December 2nd, the Club will meet at 7 p.m. every Thursday evening at Belmont Schools, Chiswick (close to Chiswick Park Station, District Railway).

During the first two meetings a proper schedule of Club proceedings and arrangements will be drawn up, a new Committee formed, and the Club put on a proper working basis.

Several of the members now possess P.M.G. permits, and the majority of others are looking forward to the time when they will also have similar possessions.

The Club caters for the budding enthusiast as much as for the experienced amateur, and short instructive lectures are to be held to initiate beginners.

Prospective members, whether beginners or otherwise, are cordially invited to attend any one of our meetings. Full particulars of membership may be obtained on postal application to the Hon. Secretary, Mr. C. W. Hirst, 58, Agnes Road, Acton Vale, W.3.

Birmingham Experimental Wireless Club.

On Wednesday, December 1st, the Club held its first meeting at the new Club-room so kindly lent by Mr. Briggs, the Principal of the City School of Wireless. With Mr. E. Hendon in the chair, a most interesting lecture was delivered by Mr. L. Dove on the subject of "Test, Life and Behaviour of Dry and Wet Cells." The lecture was fully illustrated with voltage and internal resistance curves, and actual results of experiments with flash-lamp batteries for H.T. working with valves were given for the benefit of members.

The Hon. Secretary, Mr. A. T. Headley, of 255, Galton Road, Warley, near Birmingham, will be pleased to furnish all particulars of the Club, upon application.

The Walthamstow Amateur Radio Club.

At the meeting of the Walthamstow Amateur Radio Club on December 1st, Mr. Hardie, the Club's Secretary, read out an estimate from a local builder for the erection of the Club's aerial masts. After some discussion the estimate was accepted, and it is hoped that the aerial will be completed in a week or two.

The Hon. Secretary will be pleased to enrol new members and all particulars of membership will be supplied on application to Mr. K. Hardie, at 58, Ulverston Road, Upper Walthamstow, E.17.

Merstham Wireless Club.

A meeting of wireless experimenters will shortly be held for the purpose of forming an amateur Wireless Club in the district of Merstham. Will any reader whose wireless interest is centred about this neighbourhood kindly communicate with Mr. G. R. Wigg, Rockshaw, Merstham, Surrey, who will be glad of both co-operation and suggestion.

Loughborough Technical College.

Under the auspices of the Loughborough College Engineering Society a lecture on wireless telegraphy was given on Wednesday, November 24th, by Mr. Cole, of Messrs. The Marconi Wireless Telegraph Co., Ltd.

The students attended in force, and for an hour and a half gave an attentive hearing.

Mr. Cole demonstrated the history of wireless telegraphy from the early stages to the present time, and at the close, by means of a small frame aerial and a 6-valve receiver, signals were heard through a loud speaker from Carnarvon, Cleethorpes and Nauen.

Mr. Driver, manager of the works department of the College, gave welcome assistance in illustrating the lecture by means of lantern slides.

A vote of thanks to the lecturer was warmly accorded on the motion of Dr. Bramley, seconded by Captain Pamment, the organiser of the wireless section of the College.

All enquiries to be addressed to the Hon. Secretary Capt. F. Pamment, at the College.

Blackpool and Fylde Wireless Society.

A meeting of the Society was held on Thursday, December 2nd, at the Café Waldorf, Mr. Thomas Sharples being in the chair. A lecture was given by Mr. C. A. Goldwin on "The Elementary Principles of Wireless Telegraphy." Although the Society has only been in existence for a few weeks, the seating accommodation of the room was taxed to its utmost. The object of the lecture was to create an interest in wireless telegraphy, and to encourage beginners to take up this interesting study. Arrangements are now being made to secure permanent quarters where an aerial can be erected, and instruments installed. The Society hope at an early date to be able to settle down to serious experimental and research work. A vote of thanks was proposed to Mr. Goldwin for his instructive lecture by the Hon. Secretary, and seconded by Mr. F. Fish. Eighteen new members were enrolled at the close of the meeting.—Hon. Secretary, Mr. Lewis Pollard, 209, Cunliffe Road, Blackpool.

Stoke-on-Trent Wireless Club.

At a meeting of the Club on November 30th, an exhibition of members' apparatus was held. The N.S. Railway Electrical Dept. Wireless Society paid a visit to the Club, and an interesting evening was spent.

The Stoke-on-Trent Wireless Club has room for more members, and anyone in the district who is interested should apply for further particulars to the Hon. Secretary, Mr. G. H. Adams, 23, Park Terrace, Tunstall, Stoke-on-Trent.

Luton Wireless Society.

At an ordinary fortnightly meeting held on Wednesday, November 24th, Mr. L. Bird lectured on Static Electricity, giving interesting demonstrations and showing applications in wireless.

The licence applying to the Hitchin Road Boys' School has been extended to the Society, and several members have received licences for the erection of receiving apparatus.—Hon. Secretary, Mr. W. F. Neal, Hitchin Road Boys' School, Luton.

Ross-on-Wye Wireless Club.

A movement to form a wireless club at Ross-on-Wye is being conducted by Mr. R. S. Bates, c/o C. Elver, Esq., Yat Holme, Symond's Yat, who is most anxious to hear from amateurs in the district.

City and Guilds Wireless Society.

At a recent meeting of some thirty students it was decided to form a wireless society at the City and Guilds (Engineering) College, and the following officers were elected: President: Prof. G. W. O. Howe, D.Sc., M.I.E.E.; Hon. Secretary: Mr. H. W. Baker; Hon. Treasurer: Mr. H. Andrewes; Committee: Messrs. Warren, Wust, Giles and Swan.

It is proposed that meetings be held, as far as possible, once a fortnight, and buzzer classes will be started as soon as possible.

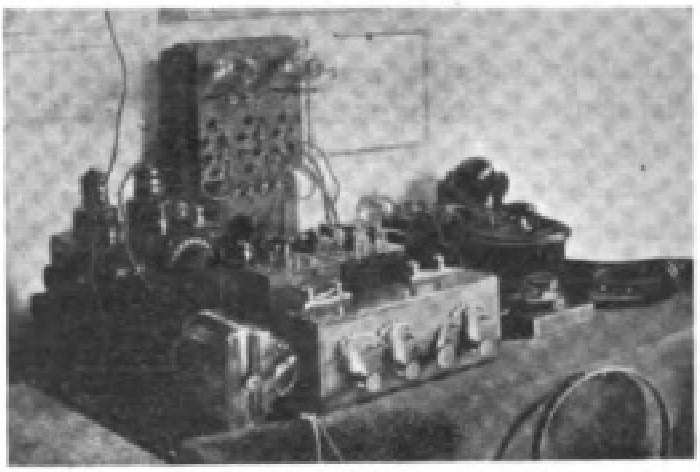
Arrangements for affiliation with the Wireless Society of London are being made. All enquiries to be addressed to the Hon. Secretary at the College.

AN AMATEUR RECEIVING STATION

THE accompanying photograph shows a simply constructed amateur receiving set belonging to Mr. G. W. Hale, of Malden. The set consists of two arrangements for tuning, one for short-wave reception and the other for long-wave.

For short-wave, tuning is made with a primary and secondary especially efficient on wavelengths between 120 and 1,100 metres; finer adjustments are obtained with a small condenser, of a type similar to that described in *The Wireless World* of February, 1920. Three valves in all are used, two being for amplification. For long-wave reception, *i.e.*, wavelengths between 1,000 and 20,000 metres, two inductances of the pancake type are introduced into the circuit.

Mr. Hale asserts that good results are obtained with the set. Annapolis and New Brunswick being audible both day and night, when using one valve only. Reception is also good on the amateur wavelength of 180 metres



Mr. G. W. Hale's neat set.

PAGES FOR BEGINNERS

DIRECTION FINDING

THOUGH we are apt to consider the invention of Direction Finders as the outcome of the war, the question of directive wireless telegraphy is one that has engaged the attention of wireless engineers since the earliest days. In 1905 Marconi found that an L-shaped aerial gave a maximum strength of signal when the transmitter was placed in a line with the horizontal wire, and in an opposite direction to that of the free end. The practical application of this discovery was limited in the case of an L-shaped aerial, in that it was impossible to manœuvre the aerial into the best position for each set of signals received.

The action of the Marconi directive aerial is somewhat difficult to understand and hence the principles underlying directive reception can be better understood by referring to later types of aerials. Let us consider the case of two vertical aerials placed a short distance apart, with the receiver connected between them. This type of directive receiver was introduced by S. G. Brown in 1899, and is sketched in Fig. 1.

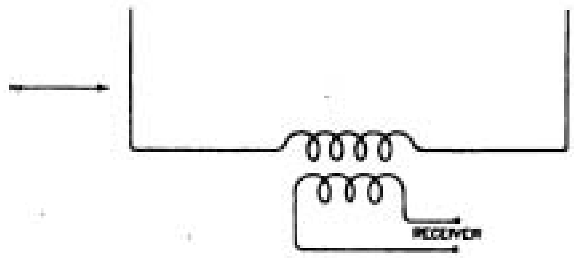


Fig. 1.

Imagine a wave travelling towards the aerial in the direction indicated by the arrow. If the distance between the aerials is equal we can understand that the first aerial will have a maximum effect induced in it, while the eff.ct in the other will be "out of phase."

It would be as well here to define the exact meaning of phase for the benefit of those who are not conversant with alternating current th ory.

Two current or e.m.f. waves are said to be *in phase* when the maximum value of one coincides exactly, in point of time, with the maximum of the other. Fig. 2 (*a*) will illustrate the point clearly, while (*b*) shows the meaning of the words "out of phase."

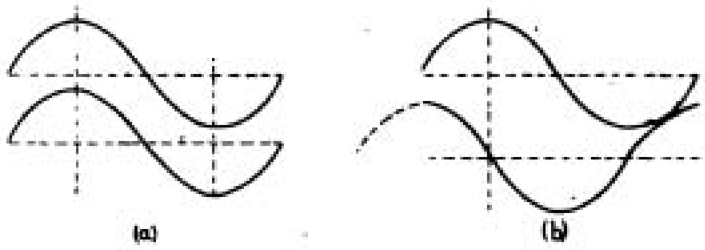


Fig. 2.

It will be seen that the maximum value of one curve occurs at the same time as the zero value of the other. In the case of the two aerials spaced half a wavelength apart, a point at the maximum value of the wave will, at a given instant and time, strike aerial 1, while aerial 2 is acted on by a portion of the wave near the minimum value (Fig. 3).

Current will, therefore, flow through the receiver from No. 1 to No. 2.

Now consider a wave travelling in a direction perpendicular to the plane of the aerials. There will be no phase difference between the current in the aerials in this case because the wave will reach both aerials simultaneously. The currents in the receiver due to both aerials will "wipe out," so to speak, and no signals will be heard.

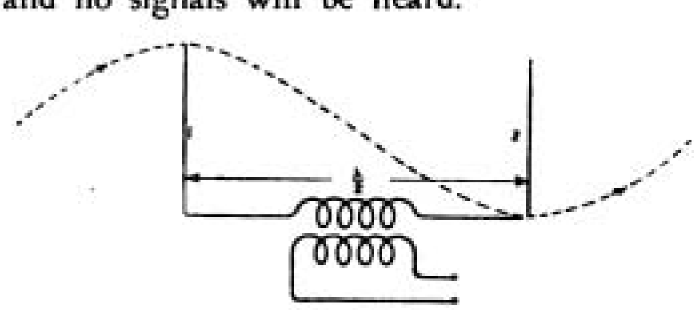


Fig. 3.

Suppose now we mounted the aerials on a rotating frame, so as to gradually swing it round while signals were being received. The sound in the telephones would increase as the plane of the aerials coincided with the direction of the transmitter and would then die away gradually as the plane finally became at right angles to the direction of transmission. By this means we could determine approximately from which direction the signals were coming, but with this reservation :—

If we stood in line with the aerials and transmitting station, it would be impossible to tell whether the station was situated in front or behind us. The effect of the incoming waves on the aerials would be the same, whether the wave was travelling as in Fig. 1, or in the opposite direction.

A method of overcoming this difficulty is to erect a third plain aerial at the receiving station and connect it to the receiving circuit. The effect induced in this aerial will be quite independent of the direction of transmission, but to the receiving circuit, the waves due to this aerial will either have an additive or subtractive effect on the waves due to the

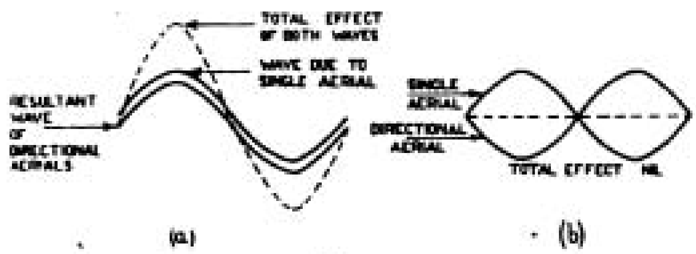


Fig. 4.

directional aerials. The phase of the two waves will either differ completely or not at all (Fig. 4). Now there will only be one maximum reading, and that when the first of the directional aerials is pointing to the side nearest the transmitter.

In practice, however, the third aerial is usually dispensed with, as the cases where confusion of place arises are somewhat rare. For ships at sea, ambiguity of place is seldom likely to arise.

The twin-aerial system of direction finding was further improved by Messrs. Bellini and Tosi in their "radiogoniometer."

This consists of two coils placed at right angles to one another, each coil being connected to a directive aerial. In the middle of the two oils is pivoted a third coil, capable of being rotated through an angle of 360°, and having a pointer and scale attached. This coil is connected to the receiving circuit (Fig. 5).

The directional aerials are in the form of two triangles (Fig. 6), about forty feet high.

The action of the "wireless compass," as it is termed, is easily understood from the preceding paragraphs. When the direction of the transmitter is in the same plane as one of the aerials, the coil connected to that aerial will have an oscillatory current induced in it, and if the moving coil is turned in a

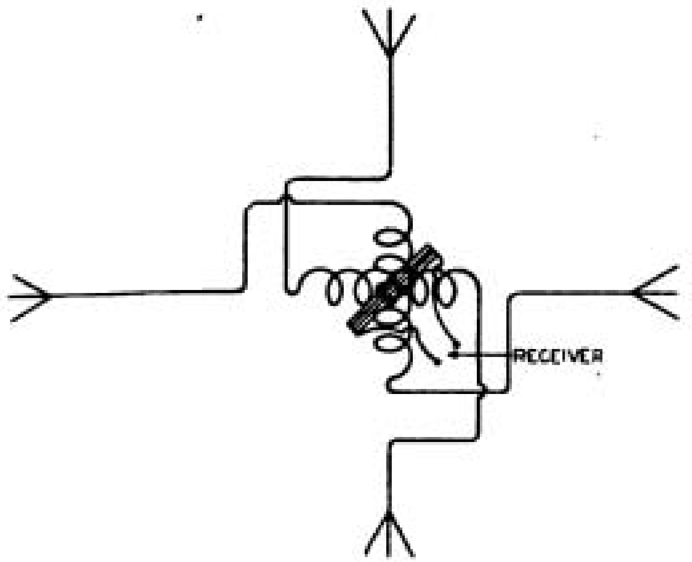


Fig. 5.

parallel direction, the strength of received signals will be a maximum. If the direction of incoming signals changes to a plane at right angles to the previous one (in the case of a ship, if she turned at right angles to her previous course), the other directional aerial would be affected, and the moving coil would have to be rotated through 90° to obtain the maximum signal strength.

Finally, let us take a case where the incoming waves are at 45° to each aerial (*i.e.*, they bisect the angle between them), as in Fig. 7. The effect on both aerials will be the same, and if the moving coil is turned to a position midway between them, the strength of signal will be a maximum. At first sight it appears that we shall get another maximum value if the coil is at right angles to the incoming wave, as shown by the dotted coil in Fig. 7. This will not be the case, however, because the current induced in the "back" part of aerial A will be out of phase with the current induced in the front part of aerial B. The two currents will be annulled in the moving coil when it is placed between them, and thus zero sound will result.

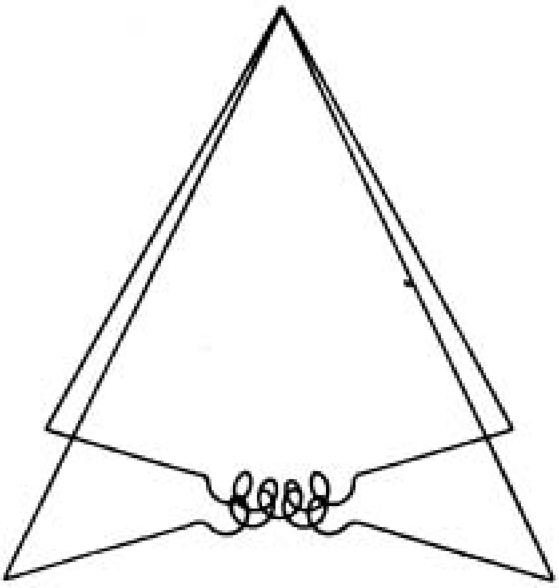


Fig. 6.

An interesting point which might be noted here is that in practice it is sometimes customary to note the minimum strength of signal, and take the direction of the transmitter as being at right angles to this position of the coil. It is usually found that a difference of two or three degrees make an inappreciable

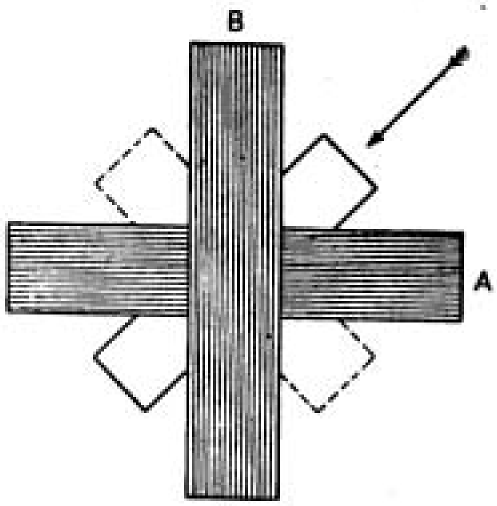


Fig. 7.

difference when listening to maximum signals, while the zero value is fairly sharply defined. Alternatively, two positions could be found at which the signal strength was the same, and the maximum taken as lying midway between these points.

The CONSTRUCTION *of* AMATEUR WIRELESS APPARATUS

A FRAME AERIAL RECEIVING SET—V.

The H.F. Amplifier Panel—(contd.)

CONTINUING from our last issue the next item to receive attention is the potentiometer; this should have a resistance of approximately 250 ohms, and may be made in circular form after the style of the filament-resistance. The necessary resistance will be obtained by winding with No. 36 bare Eureka wire, which has a resistance of approximately 1 ohm per 3" length. A neat former can be made by using a strip of Bristol-board $\frac{1}{32}$" thick, 8" long, and 1¼" wide. The resistance wire should be tightly wound on to the former, together with an ordinary stout cotton thread, slightly smaller in diameter than the wire. This method of insulating the turns from one another, is much better than using covered or enamelled wire and rubbing off the insulation for the slider.

A space should be left at each end of the former, and brass paper-clips fitted, to which the ends of the wire can be soldered. The average number of turns of wire per inch will be about 40, and if we use about 6¾" to 7" of the former, the resistance will be approximately 250 ohms. When the former is finished it should be securely mounted to the periphery of a wood block 2¾" diameter and 1" diameter, by means of wood screws through the ends of the former.

This block should be mounted to the panel by means of two wood pillars, 2¾" high, 1⅝" wide, and ¼" thick. The block may be secured to the pillars either by means of wood screws passing right through the block, or by screwing a wood disc, 2¾" diameter and ⅛" thick, to the pillars, and then screwing the disc to the back of the block. The block should have a ¼" clearance hole through its

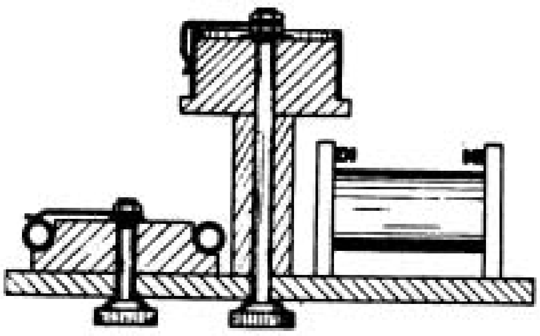


Fig. 11.

centre, and should also have a large brass washer screwed to its top to act as a bearing surface. Secure the pillars to the base through the four holes in the centre of the bottom half of the panel. Fit a spindle and slider arm, as shown in Fig. 11. The first-named should be of ¼" brass rod, 4½" long, to one end of which is fitted a small ebonite or wood knob; the other end being screwed ¼ thread for about ½ an inch. After placing the spindle in position, first fit a spring washer to rub against the brass bearing surface on the potentiometer block, next fit a ¼" hexagon nut, then the slider arm and another nut. Lock the nuts so that there is just sufficient tension on the spring washer to give a smooth movement when turning. The slider arm should be made of flexible strip brass, and its tension adjusted so that while good contact is assured the wire is not likely to be cut.

It should be noted that the centres of the spindle holes should be 1⅞" and not 1⅝", as given in Fig. 7, November 27th issue.

The last item is the telephone transformer. This is mounted on the bottom right-hand corner of the panel, and is outlined in Fig. 11.

The following material will be required for its construction :—6 ozs. No. 30 S.S.C. copper wire, 3 ozs No. 44 S.S.C. wire, 4 ozs. No. 24 bare soft-iron wire, and two hard-wood end cheeks, 2½" square and ¼" thick. A small quantity of paraffin wax, ⅛" rubber tube, and insulated tape, will also be required.

Drill a ½" hole in the centre of each cheek and cut the iron wire into 2½" lengths. Make up the core (with the iron wire) to a diameter of ½", and fit the end cheeks. Keep adding iron wire until the cheeks are firmly secured, after which insulating tape should be bound round the core.

The No. 30 winding which we will call the secondary, is wound directly over the insulated core. A small hole should be drilled through one of the cheeks, just above the core, and the wire covered with a short piece of ⅛" rubber tubing should be passed through the hole. The first two or three turns should be bound with cotton to take the pull on the wire, after which carry on winding, going from one side to the other and back, in even layers, until the 6 ozs. are used up. Windings should be made in the same direction, and an even pull on the wire maintained.

It will be found easier to wind over the bobbin, *i.e.*, turn the transformer bobbin clockwise, feeding the wire through the finger and thumb — the reel of wire being mounted on a screw-driver held in a vice. The last turn should be finished with a cotton tie (to keep the winding tight), and the end taken through a hole in the cheek (the same side as the start) just above the winding. Wrap two or three layers of waxed paper round the secondary as this insulates one winding from the other and gives an even surface upon which to commence winding the fine wire.

The primary winding should be wound in the same manner as the secondary, and the ends taken through the cheek opposite to that through which come the secondary ends. More care must be exercised with this winding than with the secondary as the wire being much finer is more easily broken, and the insulation rubbed off. Watch for bad places in the insulation, where it will be necessary to cover the wire with a small piece of cotton wool.

When both windings are finished, the continuity of the circuits should be tested with a pair of telephones and dry cell, before waxing. The secondary winding will give a much louder click, owing to its resistance being lower than that of the primary. Both windings should give a click when the circuit is made, and a similar click when it is broken. If there is a break in one of the windings a faint click will be heard when making, and nothing when breaking the circuit. This is due to a small charging current, caused by the capacity effect of the broken circuit. A similar click is given if the cell and telephones are connected to one side of the secondary and one side of primary. If this test gives satisfactory results the transformer may be placed in a bath of melted paraffin wax, to impregnate the windings, where it should remain for half-an-hour and then allowed to drain; finish off with two or three layers of waxed paper. When finished mount it on to the panel, taking care that it does not foul the potentiometer.

When all parts are made and mounted, the panel may be wired up.

For all H.F. amplifiers the connecting wires should be as short and direct as possible, a very good plan being to use stiff bare wire.

Procure some No. 18 bare copper wire and make the connections as shown in Fig. 12. All the joints should be soldered—first of all tinning the screw heads and also the ends of the wire. Do not hold the soldering-iron on the screw heads too long, otherwise the ebonite will soften and loosen the clips. Do not use any acid soldering paste, but use

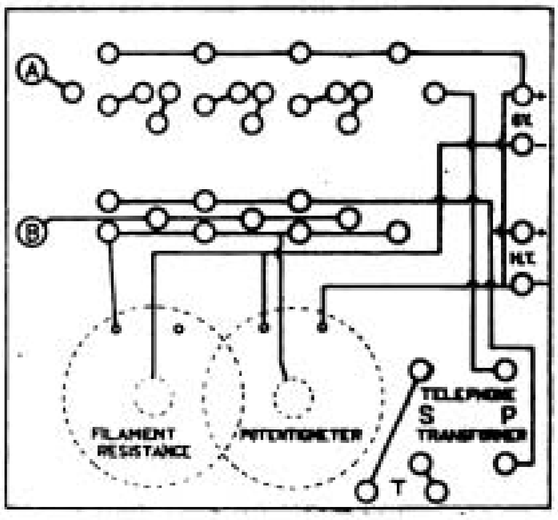


Fig. 12.

instead a flux of resin dissolved in methylated spirits. Acid flux will in time eat away the wire connection. When all joints are made test the continuity with the cell and telephones. Good joints will give sharp clicks—bad ones a continuous rumble in the phones. Where wires cross, place a piece of Cistoflex tubing over one of the wires to avoid short-circuits.

Note.—In the November 27th issue the thickness of the ebonite panel was given in error as $\frac{3}{8}$"; it should have been $\frac{1}{4}$".

TRADE CATALOGUES

H. D. Sullivan.—The catalogue "W.2." referred to in our issue of October 30th, is now available.

Economic Electric Co.—This firm of electrical engineers has recently published a new catalogue of wireless apparatus.

The Edison Swan Electric Co. have recently sent us particulars of the "Ediswan Acme Accumulator." These storage batteries are of special design and would-be buyers of accumulators would do well to consult List No. BB179.

Messrs. Radio Supplies, 12 to 14, Red Lion Court, Fleet Street, E.C., wish to bring to the notice of all wireless experimenters and amateurs that the list issued by the Firm is reprinted at least once a month, thereby insuring customers of buying at the correct prices.

Messrs. Burnham & Co. have recently published a sectional catalogue of wireless apparatus suitable for amateur purposes.

Waterman Pens. The makers of these pens have recently sent us an illustrated catalogue, which would seem to be full of suggestions for overcoming that perplexing question.—What shall the Christmas gift be?

QUESTIONS AND ANSWERS

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

ZINCITE (Portsmouth) *asks* (1) *What is the wavelength in metres of a coil, 10" long, 1½" wide, wound with No. 28 silk-covered wire.* (2) *Would the coil in question* (1) *be capable of receiving from the Eiffel Tower and other large stations in a circuit of which he gives the diagram.* (3) *For criticism of an aerial of which sketch is enclosed.* (4) *If the lead-in wires of an aerial used for crystal work must be of a high tension.*

(1) The wavelength of a coil depends on the circuit in which it is included (except of course where the natural period of the coil itself is meant; this information is of no value from your point of view). See answer to (2).

(2) The coil in a standard P.M.G. aerial would tune to 1,700 metres, which is too short for Eiffel Tower. Apart from this your circuit is wrong; see article in issue of September, 1919, regarding typical crystal circuits.

(3) Quite satisfactory.

(4) They must be well insulated, if that is what you mean.

D.D. (Haarlem) *asks for a diagram of a wireless control apparatus similar to that on page 387 of the present volume, but simplified, only starting and stopping of the motor being necessary.*

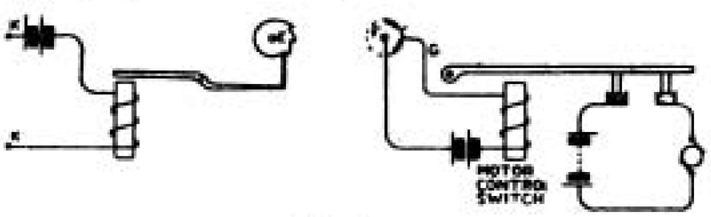


Fig. 1.

We suggest an arrangement on the lines of Fig. 1. The arrangement of aerial, coherer and decoherer is as before, but the relay terminals are connected only to the coil actuating the ratchet wheel E. This and the commutator F are as before on a common axis D. The commutator consists of a copper cylinder, into the circumference of which are inserted insulating strips, thus dividing it into equal segments of conducting and insulating material. The total number of segments is the same as the number of teeth in E, this being supposed even. The commutator is provided with a brush G, and a circuit is made or broken through the switch which controls the starting and stopping of the motor. A single dot will in this case start the motor if stopped, and stop it if running.

A.B.C. (Essex) *sends sketch of a proposed valve transmitter, and asks* (1) *If circuit is suitable.* (2) *What gauge wire to use, and what size formers.*

(1) The set is not quite suitable as shown, a condenser should be added as shown dotted in Fig. 2. The earth should also be as shown.

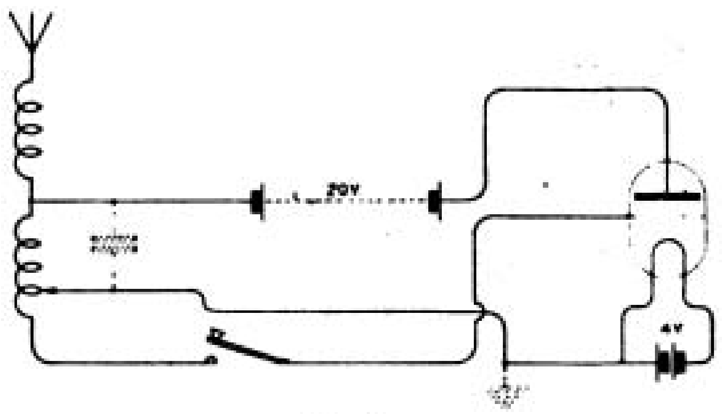


Fig. 2.

(2) About No. 10 wire would be suitable. We are afraid we cannot give the size of formers without knowledge of the required wavelength, which you do not state

G.D.D. (Bishop's Stortford) *encloses diagram of a single-valve receiver with a crystal in the plate-circuit for rectification purposes and asks* (1) *If the circuit is correct for receiving spark and C.W.* (2) *What is the inductance of his A.T.I. which is 12" × 3½" wound with No. 28 enamelled copper wire, ½" being left unwound at each end.* (3) *With reference to his licence, which is to use a receiving set without valves, how many circuits is it necessary to furnish to obtain authority to use valves.* (4) *If a 20 ft. lead to a water-pipe will be too long for an earth.*

(1) It is a very doubtful policy to connect a crystal in the plate-circuit of your valve. You should include a tuned circuit and place your detector-circuit in parallel with the condenser. See issue of September 18th for diagram of such a circuit (Crystal Receiver with Valve Magnifier).

(2) About 116,000 mhys.

(3) Only one circuit is necessary.

(4) It should not spoil reception completely, but may weaken signals.

E.C.S. (Thornton Heath) *encloses a diagram for criticism. He asks further*—(1) *With reference to his telephone transformer which has two terminals unlettered and two marked 18 and OS, should the unlettered terminals be connected to telephones.* (2) *What ranges he might expect to get without any inductance.* (3) *To what wavelength could he load it to receive efficiently.* (4) *If 50 to 70 volts H.T. will be all right with V24 valves.*

You give no indication of the nature of your intervalve transformers, but as far as we can understand them your circuits are diagrammatically correct. The capacity of your tuned circuit condenser (·001 mfds.) is too large; better, ·0003 mfds. Your last valve should be a Q or your present one provided with a grid condenser and leak. A potentiometer for the two amplifying valves is advisable.

(1) We do not know. The resistance winding should be in the valve circuit.

(2) With ·001 mfds. up to 3,600 ms. With ·0003 mfds. up to 1,900 ms.

(3) You cannot receive efficiently on a much higher wavelength than those given. More turns are required on the loop. See diagram on page 185 of the June 12th issue.

(4) Yes, with negative potential on the grids of the valves.

CARBORUNDUM (Monkseaton) *asks* (1) *In a P.M.G. aerial is it necessary for the length of the earth lead and the length of the down-lead to be deducted from the 100 ft. allowed.* (2) *In purchasing apparatus from friends, is it necessary to have a permit from the P.M.G.* (3) *Is it necessary to produce a licence before or after erecting a receiving station.*

(1) The down-lead should be deducted, but we believe not the length of the earth lead.

(2) Yes.

(3) Before erecting the station.

ARDENT (Llantwit Vardes) *encloses circuit for criticism, and asks* (1) *Is the circuit suitable for use with honeycomb type coils, and if so, could C.W. be dispensed with without affecting the efficiency of set.* (2) *Should fixed capacities be placed across the primary windings of the intervalve transformers.* (3) *When using 1 Q and 2 V24 valves or 1 R in place of Q, these transformers should be air or iron cored.* (4) *Should resistances be placed in series between H.T. battery and primary of the transformers, also between H.T. and plate of 3rd valve, and if so what values.*

The Q valve is unsuitable for rectification with grid condenser and leak, except with very high H.T. which would not be suitable for V24 valves. Better omit condenser and leak, or use an R valve in place of the Q, as you suggest. The telephone transformer should be situated on the positive side of the H.T. battery, and not in the common circuit of the three valves. A by-pass condenser (·003 mfds.) is required from the common point of the reaction coil and the first transformer to earth. (N.B.—Grid condenser and leak method applies to both spark and C.W.)

ANONYMOUS (Preston) *asks* (1) *Who are SXG and RAF.* (2) *When will the new Year-Book come out with the up-to-date 4-letter calls.* (3) *For a description of the peculiarities of Q, R, B, and V24 valves, or for a reference to past articles describing these.*

(1) These stations are unknown to us.

(2) Probably in February of next year.

(3) We regret we cannot refer you to past articles, and it is clearly impossible to treat such a subject adequately in these columns. Q valve: Used for rectification with 50 volts H.T. on lower bend of characteristic. Grid connected to negative of filament. Amplifies with 200 volts H.T.: can also be used as grid-condenser rectifier at this voltage. R. valves—Used as amplifier, as grid condenser rectifier with 75 volts H.T.; will also rectify on top bend of characteristic. For amplification, slight negative potential on grid desirable, or less H.T. voltage can be employed. Good oscillator. B. valve:—Similar to R. valve but harder. Can be used as generator of more powerful oscillation for wireless telephony by employing about 400 volts H.T. V24 valve:—Can be used with 24 volts H.T. Particularly useful for high resistance transformer amplifiers. Requires more reaction than previous valves to generate oscillations.

F.J.M. (W. Hampstead) *asks* (1) *How will an ordinary buzzer transmit if base line is 25 ft.* (2) *What is the lowest resistance telephone-receiver that can be used.*

(1) Impossible to give a definite figure, so much depending upon local conditions, the buzzer, and the amplification at the receiving end. With considerable amplification you might possibly cover some hundreds of yards but without amplification we doubt if you would cover a hundred yards with such a short base line.

(2) For use in this way, telephones with a resistance not less than 100 ohms. will be suitable.

B.K.E. (Seacombe) *asks* (1) *If an aerial as in Fig. 3 will be efficient.* (2) *If the effective height of the aerial is 75 ft. or* (3) *Is the proximity of the roof detrimental.*

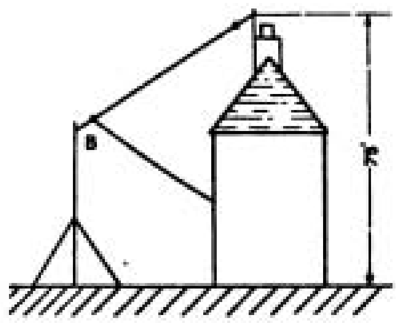


Fig. 3.

(1) An aerial of this type is certainly not very efficient for various reasons, as the bend back at B—, and the screening due to the house. We cannot say how bad it is, however, without knowing the dimensions of the various parts which you do not give.

(2) The mean effective height would certainly be less than 75 ft., the height of the highest point. It would probably be somewhere round half this figure.

(3) The detrimental effect of the roof will be considerable if there are only a few feet between it and the aerial.

E.W.A. (London) *encloses specification of his receiver and asks* (1) *For the best connection of a valve detector to his set.* (2) *The necessary alterations or additions for increasing the wavelength to, say, 2,000 metres.* (3) *The approximate ranges using a standard P.M.G. aerial 30 ft. high.* (a) *With crystal only.* (b) *With valve.*

QUESTIONS AND ANSWERS

(1) See Fig. 4. The part of the sketch on the left of the dotted line constitutes your original apparatus.

(2) Add inductance to both open and closed circuits. This may be done by inserting separate coils in series with your existing primary and secondary inductances. You do not state sizes or values of the latter so we cannot give any exact information. Your best course is to go on adding inductance until you get the required amount.

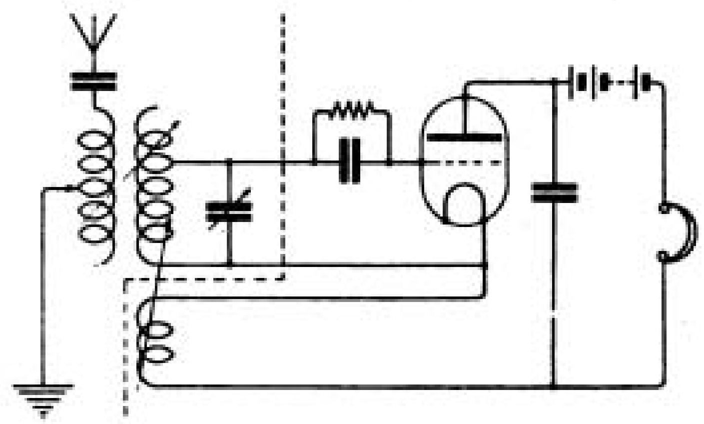


Fig. 4.

(3) It is impossible to say, as so much depends upon the workmanship of the set, the proficiency of the operator, and many other things.

F.B. (Bradford) *asks* (1) *If we can recommend a good instruction book on the making and use of a wireless telegraph set.* (2) *For the connections of the rotary studded disc in the Marconi system of high-frequency production, and if it is true that frequencies from* 1 *to* 100,000,000 *can be obtained by this method.* (3) *For any properties (electrical or chemical) of the substance Pitch Blende (used in radium extraction).*

(1) Follow the constructional articles in *The Wireless World.*

(2) Connections are as given in Fig. 5.

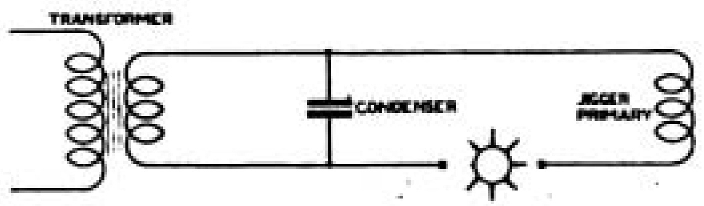


Fig. 5.

The frequency of the H.F. produced, depends on the values of the capacity and inductance of the circuit. The efficient limits of H.F. are about 50,000 to 2,000,000. The discharge-frequency depends on the number of studs and speed of disc, and is of the order of 600.

(3) Pitch-blende is a mineral of rather complex nature, the greater part of which consists of an oxide of uranium of constitution probably UO_2 $2(UO_3)$. It contains also minute traces of radio-active substances. In view of the latter constituents the mineral possesses very slight radio-active properties, but we are not aware of any other special electrical properties associated with it.

FED UP (Sydenham) *describes his receiver with which he states he has heard nothing; he asks* (1) *For our views on the above.* (2) *If in the circuit shown (Fig.* 6) *it is correct to tune:—(a) So that the product of the aerial capacity, and the sum of the aerial inductance, and the inductance of* AB *is equal to the product of the inductance* BC *and the capacity* DE *shunted across it, both products corresponding to the required wavelength: or (b) so that the inductance* BC *and the sum of the aerial capacity and the capacity* DE.

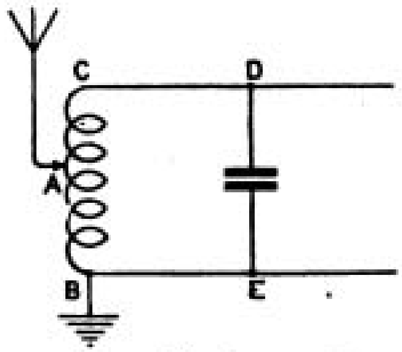


Fig. 6.

(1) We have read your description closely and can see no reason for your getting no signals. Your gauge of wire is small, and, as you suggest, the insulation may be faulty. Have you tested various parts of your apparatus?

(2) Your suggestion (*a*) is more nearly correct than (*b*). It is clear that as the inductance AC is included in the circuit BACDE, and not in the aerial circuit, these two must be regarded as distinct circuits, being in fact a pair of oscillating circuits coupled together by an auto-jigger. In this case the wavelength of the two circuits together is not the same as that of either by itself, only approaching it when the coupling is very weak, *i.e.*, when AB is very small in comparison with BC.

C.F. (St. Annes-on-Sea) *asks* (1) *What will be the capacity of a home-made pocket accumulator,* 4 *volts, two plates in each cell, each plate having an active surface of* 15 *square inches.* (2) *If it is possible to make an oil condenser using zinc plates, and if so what size and number of plates for a capacity of* ·0003 *mfds.* (3) *What is the best oil for the above.* (4) *If it is possible to convert* 240 *volts* D.C. *down to a lower voltage, say* 20 *to* 50 *volts, for general testing purposes.*

(1) We cannot say exactly; if 15 square inches is the area of each side of each plate, probably about 8 amp. hours; if 15 square inches represents the area of both sides of a plate, about half this.

(2) Yes, but we do not recommend it. The dimensions will depend on the use for which it is required—if for reception, the plates may be as close as they can be arranged without touching. If for transmission, space about 1/10th inch for each 1,000 volts.

(3) Any good mineral oil, dry, and of fairly high flash point will be suitable.

(4) Unless you use an expensive motor generator set you can either drop some of the voltage by means of a resistance, (*e.g.*, lamps), which is most convenient if you want currents of 1 amp. upwards,

or else use a potentiometer (of resistance about 1,000 ohms), if small currents, say less than ½ amp. are required.

C.A. (Liverpool) *states that he has been warned by the P.M.G. not to use a radiating receiving circuit on account of his proximity to GLV, and asks (1) For a diagram of a good combination for a crystal detector. (2) For a diagram of a good non-radiative circuit with 2 valves and crystal rectification for spark, C.W. and telephony. (3) With reference to his diagram of an aerial, what would be the best height at the chimney end.*

(1) See article in issue of September 18th.

(2) You should use a separate heterodyne. This will ensure that there is no radiation, and will very much improve your set in point of selectivity, though you have to employ an extra valve. Fig. 7 shows one possible arrangement.

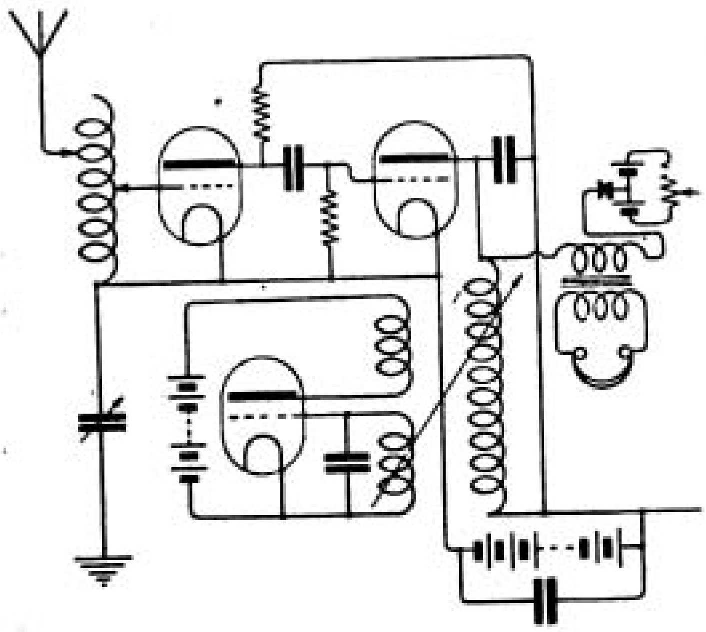


Fig. 7.

(3) Broadly speaking, the higher the better.

R.A.H. (Nottingham) *asks (1) If a telephone transformer can be used with crystal set. (2) If an ordinary telephone induction coil could be easily altered to make a telephone transformer for telephones of 1,000 ohms; if so, how. (3) What range hot wire ammeter would he need for his aerial-circuit, using a 1" spark coil. (4) Which of two sketched aerials is the better.*

(1) Certainly.

(2) No; primary would have too low a resistance. In any case a telephone transformer, however well proportioned, is of doubtful utility with telephones of as high resistance as 1,000 ohms.

(3) We cannot say exactly without more data with regard to the set, but a range of 0·1 amps. will probably be suitable.

(4) Neither is at all good. If at all possible we should prefer as in Fig. 8, raising the height of mast as much as you can.

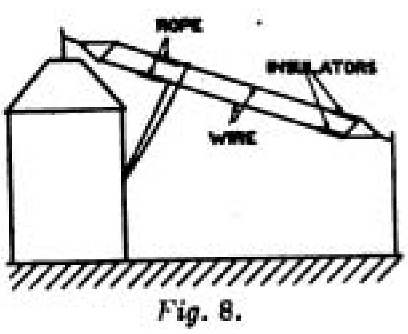


Fig. 8.

BOTHERED (Bayswater) *sends a sketch of a receiver and asks (1) For criticism. (2) If we can recommend other gauges of wire for the coils. (3) If we can recommend a coil to receive FL without any tappings or condensers, good tuning not essential. (4) If there are any amateurs with transmitting licences near him.*

(1) and (2) The type of receiver—a two tuned circuit type—should be satisfactory. We regret the samples of wire sent have got mislaid, (all samples should be very firmly fixed to covering letters). We should have thought that you were hardly using large enough coils in either circuit, but as your tuning appears all right we should recommend not altering the windings unless you wish to receive longer wavelengths. The set should be efficient up to about 3,000 ms. with suitable coils.

(3) A coil 9" × 6" wound with No. 24 should be satisfactory with a P.M.G. aerial.

(4) See paragraphs headed **Amateur Call Signs** as from October 16th issue.

"DOT" (Dorchester) *sends a sketch of a proposed transmitter, using an ignition coil and auto-coupled circuits. She asks (1) How far she could transmit. (2) If connections are right. (3) If not, could we publish connections.*

(1) The connections are quite correct, but you will not get satisfactory tuning or range with a transmitting condenser as small as you suggest; the capacity is about ·0005 mfds. For a set of this type you should try capacity at least 6 times as big. Preferably immerse your condenser in insulating oil.

SHARE MARKET REPORT.

Business has been very quiet in the Wireless Group during the last fortnight. Prices as we go to press (December 16th) are:—

Marconi Ordinary	£2 - 8 - 9
,, Preference	£2 - 7 - 6
,, Inter. Marine	£1 - 5 - 0
,, Canadian	7 - 0