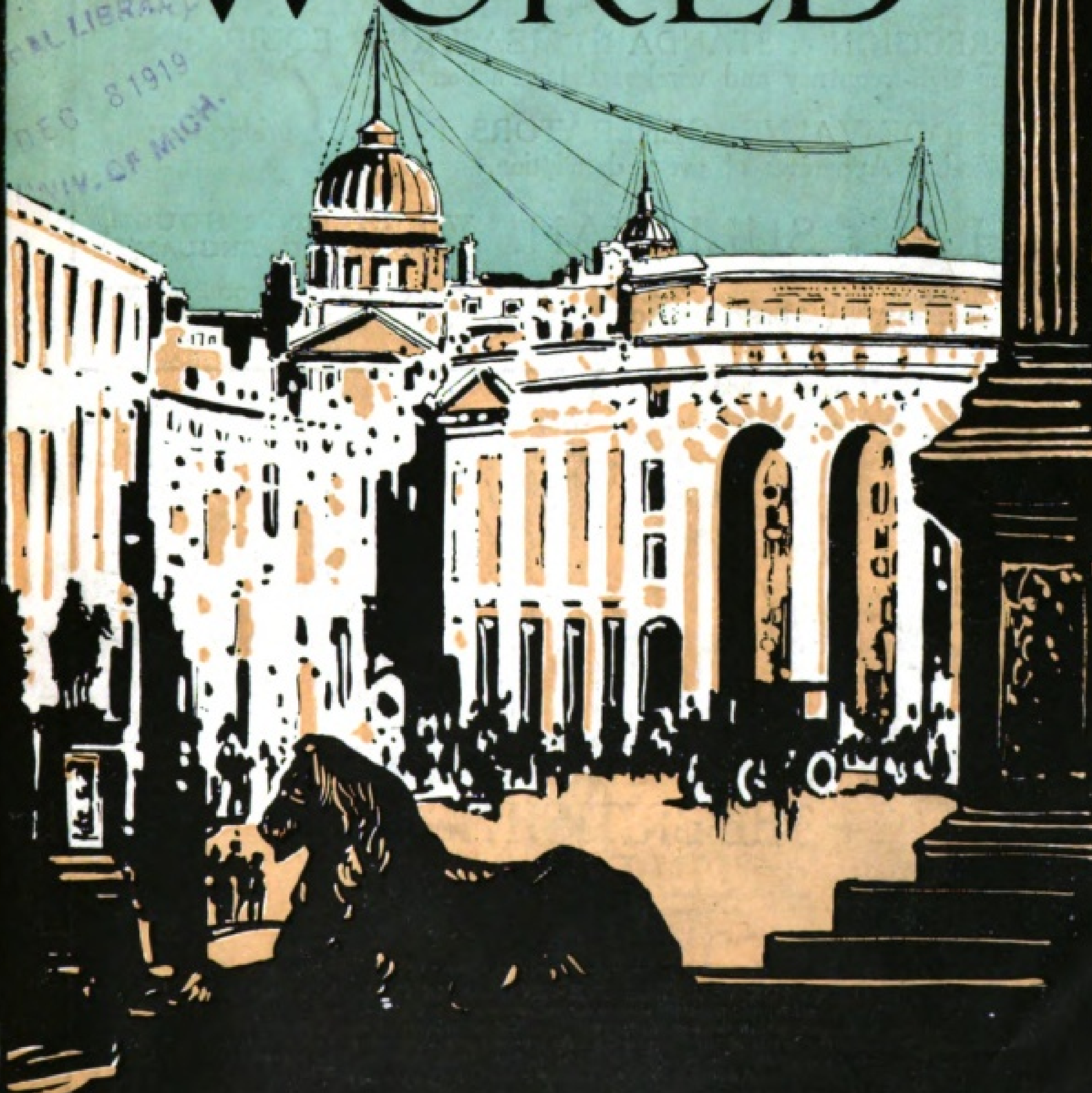
The WIRELESS WORLD



THE WIRELESS WORLD

No. 80 Vol. VII

NOVEMBER, 1919

Great Wireless Stations

TOWYN

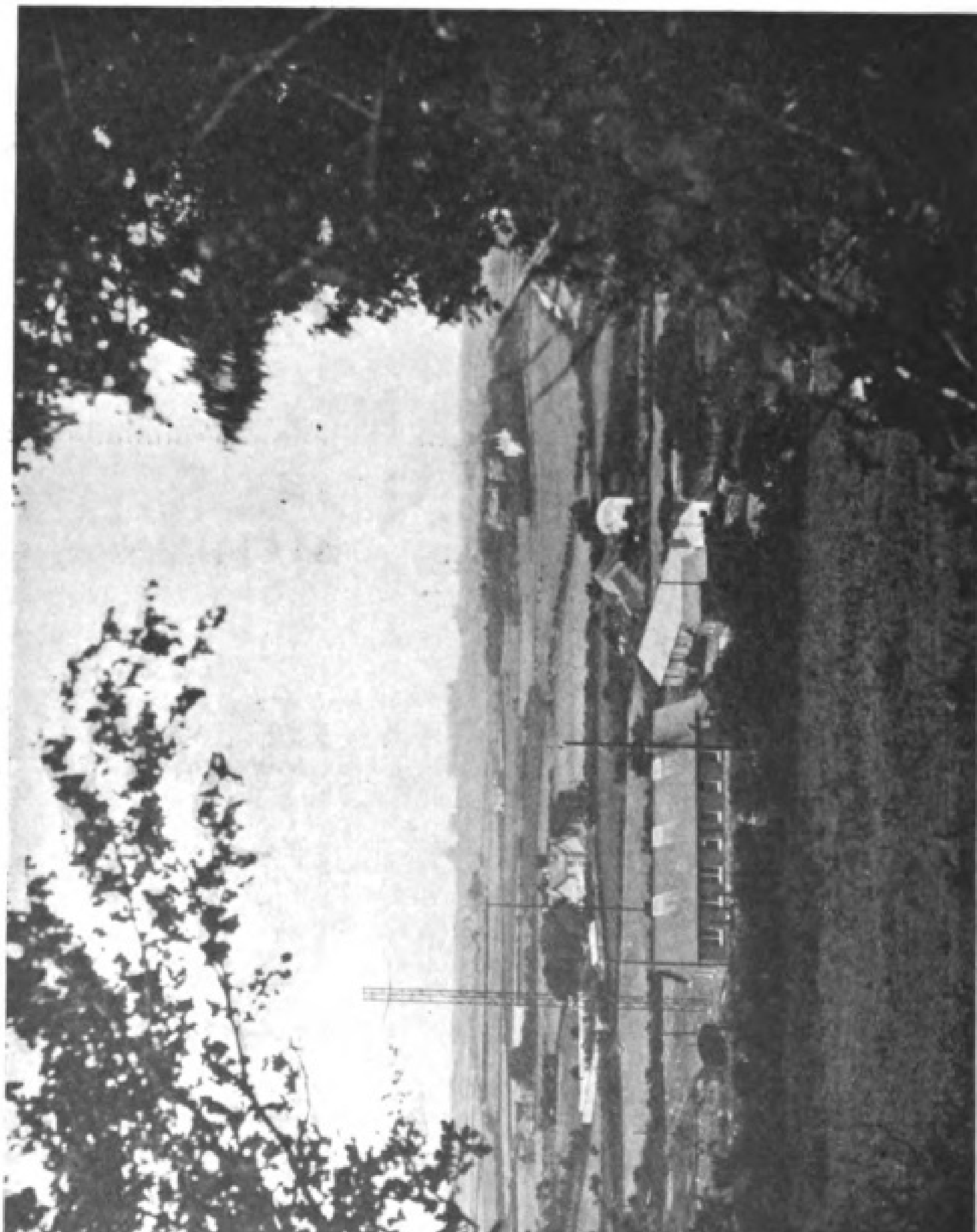
IN our September issue we described the transmitting station at Carnarvon, thereby giving our readers some idea of what is really no more than half of the European establishment of that important transatlantic wireless service which might be called the Great Britain—America aether-line. To permit of duplex working another station, for reception and traffic handling, has been built at Towyn, some 60 miles south of Carnarvon. Although this station is only about 100 feet above sea-level it is surrounded by some of the finest Welsh hill scenery including the famous Cader Idris.

The main aerial runs from the station almost due east for a distance of 10,000 feet, ascending the steep Escuan hill, and is supported by five lattice-work masts and a smaller derrick at the leading-in end. Its height is about 1,500 feet above sea-level, from which position is commanded a fine view of the Dysynny Valley and Cardigan Bay. Parallel to this runs the reserve antenna, also 10,000 feet long, supported by 36 wooden masts each 35 feet high. Both aerials are directional for reception from the station at New Brunswick, and it is said that the lower one is of only slightly less value as regards strength of received signals than the main aerial, and that it is much more useful than the latter when "atmospherics" are troublesome.

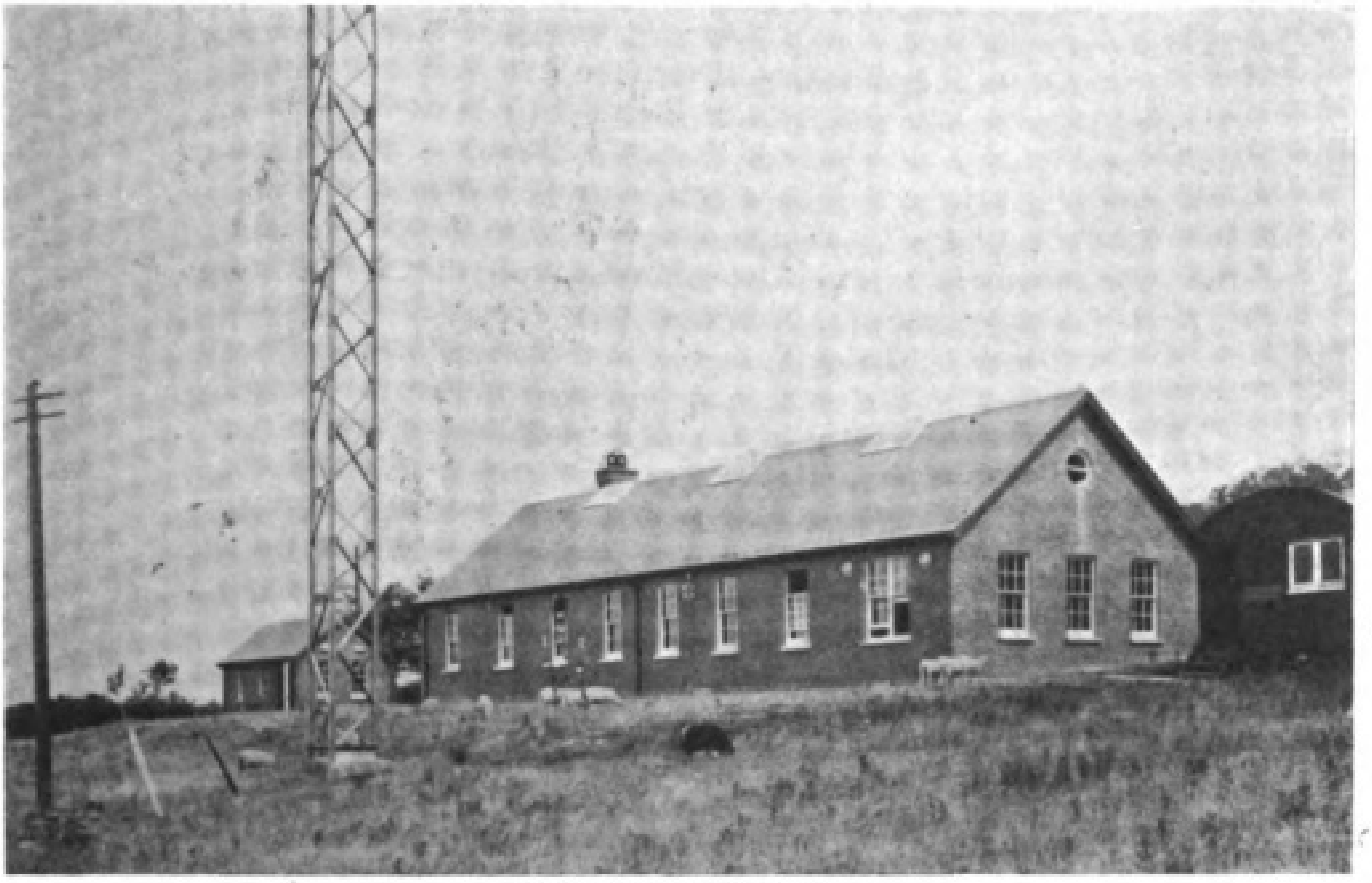
At right angles to these aerials are the balancing aerials which are designed to eliminate interference from Carnarvon.

The receiving apparatus is elaborate, strictly up-to-date and designed with a view to maximum efficiency. The principal set comprises a high-frequency thermionic valve amplifier, with a balanced-crystal board for X-stopping.

The amplified and rectified signals are again amplified by a two stage L.F. valve amplifier. For "beat reception" a separate heterodyne circuit is provided. Automatically-transmitted signals are recorded on dictaphone cylinders which are transferred to special machines which can be regulated to enable the signals to be read by ear.

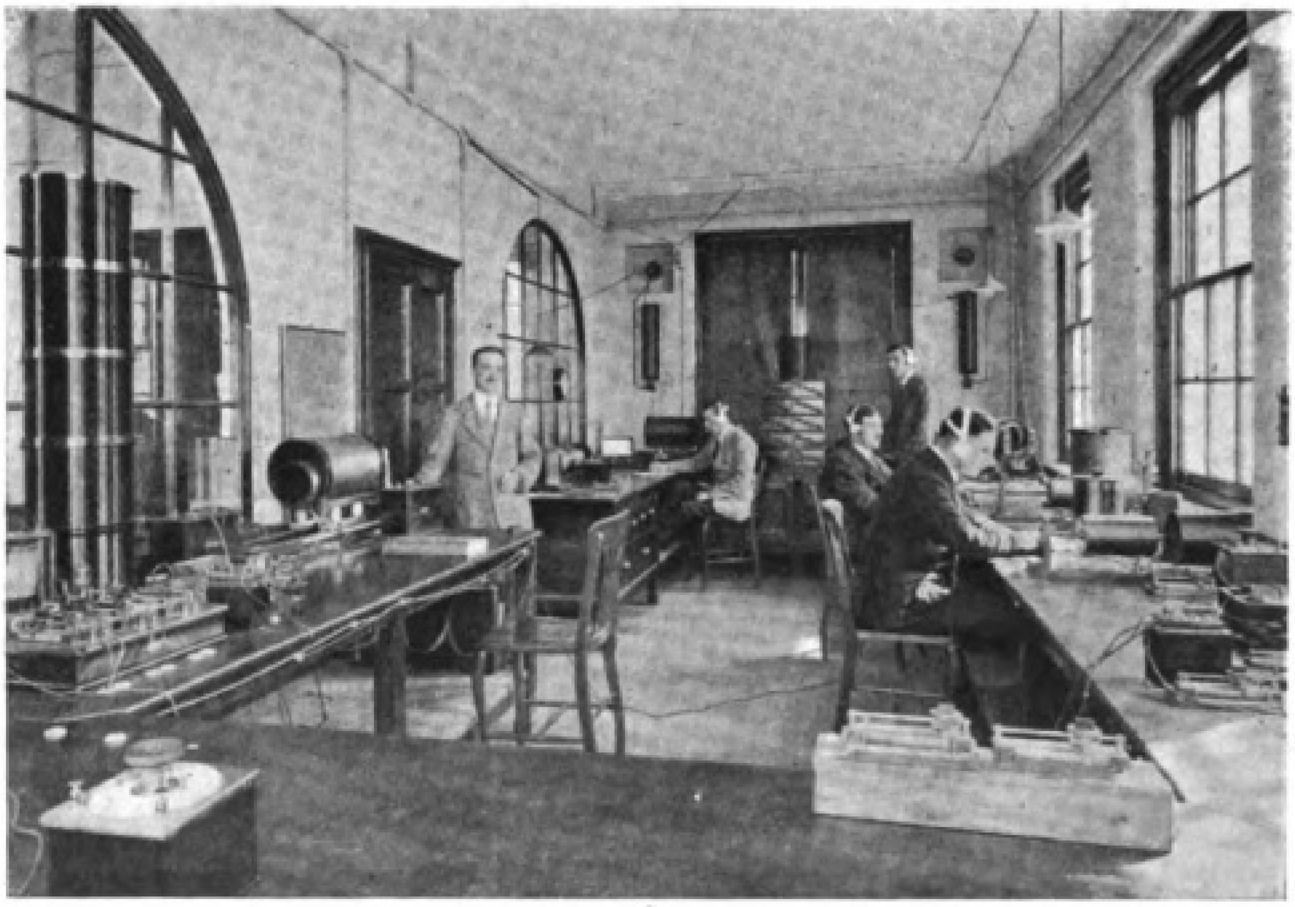


General View of Towyn Station.



The Station Buildings.

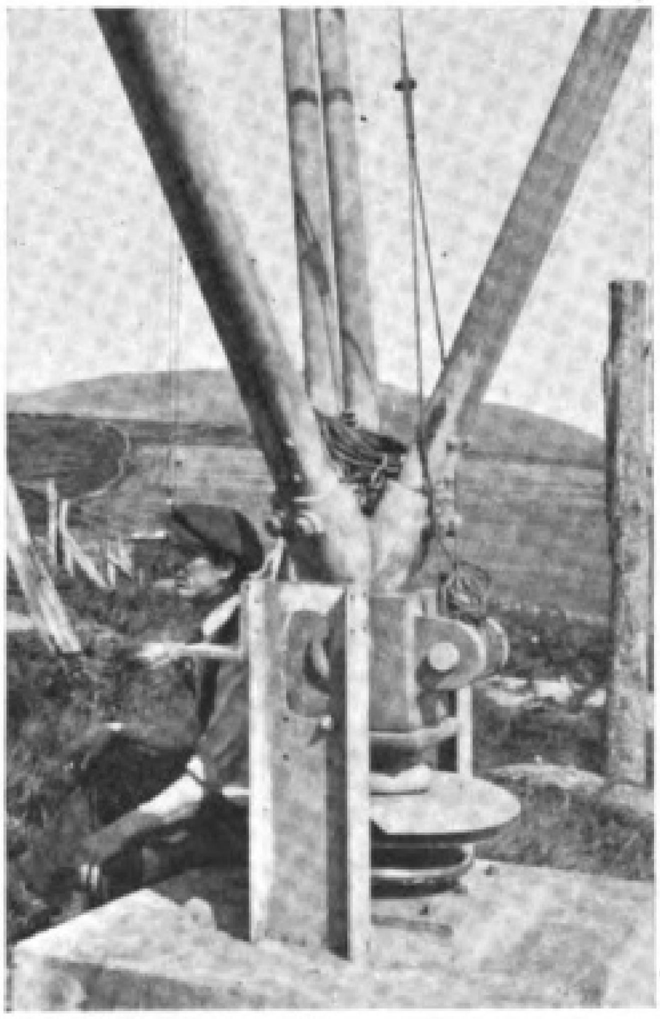
The ***Transmitting*** *Room.*



The Receiving Room.

The Dictaphone Room.

As regards transmission, although the power plant is situated at Carnarvon the actual operating is performed at Towyn. Let us imagine that a Bradford merchant wishes to communicate with his agent in New York, and follow the adventures of his message. It is handed in to the nearest postal telegraph office and sent to the Marconi Company's Fenchurch Street Office. At Fenchurch Street it is "punched" by a skilled operator, that is, it is transferred in the form of perforations to a paper tape, which is passed through an automatic transmitter which sends it along a special wire to Towyn. Here it is automatically reperforated and at once passed through an automatic wireless transmitter which is connected by landline to the signalling switches at Carnarvon. By this means Morse signals corresponding to the perforated paper tape are transmitted by the high-power Carnarvon plant at a speed of 100 words per minute. The receiving station on the American side is situated at Belmar, near New York, and here the message is received and forwarded by a short special landline to the public offices of the American Marconi Company in New York City for despatch to the addressee.



The base of a mast.

Messages received at Towyn from America are read from the dictaphone records, as previously mentioned, and transferred by "punching" to paper tape which is passed through an automatic machine over the landline to Fenchurch Street, where it is reproduced. It is then attended to by a Creed Printer, an automatic typewriter which translates the Morse Code into Roman characters on another paper slip. The latter then passes through the gummer and is affixed by the operator to the ordinary message form. Finally, the completed message is "unpacked;" this process consists of decoding the address, writing the full name and address of the addressee, plus any special instructions given and sending the whole to a delivery department where it is despatched by a messenger, or sent to the Central Telegraph Office for transmission to and delivery in the Provinces.

What has been described, taken in conjunction with our article about Carnarvon forms a picture of a model modern transocean duplex wireless telegraph system, and the British public may well ask why the entire Empire is not already linked by wireless, seeing that such an excellent demonstration of commercial long-distance working has been afforded as the result of private enterprise here in our own country.

WILLIAM NOBLE, ESQ.

Personalities in the Wireless World

MR. WILLIAM NOBLE, who has been appointed to succeed Sir William Slingo as Engineer-in-Chief at the General Post Office, entered the service of the Post Office in 1877, serving as a telegraphist in the Aberdeen Office during the earlier part of his career. In 1893 he received his appointment as a second-class engineer, being promoted four years later to first-class engineer in the Engineer-in-Chief's Office.

In 1900 Mr. Noble was made a technical officer and rapidly rose to be an Assistant Superintending Engineer in the Central Metropolitan District, in which position he bore his full share of the "heat and burden of the day," which was specially arduous on account of the telephone competition which arose. By his energetic handling of the manifold problems and difficulties which always specially beset the path of a second in command, Mr. Noble thoroughly earned his promotion in 1905 to first-class staff engineer. In accordance with the wise policy which forbids that the senior officials should plough a single furrow, Mr. Noble was then called upon to direct the Telegraph Section at headquarters. In 1907 he was appointed Superintending Engineer of the Central Metropolitan District, in which capacity he at once devoted himself to improvements in organisation, and in this, the supreme test of an administrator, he was eminently successful. As a result he was soon appointed a member of the Superintending Engineers' Committee, the prelude to a long series of appointments on committees for his work on which he received special recognition in the form of an allowance of £100 per annum.

March, 1912, marked Mr. Noble's ascent to the position of Assistant Engineer-in-Chief, and it is easy to judge how arduous and exacting his duties must have been since then, considering that nearly five years of war have intervened, bringing with them their inevitably heavy demands upon a great government department. Nevertheless, Mr. Noble's recent appointment as Engineer-in-Chief is warranty that his head and shoulders proved equal to their respective tasks, and that in making it the responsible authorities have but acted upon a perfectly logical conclusion.

Amongst his other multifarious responsibilities Mr. Noble will have much to do with regard to wireless telegraphy. The sound engineer's judgment, the conscientious and unfaltering pursuit of efficiency—the engineer's true hall-mark—and the recognition of the far-reaching effects of his decisions, which Mr. Noble surely brings to his new post will, we trust, help in no small measure to place and maintain the Empire's official wireless services on a fittingly high plane.

Notes on the Design and Construction of Vacuum Tube Amplifiers

By J. Scott-Taggart, M.S.Belge E., A.M.I.Radio E.

I.—LOW FREQUENCY AMPLIFIERS.

THE valve amplifier in modern wireless telegraphy has become an indispensable piece of apparatus. At first only experimental circuits were used. Now, however, circuits capable of giving very great amplification are embodied in a compact instrument and made commercially. No station is complete without such an amplifier and no experimentalist will fail to possess an instrument which will enable him to receive over distances perhaps ten times his normal range.

Such amplifiers may conveniently be divided into the two classes, high and low-frequency amplifiers. The first class is suitable for use in any detector circuit where normally ordinary telephones would be used. They do not rectify but simply magnify rectified pulses of current. They are also useful for amplifying telephonic speech if the latter is faint. In a word, they will magnify current variations of low-frequency.

The second class, the high-frequency amplifiers are usualy complete detector-amplifiers. They may be connected across any circuit in which an oscillatory current is flowing and will produce loud signals in the amplifier telephones.

The high-frequency amplifier varies somewhat in design, but it often consists of a rectifying valve followed by one or two low-frequency amplifying valves. It is proposed in the following pages to discuss from an essentially practical point of view the design and construction of several types of successful amplifiers. Their construction presents no great difficulty in spite of the mystery in which they were shrouded during the war.

Since a high-frequency amplifier often consists partly of a low-frequency amplifier, the latter type will first be considered.

There are one or two points of difference between the "diagram" type of amplifier circuit and the actual practical instrument. The former generally consists of one or two valves with separate lighting accumulators and separate high-tension batteries. It serves to illustrate a principle; it is forgiveable in a fixed station, but as a practical circuit it is unnecessarily cumbersome and extravagant. One requires something easily portable; something that can be rapidly connected to different circuits. Our first thought, then, is to develop amplifiers using *one* lighting accumulator for all the valves and *one* plate battery.

The coupling between the valves, whereby the magnified voltage variations are transferred from the plate circuit of one valve to the grid circuit of the next, is another matter for consideration. There are three well-known methods of effecting this coupling, namely:—

(1) The use of inter-valve transformers,

*(2) The use of auto-transformers between the valves,

*(3) The use of high-resistance couplings.

Of these three methods, the first appears to be the most satisfactory for low-frequency amplification, and it is proposed to deal, in the present article, with that type.

In Fig. 1 we see a very simple one-valve amplifier which could be connected to any circuit where normally an ordinary pair of telephone receivers

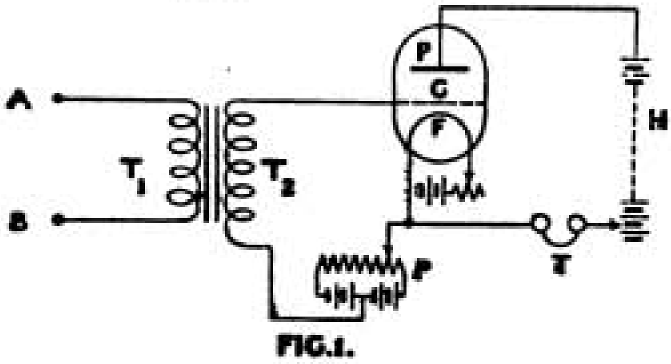


FIG.1.

A single-valve Amplified Circuit.

would be connected; for example, we could connect A and B to the telephone terminals of an ordinary crystal detector receiving circuit. T_1 is the primary winding of a small step-up transformer, the secondary T_2 of which is connected, through a potentiometer P, across the grid G and filament F of a vacuum tube. The plate circuit of the valve consists of the plate P, a battery H of about 80 volts (loosely termed a high-tension battery), a pair of high resistance telephones T, and so to the filament F of the valve.

As this simple amplifier will be the basis for more elaborate instruments we will look at it in further detail. The step-up transformer claims our attention first. The primary winding T_1 should have the same resistance approximately as the circuit to which it is applied. In the case of a crystal detector circuit this resistance is high, and we should therefore wind the transformer with fine insulated copper wire to a resistance of from 300 ohms to 2,000 ohms or even more. The secondary winding T_2 may conveniently have about ten times as many turns as the primary. The voltage across the secondary winding of the transformer will therefore be about ten times that across the primary. The value of having this initial transformer will therefore be readily seen, since the greater the variation of grid potential, the greater will be the current variation in the plate circuit of the valve.

The transformers used in most amplifiers are of the closed-core type. Fig. 2 shows a simple form which can be constructed without much difficulty. It is built up of an ebonite tube about ½″ external diameter and 2″ long. At each end is fixed a square ebonite cheek 2″ x 2″ through which a ½″ hole has been drilled. Wooden cheeks and a paper tube soaked in paraffin wax, could be used if desired. On this tube is wound the primary winding. This can best be

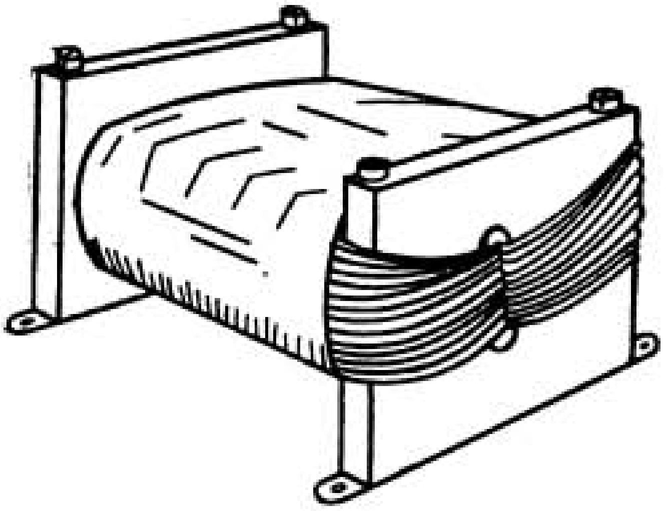


Fig. 2.

The completed Amplifier Transformer.

accomplished by rotating the tube on the shaft of a small electric motor. The two ends of the winding should then be brought to two small terminals fixed on one of the cheeks. The secondary winding may be wound in

*Vide the Author's "The Use of Impedance, Capacity and Resistance couplings in High-frequency Amplifiers." WIRELESS WORLD, Feb., 1919.

the same direction in a similar manner, the two ends being brought out to terminals fixed on the other cheek. The greatest care should be taken to insulate the windings which should be separated by one or two layers of "Empire" varnished cloth. It is also preferable to wind the coils in sections to prevent the insulation breaking down.

The iron core is the next consideration. This may conveniently consist of a bundle of soft iron wires. As there should be no residual magnetism in the core during the operation of the transformer, the wires should preferably be made of "Stalloy," a special commercial product eminently suitable for this purpose. The wires should preferably be lacquered to prevent the setting up of eddy currents.

The bundle of wires forming the core should be about 7″ long, and, when fitted into the ebonite tube, should project about 2½″ beyond the cheeks. This done, the wires at each end should be parted into two, each half being bent round the side of the cheek. This is shown in Fig. 3 which is a plan of the transformer. The ends A and B, and C and D, are now worked into each other so that the core appears as two rectangular rings. The body of the transformer is now wound round with varnished cloth and securely bound. Its finished appearance will be as shown in Fig. 2.

Suitable windings for an initial transformer for general work are:—

Primary: S.W.G. 44 S.S.C. copper wire, 300 ω.
Secondary: S.W.G. 44 S.S.C. copper wire, 3,000 ω.

The resistance of this size of wire is about 1 ohm per foot, so that 300 feet would be required for the primary and 3,000 feet for the secondary.

The potentiometer P can usually be dispensed with, although when distortion of the current variations is to be avoided (as in wireless telephony) some arrangement for varying the grid potential is highly desirable. The reason for this has been fully explained by the author elsewhere.*

The arrangement in Fig. 1 consists of the usual potentiometer, which

* Vide "On Valve Characteristic Curves and their Application in Radiotelegraphy." Wireless World, September and October, 1918.

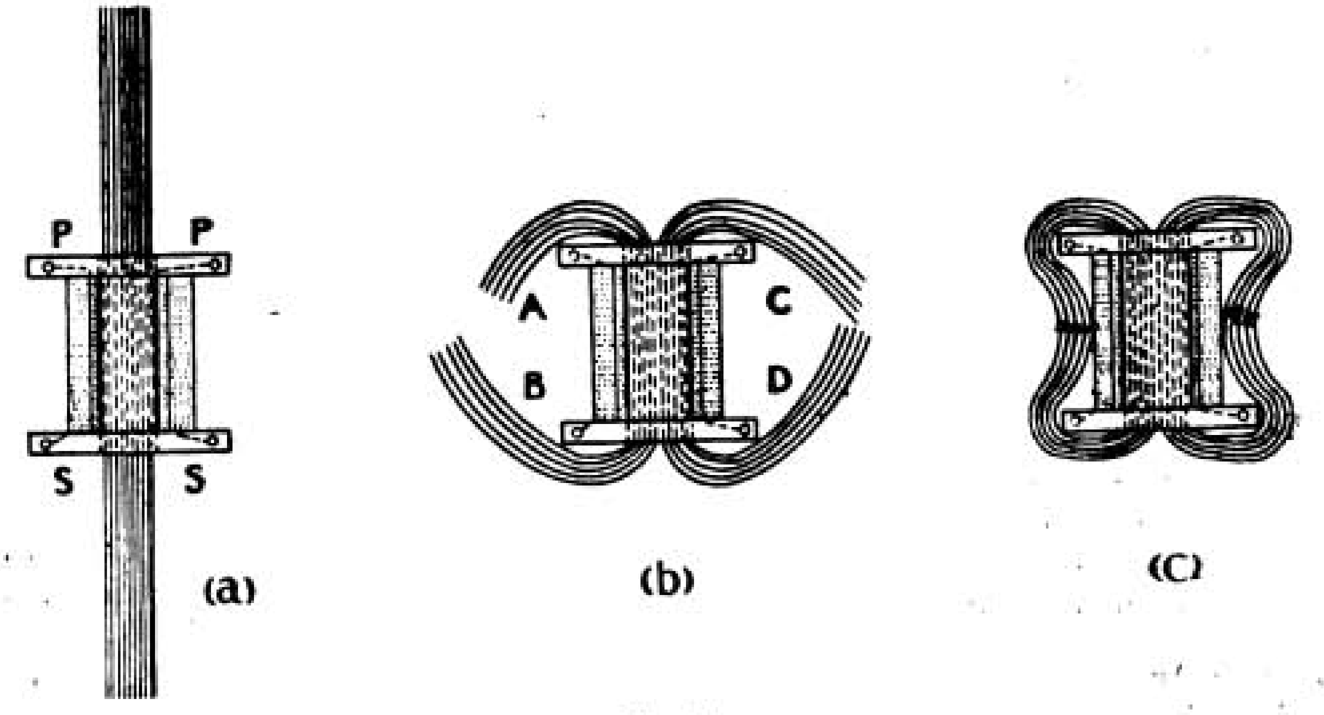


Fig. 3.
The stages in the construction of an Amplifier Transformer.

enables either a positive or negative voltage to be imparted to the grid. There are two important disadvantages of this arrangement:

(1) The potentiometer battery is continually "running down,"

(2) The potentiometer battery requires to be twice the maximum voltage it is intended to give the grid.

The first disadvantage is accentuated on some instruments where a potentiometer switch is provided. The operator frequently omits to switch off his potentiometer battery when leaving the instruments. This could be remedied by arranging that the potentiometer switch is opened when the filament current of the valve is turned off.

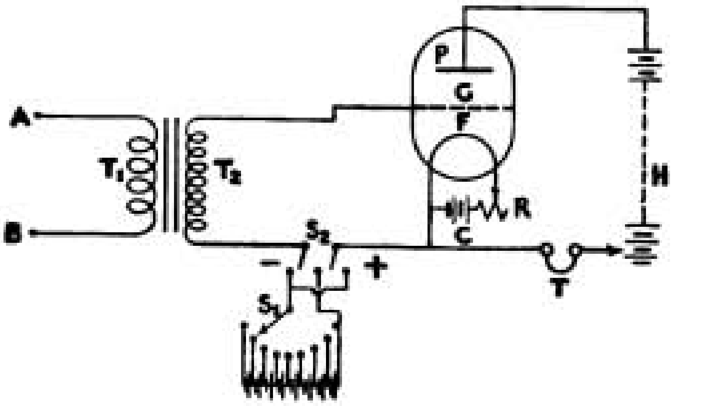


Fig. 4.
A Single-Valve Amplifier.

The author prefers the arrangement shown in Fig. 4 and which has been used by the Marconi Co. Instead of a potentiometer we now have about 10 small dry cells and a radial switch S_1 of ten studs which enables us to tap off the voltage we desire to give the grid. The three cells found in an ordinary flash-lamp battery are of a suitable type for use in this connection. The voltage is variable in steps of about 1.3 volts, and the range is sufficiently large to enable us to use any part of the grid potential-plate current characteristic curve of the average small valve. The normal adjustment to use is the half-way point along the steep straight portion of the curve, although for undirectional pulses any point may be chosen provided the representative point does not move off the steep straight portion of the curve during the pulse.

A small commutator switch S_2 may be provided if desired. This, together with the radial switch, enables the operator to vary the grid potential from −13 volts to + 13 volts. When amplifying speech or currents of an alternating nature, it is advisable to increase the voltage of the battery H until the curve of the valve lies completely to the left of the grid zero ordinate. A suitable negative voltage of the grid is then chosen to bring the representative point to the middle part of this curve. This can be accomplished with a sufficient degree of accuracy by means of the grid voltage radial switch. No rectification will now result through the establishment of grid currents.

Instead of connecting a pair of high-resistance 'phones directly in the plate circuit, it is preferable to use a step-down telephone transformer T_3 as shown in Fig. 5. Its high-resistance winding is included in the plate circuit, and may conveniently be wound with S.W.G. No. 44 single silk covered wire to a resistance of about 5,000 ohms. The low-resistance winding may be wound with the same wire to a resistance equal to that of the 'phones to be used—perhaps 120 ohms. The author will, in various diagrams, sometimes omit to show the telephone transformer for the sake of clearness.

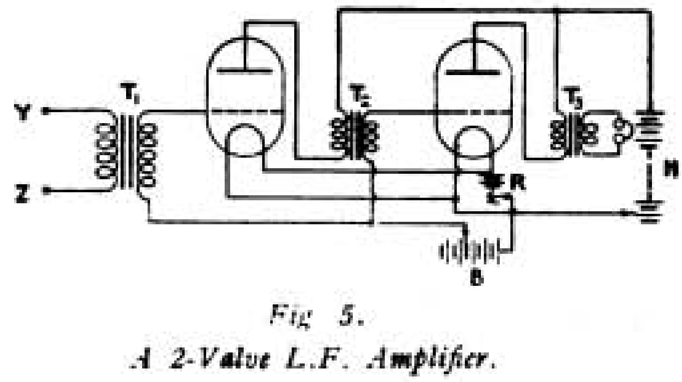


Fig 5.
A 2-Valve L.F. Amplifier.

We now come to the 2-valve amplifier, shown in Fig. 5 which employs an additional valve and a coupling transformer T_2. This transformer is of the same type as the first one described. It serves to step-up the voltage changes taking place in the plate circuit of the first valve and passes them on to the second valve. The voltage changes across the grid and filament of the second valve are made about 5 times as great as those across the windings included in the plate circuit of the first valve. The transformer ratio is, in other words, one to five. The primary winding may be wound to 300 ohms and the secondary to 1,500 ohms, using the same wire as before. These values give excellent results, but there is no reason why they should be too closely followed. Different commercial types of amplifiers vary very much indeed in the resistances of their transformer windings.

It will be noticed that the filaments of both valves are connected in parallel. The filament current rheostat R, which consists of a resistance wire of about 5 ohms and a sliding contact, affects both valves, and is adjusted to the value which gives the loudest signals.

The plate battery H is variable in steps of 15 volts by means of plugs, and serves the plate circuits of both valves.

The voltage of the grid cells B is communicated to the grids of both valves by suitable wiring, as shown in the figure. This is desirable since both valves will function best under almost exactly the same conditions.

The telephone transformer is connected in the plate circuit of the second valve.

A 3-valve low-frequency amplifier is shown in Fig. 6. As will be readily seen, it is a similar circuit to that of Fig. 5 except that an additional valve is provided, the telephones being included in the plate circuit of the last valve.

It will be found advisable on these types of amplifiers to connect all the iron transformer cores together by a wire which is also joined to the positive pole of the high-tension battery.

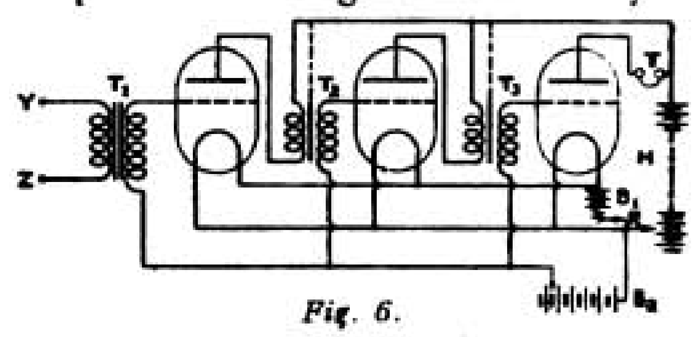


Fig. 6.

A 3-Valve Low-Frequency Amplifier.

This wiring is shown by dotted lines in Fig. 6. This helps to eliminate the sizzling noises frequently heard during the operation of these amplifiers.

(*To be continued.*)

OUR COMPETITION FOR WIRELESS OPERATORS.

In our September number we announced the opening of a competition solely open to ship and shore wireless operators, our aim being to stimulate their interest in the problems of their profession and to provide data from observations taken all over the globe (as a result of their work in the competition) for the use of scientists. Competitors are intended to read the special article which was written for their guidance by Dr. W. H. Eccles, and published in our September and October numbers, and then to proceed to work at that particular problem for which they feel best fitted, both as regards personal taste and opportunity. Full particulars of the rules of the competition are given in the September issue. The prizes offered are:

First prize, twelve guineas; second prize, six guineas; four consolation prizes, each consisting of Dr. Fleming's new book, entitled *The Thermionic Valve and Its Developments in Radiotelegraphy and Telephony*, and Mr. Philip R. Coursey's *Telephony without Wires*.

Digest of Wireless Literature

By E. V. Appleton, M.A., B.Sc.

SHORT-WAVE RECEPTION AND TRANSMISSION ON GROUND WIRES (SUBTERRANEAN AND SUBMARINE).

By Lieutenant-Commander A. Hoyt Tayler.

Proceedings of the Institute of Radio-Engineers, August, 1919.

THE experiments of Clark, Rogers, and Lyons, carried out in America, have shown that practically all the Arc stations in the country can be received easily with subterranean and submarine antennæ. The signals are, of course, much weaker than those received on an ordinary antenna, but there is one advantage in that, whereas strays very often prevent reception with ordinary aerials they produce comparatively much smaller effects in the case of ground antennæ.

The results of Rogers are the most satisfactory in that his experiments were made with valve detectors which have brought about the many practical possibilities in subterranean reception. In his experiments Rogers had an underground room into which leads were run from various wires buried underground at approximately a depth of one foot and which ran out in various directions. These wires varied in length from 300 to 1,000 feet. Some were bare wires, some were insulated, and some were laid in baked clay for part of their distance. The receiver consisted of ordinary coupled circuits with valve reception. Tests on short waves in the neighbourhood of 600 metres were made to determine whether the apparatus was directive and also to determine which kinds of wires gave the best results. The wires were usually tried in pairs in a straight line, one wire being connected to the antenna terminal of the receiver and the other to the earth terminal. Directivity was quite evident, the best results being obtained with signals coming parallel to the wire pair. The bare wires were found to give the greatest strength of signals. It appeared that the proper length of bare wire for optimum signals at 600 metres lay between 300 and 500 feet (92 and 153 metres). The strays were found to be more completely eliminated when the set was tuned for short waves than when tuned for long waves.

The present communication consists of the results of further experiments on these lines. In these experiments which were carried out at Great Lakes it was found that several receiving sets could be connected simultaneously to the same pair of ground wires without interference. In continuous wave reception the heterodyne notes of course are present, but when the wave-lengths are not too close together interference can readily be avoided.

The primary circuit formed by the wires, the primary inductance, and a series condenser were tested by means of a wavemeter, and it was found that with wires over 100 feet in length the lengths of the buried wires had practically no influence on the tuning of the primary. This would seem to indicate that the ground wires themselves formed an aperiodic system. Further more detailed experiments (described later) however, showed that this conclusion was not strictly true.

The work was carried out in close proximity to the Great Lakes station which possesses two overhead antennæ for transmission. It was possible to receive Arlington spark signals on 2,500 metres on a north and south pair of ground wires at the same time as one of the ordinary antennæ of Great Lakes was radiated on 600 metres, and to read Milwaukee on 600 metres (a station 50 miles distant) when the Great Lakes arc was in operation on 6,000 metres radiating 50 amperes. As far as handling regular traffic was concerned the subterranean antenna station was able to do much better work than the station with overhead antennæ owing to the elimination of strays and to the ability to work through storms during which the overhead antennæ had to be earthed. The best signals were always obtained with well insulated wires laid in wet sand. Iron pipe earth connections were tried at the ends of both antennæ, but no difference in signal strength was noticed. The strays, however, were slightly worse. The use of multiple wires appeared to offer no material advantage.

Some further experiments of a more quantitative nature were carried out to determine the lengths of wire necessary for optimum signal strength for any wave length. Switches were installed at various points along a pair of north and south wires 300 feet long and audibility measurements were taken of various stations. The optimum wire length was always found to be approximately one-eighth of the wave length. The experiments showed that there was in most cases quite an abrupt rise in signal strength when the optimum wire length was secured. This was marked for short wave lengths, but for longer waves the signal strength was independent of the length of the wire. The optimum lengtn was found not to depend on the direction from which the signal came.

In these experiments strays as a rule were practically absent. Sometimes loud cracks widely separated were received. These isolated strays, although loud, did not interfere with the reception of signals on account of their brief duration. When the optimum wire length is used it is very important that the wires should be properly insulated since earthing a wire produced a diminution in signal strength. Here it was again evident that for the best results the wires should be laid in fairly wet soil or in water in which case (a) the signal strength is a maximum, (b) the relative suppression of strays is most marked, and (c) the set is most selective when the optimum length is used. If the wires are laid in salt water they must not be fixed too deep as the signal strength falls off with increase of depth. Curiously enough in fresh water, for long waves at least, no diminution in signal intensity is noticed even when the wires are laid as deep as 60 feet below the surface.

If one wire and an earth are used instead of a pair of wires in a straight line the signal strength is reduced about 35 per cent., but the optimum wire length is still the same. Such a wire and earth system is highly directive so that the best listening-in arrangement for picking up signals is obtained by connecting a pair of wires situated at right angles both to one terminal of the receiver, the other terminal being well earthed.

The theoretical explanation of this system of reception is not wholly understood, but the following points seem noteworthy. Since ground wire reception may be carried out with wires very near the surface of the ground (although not as efficiently as when the wires are buried deeper), the phenomenon must depend upon the well known inclination of the advancing wave front, thus giving a horizontal component of the electric force in the æther parallel to the ground wires. It is also likely that this angle of inclination increases with the penetration of the wave, especially when that penetration reaches wet soil of considerable conductivity. It is possible, of course, that buried wires may also act in a way like loops, the capacity of the antennæ to the ground supplying (by means of the conducting ground) the complete circuit.

Signal reception on ground wires follows the same law of diurnal variation and seasonal variation as reception on an ordinary antenna.

Only preliminary experiments on transmission with subterranean antennæ have as yet been carried out, but they have already shown that continuous wave telegraphy with low power sets may be carried on over considerable distances. The greatest communicating distance obtained was between Great Lakes and Chicago, a distance of 36 miles. In this particular case the antenna current was 0·8 of an ampere.

AMPLIFIERS FOR CONTINUOUS AND VERY LOW FREQUENCY CURRENTS.

By MM. Henri Abraham and Eugene Bloch.

Comptes Rendus, 168, June 30th, 1919.

THREE-electrode valve amplification has been utilized to a large extent in the case of alternating currents of higher frequencies, such as those utilized in wireless telegraphy and telephone circuits. It is, however, important in certain applications to be able to amplify in a similar manner alternating current of extremely low frequency (of 1 to 100 alternations per second) or even continuous currents. This problem arises if it is proposed to record wireless signals mechanically. The mechanical recorder (recording galvanometer, Morse apparatus, etc.), requires working currents of the order of one milliampere. If a current of this value is to be reached without a mechanical relay the valve amplification must be pushed to a maximum. A feasible scheme appears to be to amplify the musical audio-frequency telephone current first and after that use an extreme low frequency amplifier, the rhythm of the Morse signals being regarded as an alternating current of very low frequency.

Two types of amplifiers have accordingly been devised:—a continuous current amplifier and an extremely low frequency amplifier.

1. If we place in the anode circuit of a valve a resistance comparable with the internal anode circuit resistance (about 50,000 ohms) a variation of grid potential produces a variation of current in the anode circuit and consequently a variation of potential across the resistance. This variation of potential can be transmitted directly to the grid of a second valve, care being taken to insert a battery in the wire connecting the high resistance and the grid in order that the grid potential may be maintained at the most favourable value.

By repeating this insertion of batteries between successive valves of a resistance coupled amplifier a circuit is found capable of functioning at all frequencies and in particular for extremely low frequencies and for continuous current.

As the connecting battery between two valves can only be varied by discontinuous steps (by two volts at a time if accumulators are used) a small variable resistance is inserted with each anode circuit resistance. The necessity of introducing extra batteries, besides the heating and anode batteries, does not make this scheme convenient for high-frequency or audio-frequency amplification. But the employment of these extra batteries is necessary in continuous work.

2. The connections between successive valves of a resistance-coupled amplifier can be carried out by means of large capacities of the order of 0·1 or 0·2 microfarads. Each condenser is then in a high resistance circuit of several meghoms and thus possesses a time constant which may be as large as several seconds. As a result the apparatus amplifies current with a period less than its own time constant. Experience shows that it is a good plan to shunt the anode circuit resistance with capacities of the order of 0·25 microfarads in order to avoid reactions between the extremely low-frequency amplifier and the ordinary audio-frequency amplifier which precedes it in the stages of amplification. In all cases the linking condensers are made as small as the rhythm of the signal currents will allow. For example, for the reception of wireless signals sent by hand $\frac{1}{2}$ microfarad is used; in the case of automatically sent signals of 40 or 50 words a minute $\frac{1}{10}$ microfarad is sufficient.

Besides applying this apparatus to the mechanical recording of wireless signals, it has also been used for the measurement of extremely feeble currents met with in experiments on gaseous ionization.

THE APPLICATION OF AMPLIFIERS TO THE RECORDING OF WIRELESS SIGNALS.

By MM. Henri Abraham and Eugene Bloch.

Comptes Rendus, 169, August 11th, 1919.

The experiments on the mechanical recording of wireless signals were carried out during the years 1916 to 1918 for the Radiotelegraphic Section of the French Army. The receiving system used consists of a framework of 1·2 metres diameter carrying 40 turns of wire 14 mm. apart. This coil is connected to a variable condenser and the two constitute the primary receiving circuit. For the recording of powerful stations relatively near (less than 2,000 kilometres distant) the strays or atmospherics were relatively so feeble that a secondary circuit could be dispensed with, and the amplifier was connected directly to the primary circuit. In the case of extremely weak signals from very distant stations it is found that it is necessary to use a secondary circuit loosely coupled with the primary. In the case of continuous waves accurate tuning is essential. In such cases auxiliary valves have been used which have the effect of introducing a negative resistance in the primary receiving circuit. It is possible to eliminate in this way the greater part of the effects due to atmospherics.

The amplifiers used on these receiving circuits are of two kinds :—

(1) The French military R6 type. This is an eight valve amplifier, comprising five stages of high-frequency amplification, one stage of rectification, and two stages of audio-frequency amplification with transformer coupling.

(2) An amplifier for continuous currents, or for currents of extremely low frequency, usually with three stages of amplification.

The recording apparatus is inserted directly in the anode circuit of the last valve in the position normally occupied by the telephone in an aural receiving set. If continuous waves are being received with the aid of a heterodyne it is advisable to place the latter inside a metallic screen through a hole in which are brought two leads to a coil which is coupled with the main circuit. By altering this coupling it is possible to alter the effect of the of the heterodyne until the most sensitive setting is obtained.

The recording apparatus may be either a Morse inker or a galvanometer with pen attachment. In both cases it is advisable to use coils of fine wire of several thousand ohms, making the resistance of the apparatus comparable with the internal resistance of the valve. For the Morse apparatus a current of two milliamperes is necessary. A sensitiveness of twelve times this amount can be obtained with a special magnetic oscillograph which makes records on prepared paper. The natural period of this latter instrument ($\frac{1}{100}$ of a second) is so small that it readily accommodates itself to the frequencies of automatic transmission.

The recording apparatus, whatever it is, functions from a zero effect to a saturation effect, that is to say the amplification is made so enormous that the anode current which actuates the recording apparatus has its maximum value during a signal and falls to zero during the interval between two signals. This mode of action, obtained without a mechanical relay possesses important advantages. It eliminates completely some of the effects of strays or atmospherics. During a signal the anode current of the last valve reaches, if the voltage is sufficient, its saturation value above which it cannot, of course, be increased. This current is therefore not altered by any strays, however strong the latter may be. During the intervals between the signals the grid of the last valve becomes strongly negative and a stray of moderate intensity will not have sufficient effect to cause this potential to mount to zero. It is thus clear that there is a double limitation to the action of strays because of the existence of what may be termed a "threshold of action" in the valve, and because of the existence of a saturation value for the anode current. Moreover, in the case of two sets of signals simultaneously heard in the telephone, but sufficiently unequal in intensity, the record of the stronger only is obtained on the Morse apparatus.

By employing the arrangement previously described it has been found possible to receive with the small coil or antenna, and to record correctly by Morse instruments, all the large European and American stations. In the case of European stations, the distances of which do not usually exceed 2,000 kilometres (Lyon, Nauen, Berlin, Clifden, Coltano, Aranjuez, Moscow, Constantinople, etc.), no particular precautions are necessary. In the case of American stations (New Brunswick, Annapolis, etc.) which are about 6,000 kilmeotres distant, special precautions are necessary to obtain optimum tuning. These stations, however, can be recorded quite correctly even while the powerful Eiffel Tower station is sending. It has been found possible to work these sets for several hours at a time.

Our Amsterdam Letter

Arrangements have been made with a prominent Dutch radio worker to publish each month a letter dealing with the practice and progress of wireless communication in Holland and her colonies. It is hoped to carry out the same idea in respect to other countries, thus providing professional wireless men with a regular, condensed account of the work and thought of overseas technicians, and a means of keeping British amateurs in touch with the doings of their confrères abroad.

I HAVE been recently honoured by a request from THE WIRELESS WORLD to keep the readers of that magazine informed of all the events in our little Dutch wireless world which might be of interest.

If a similar request had reached me prior to 1914 I should have been obliged to refuse, simply because there was next to nothing worth mentioning, except that the Belgian Marconi Company had again given the advantage of wireless to so many ships; that our army had no proper working field station, or that it had come to my knowledge that the Government had ordered a Marconi telephone condenser, and that the electrolytic detectors in use at the Scheveningenhaven station were home-made. Perhaps it would have interested you to know that plenty of our responsible authorities were careful enough to receive with reserve the significant reports from abroad about long-distance working and its possibilities, and that in consequence they gave the problem of a wireless communication with our colonies hardly a serious thought. No, there was not much to be recorded at that time.

But all that is quite altered now! Since the war turned the whole world topsy-turvy it is all wireless bliss in little Holland. Even the old people no longer charge the ether waves with causing the bad summer season. They only shake their heads thoughtfully when they listen to the wireless speeches coming from Marconi's Wireless Telephone Station at the E.L.T.A. (First Aircraft Exhibition at Amsterdam.)

When as a consequence of the war Holland became practically isolated from the rest of the world, wireless telegraphy became the pet of every Dutchman, and judging from appearances it throve well under the fervent attention it has received since that period.

Every one wanted his own receiving set in order to get the latest news. Many a broker and banker bought a coil and detector and sat listening for days, hoping to intercept stock quotations from America.

As there were no instruments coming from abroad, many people became constructors of wireless receiving apparatus which were promptly sold for good money, while the "odds-and-ends" shopkeepers became prosperous as never before, because they got rid of all sorts of wire, serviceable or not, for the manufacture of receivers.

Here is a story which speaks for itself. One day a gentleman dropped in with the request that I would look at his receiver, with which he had no success whatever, he said. At his office he showed me an instrument of poor workmanship which seemed to have been built for demonstration purposes. When I made inquiries as to the whereabouts of his aerial wires, he scrambled on the top of a cupboard and produced two brass discs of 4 inches diameter, fixed at the end of two rods each a foot long. When he was asked what he expected to receive with it, he said: "Well . . . eh . . . some war news and . . . well, yes, America, if possible." Asked about his ability in receiving, he said: "Oh, yes, dots and dashes. That would be all right; such a Morse alphabet could be easily obtained . . !" And this man paid over £8 for his receiver, and dreamt of reading American stock quotations!

That with so much interest in the radio art life would be given to an amateur club is easily understood. This joyful event took place in 1916, and at present we number nearly 1,100 members and a monthly magazine. This is certainly not bad for little Holland. In every town of importance in Holland a section of this club is formed, having their own clubrooms, where weekly meetings, with instructional courses, interesting demonstrations and lectures are occasionally given. The home-made radiotelephone set which I have seen at the wireless den of one of our members is remarkably good, and shows that the Dutch amateur is certainly no longer at the rear.

I hear that there is a movement amongst the members to obtain the Government's permission to use transmitting sets on a small scale and on similar lines to those of our American friends.

But I have my doubts whether this desire, at the mere thought of which our amateurs' hearts are throbbing, will be granted soon, unless our Society is able to convince the authorities of the utility of such a freedom for non-official dabblers. I hope it will not be too difficult a job for our administration! Official Holland has sometimes such queer habits where novelties are concerned.

Do you know why Holland is said to be always behind other countries in some respects?

For instance, there is not one Dutch pilot-boat equipped with wireless apparatus yet, and our shipping companies are not yet compelled by law to carry wireless on their ships above a certain tonnage, while in nearly every seafaring country it is compulsory. It is not a consequence of conservatism or lack of diligence on the part of our governors, but only because they are so extremely averse to being called imitators. This may also be the reason why in Holland advantage is seldom taken of experiments for the perfecting of instruments which are made abroad. They prefer to stick to expensive trials, coming finally to the same results, than to be more practical and build further on the knowledge offered to them from abroad.

A few days ago the agreement between the S.A.I.T. and Radio Holland was finally signed. The latter will henceforth instal and control the wireless installations on board ships in Holland and in the Dutch East Indies. Thus our good old S.A.I.T. sun disappears out of sight, but surely not out of the hearts of all those who have been in her service. Radio Holland certainly starts business on far better conditions than her predecessor; a good number of ship stations, a well-trained staff of operators, and, above all, the ever-growing belief that wireless is an indispensability on sea-going ships.

The new Company belongs to the Marconi Associated Companies, and participates in the privileges to which the ship stations of the Marconi Wireless organization are entitled.

BUZZER.

"W/T. R.E."

An Account of the Work and Development of Field Wireless Sets with the Armies in France.

By Capt. B. F. J. Schonland, O.B.E., R.E., late Staff Officer (Wireless) 1st Army, France.

(Continued from October Number.)

I HAVE already briefly described the power buzzer, the "loop" set and the B.F. set. The first was an ingenious adaption of the early experiments in "wireless" conduction through the earth, the last-named a compact 50-watt spark set using an induction-coil with magnetic make-and-break. The loop set, specially designed for forward trench work or open fighting, presents many points of interest. Transmission is carried out on a "closed" circuit, the inductance from which energy is radiated being a square frame-work of brass tubing about a metre inside.

For effective radiation the wavelength used must be small, power being limited by the weight of the accumulator carried. The set is made for wavelengths of 65 or 80 metres, the brass loop fitting on to a small ebonite box containing spark-gap and condenser, which in turn clips on to a bayonet stuck into the ground, while a rubber lead enables the operator to manipulate his key and have induction-coil and accumulator under shelter some twenty feet away. The receiving apparatus comprises a two-valve circuit of a most ingenious type and ground aerials only seven yards long. Though the power of the set is only twenty watts, it is capable of signalling over from two to five miles, while the forward transmitting loop can be completely screened from enemy observation by being placed in a trench or dug-out, without much weakening of signal strength.

A technical description of the types of continuous wave sets used is beyond the scope of this article. The circuits employed have in some cases already been described in THE WIRELESS WORLD by other writers.

One or two valves were used for transmission, high tension for the plate circuit being supplied either by small primary cells, special types of induction coil (tonic train), or small rotary converters with or without rectifying devices.

While the sets for forward use were small and designed for simplicity and portability, other more complicated sets were fitted up in cars and lorries for special work behind the lines.

Masts and aerials varied in type and height according to the set used, and its proximity to the enemy. The usual spark trench set mast was fifteen feet high and made up of small tubular steel sections, while the aerial varied in length from 50 to 100 yards. Usually when shelling was particularly bad a number of aerials were erected, led in at different points to the dug-out used as station, so that if one was cut another could be employed. In the case of C.W. sets a very short and low aerial was possible, sometimes measuring no more than ten yards long and four feet high, and supported on tripod masts or any convenient ruin to hand. The directional property of the L type aerial was found to be very strong, even with short-range sets, and of course especially so in the case of low or ground aerials.

As a rule the aerial was led into the dug-out which housed the set, by means of thick rubber-insulated cable, though the damp walls of the shafts and stairways often gave trouble, especially with continuous wave sets. For earth connection a copper gauze mat was used, buried or simply laid out on the ground if the station had to be very mobile.

It is easily seen that messages sent by wireless, unless extremely urgent, could not be sent in " clear." The Germans, like ourselves, had special arrangements for intercepting wireless messages and special facilities for letting the fighting troops take advantage of anything learnt from our messages. So that, unless delay was dangerous, our messages were enciphered before being sent. So adept did our operators become that unless the message was a long one, the loss of time in this way was small. For messages which could not wait, the endorsement " To be sent by wireless in Clear " was all that was required. Cipher messages were always sent twice to ensure correct reception.

The daily routine of the operator in trench warfare when no fighting was going on was mainly concerned with the fetching and carrying of rations and accumulators, and the disposal of a few practice messages each day, as well as keeping a continuous watch by day and by night, in case of sudden attack. Of his work when a battle started, the moving and carrying forward of his station, erecting masts and aerials, " getting through," sending and receiving messages all in the dust and din of the fighting with shells breaking his aerial every few minutes—of this an epic could be written, but he himself would merely glance at the medal he wore, and say nothing.

The necessity for keeping strict control and continuous watch over our sets in the line was due to the fact that the Germans possessed a very complete system of intercepting stations, with a staff of expert deciphers. The latter were ready to pounce on any message where the operator had made a blunder, hence the reason for strict control of our traffic. German army headquarters kept a tame mathematical Herr Professor for deciphering our messages, according to captured German wireless operators. The Herr Professor apparently hardly earned his pay to judge by the secrecy maintained in our heavy traffic during battles.

On our own side we were well organised for obtaining important information from the distribution of enemy wireless sets as well as for decoding their messages. For the former we employed special position-finding (P.F.) stations. The usual name " D.F." would be more accurate, for in each of our five armies we had a number of such stations all connected by telegraph and telephone to a central headquarters where the bearings made by our stations on enemy sets were plotted, and the positions of the latter found within a few hundred yards.

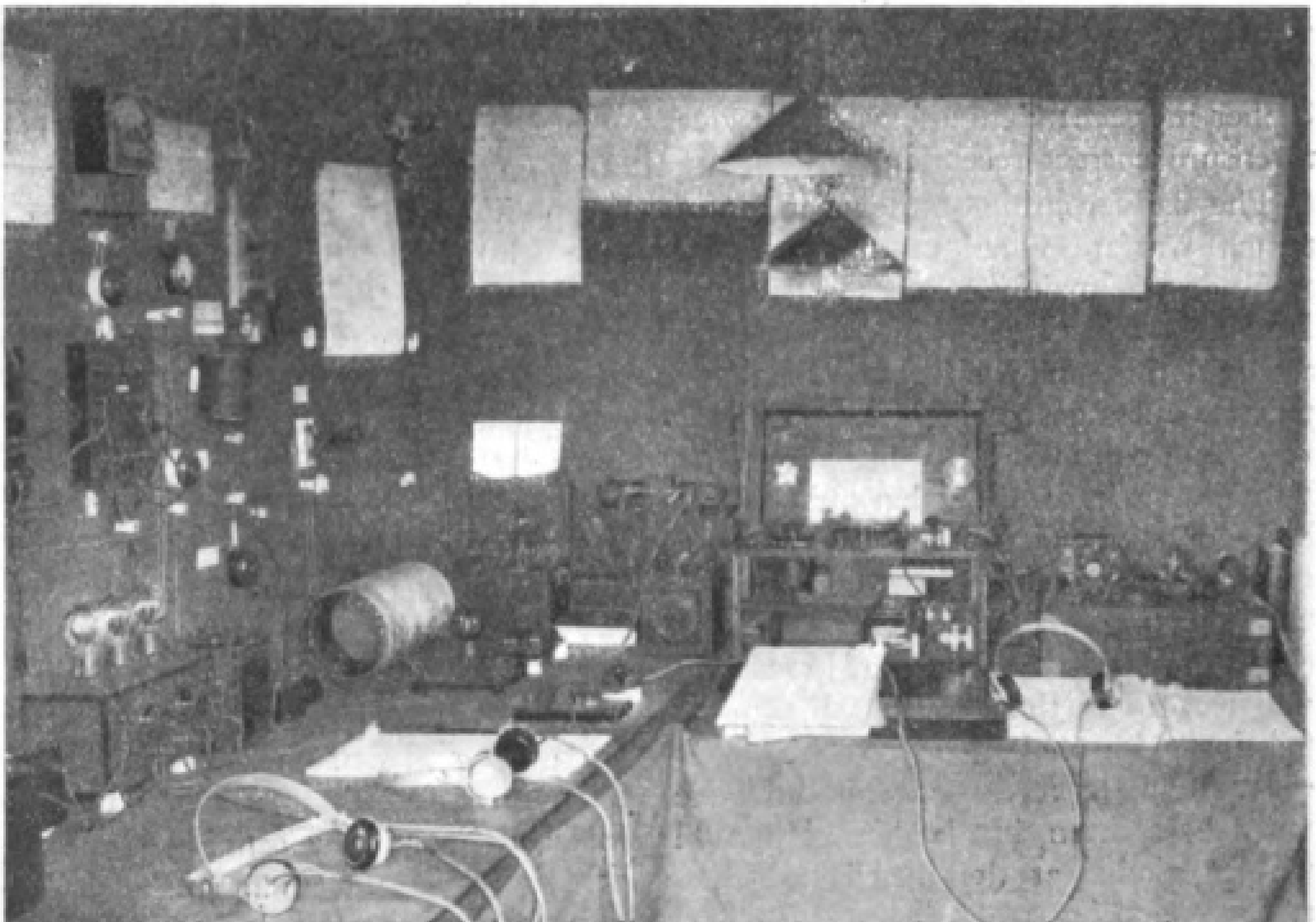
The *interception* of enemy messages was also an important part of the work of these "Wireless Observation Groups" as they were called. For although the Boche used a difficult code for his messages, a code changed every few weeks, we too had our decoders, and very able ones. The weekly acrostic in the *Sunday Times* was a good preparation for wrestling with German messages and many of our code experts were recruited from the ranks of the acrostic-solvers! Sometimes, too, the methodical German made a slip and by sending a message first in code and then in "clear" or something similar, made us a present of his efforts in encoding any further messages.

Yet another portion of an Army

Wireless Observation Group was devoted to the rapid location of any enemy aeroplanes observing for their artillery. From the moment the poor Boche tried his wireless over the aerodrome he was kept under wireless observation and before he had properly begun registering the "shoot" a special R.A.F. squadron had been telephoned to and a 'plane was on its way to interrupt the proceedings. Great success was obtained by these aeroplane P.F.'s., and while numerous "shoots" were stopped, sometimes a dozen enemy 'planes would be shot down in a week owing to the information as to position given in this way.

Of the instruments and apparatus used in our later P.F.'s. it will suffice to say that with the advent of the hard valve it was found possible to effect many changes and improvements on the original Bellini-Tosi aerial system and the circuits used. The big amplification obtainable nowadays made it an easy matter to reduce the size of the triangular aerials, and in fact to make the direction-finding depend not on the balancing of a radiogoniometer but on the actual rotation of a triangular loop aerial. All this made for simplicity and lightness, important factors in military work.

The development of these cunning wireless intelligence devices made both sides become more and more cautious as time went on. Camouflage and counter-camouflage in 1918 made things very interesting. Wireless sets were concentrated in areas where no attack was contemplated, and sets in areas where attacks were preparing, were kept normal. Many were the devices employed to cover up weaker points in our



An Army H.Q. Telegraph Station.

line by using extra sets at dummy headquarters and by moving existing sets from one spot to another. Every weak point in our system was watched, and utilised to delude the trusting Hun on P.F. or intercepting set.

Of German spies with wireless sets spotted by our P.F.'s., of others with receiving sets found in other ways, of weary journeys in motors in search of wireless spies—which sometimes ended in the discovery of a misguided British wireless operator in the back-areas (after one had crept dramatically up, revolver in hand)—much could be written. But I cannot close this narrative without a reference to the "I.T.'s." or listening sets, which though not strictly "wireless" sets were yet so important a part of the wireless sections work.

The "I.T.", so called apparently because it was a "hush-hush" apparatus simply consisted of a special three-valve amplifier placed in a dug-out close to the front line and used to pick up enemy telephone, buzzer and power-buzzer messages by means of earth-pins inserted in the ground at points as near as possible to the German trenches. These pins were placed in No Man's Land at night and cable leads led back from them to the dug-out containing the amplifier. The Germans, like ourselves, used telephones freely at one time in their front-line system, and owing to leakage from the telephone cables, either actual or by induction, it was possible to hear German officers talking sometimes louder than they could hear themselves. In this most important department of intelligence the Germans were first in the field, hence their almost uncanny knowledge of such things as infantry reliefs. Our first listening sets were in use in the spring of 1916 and grew in number as their value was realised. They were manned by German-speaking operators attached to wireless sections and their installation and up-keep devolved upon corps wireless sections. The information gained by them was most important, comprising conversations giving away the strength of the units holding the trenches, times and dates of reliefs, projected raids, mine-explosions and attacks, as well as the names of divisions, brigades and battalions in the line. I can only give one example from a host of cases where the "I.T.'s." information saved the lives of numbers of our men or caused German plans to fail. On September 7th, 1917, the interception of German messages by one of our listening sets enabled warning of a hostile raid to be given some time before it was launched. The attack at 5.30 a.m. was completely repulsed. The following were the points noticed which led us to take successful counter-measures:—

(1) Unusual amount of conversation over the telephone from 8 p.m. onwards.

(2) A speaker appeared to be very anxious that everyone should be on the alert. This was reported to our battalion H.Q. at 10.20 p.m.

(3) Time signals for synchronisation of watches were interchanged at 4.41 a.m.

Here is another case—December 5th, 1916. "Hullo, who is there?"——

"Berlinerhaus here, what do you want?"——

"What, a mine to-night?"——

"Well, good health."

The conversation was faint, but our listening set warned Brigade H.Q., and the mine went up late that night.

The Thermionic Valve as an Oscillator

AN IMPORTANT LEGAL DECISION.

In the judgment given below it is declared that Claim 1 of Dr. J. A. Fleming's United States patent No. 803,684, for the thermionic oscillation valve, covers its use not only as a radio-detector but as an oscillation generator. This decision is of special interest because it upholds the view that a patent covers not only the use of an invention in the manner described by the patentee, but also the use of the invention in a reverse manner, even if the possibility of the reversed use is discovered after the date of the patent.

UNITED STATES DISTRICT COURT.

Southern District of New York.

MARCONI WIRELESS TELEGRAPH COMPANY OF AMERICA, *Plaintiff*,

AGAINST

DE FOREST RADIO TELEPHONE AND TELEGRAPH COMPANY, *Defendant.*

J. Edgar Bull and L. F. H. Betts, of New York City, for plaintiff.

Samuel E. Darby and Samuel E. Darby, Jun., both of New York City, for defendant.

Final hearing on supplemental bill. Mayer, District Judge:—

The Fleming patent No. 803,684, so far as concerned a detector for radio waves, was fully discussed in *Marconi v. DeForest*, 236 Fed. Rep 942; affirmed 243 Fed. Rep. 560.

The effect of the decision *supra* of this court, as affirmed by the Circuit Court of Appeals, *supra*, was to accord Fleming's invention a high place in the art.

Eight or nine years after the date of the Fleming patent—the exact dates are unimportant—Armstrong, Hogan, Waterman, Weagant, and probably other experts in the radio art, while using these devices as radio wave detectors, independently observed that the detectors possessed the function of oscillating or, in other words, of generating radio waves. This was an extraordinary additional property or function of the so-called incandescent lamp detector of which Fleming had no knowledge.

Claim 1 of the patent in suit reads:

"1. The combination of a vacuous vessel, two conductors adjacent to but not touching each other in the vessel, means for heating one of the conductors, and a circuit outside the vessel connecting the two conductors."

While the claim covers broadly the device when used in the radio art, yet when read with the context of the specification, it is plain that Fleming's disclosure was addressed to use of the instrumentality as a detector only.

It is, however, a principle of the patent law—so well settled as not to call for citations of authority—that a patentee is entitled to all the benefits of his invention whether or not known to or foreseen by him.

Thus, the first inquiry is whether the Fleming valve, as disclosed by the patent, will oscillate when used in circuits and with instrumentalities available as of the Fleming date and of the kind and character which, upon the evidence, it would be assumed would or could have been used as of that date.

The testimony of the experts and numerous demonstrations in the court room (some required by the court by way of extra caution and assurance), proved beyond peradventure that the two element valve possesses inherently the same capacity for generating radio waves as is possessed by defendant's three element device.

The only question in this connection is whether plaintiff, in order to hold this feature of the Fleming invention, may use a battery.

Obviously, the Fleming valve cannot oscillate unless a battery is used; but, to use a battery would, of course, not involve invention, once it is determined that the Fleming valve possessed inherently the ability to generate radio waves.

As counsel for plaintiff aptly say, "one might as well ask whether a boiler could be made to generate steam without a fire under it or whether a dynamo could be made to generate electricity without an engine to drive it."

Indeed, on this branch of the case, the question is whether, in order to make the Fleming valve oscillate, anything need be done or added which would amount to invention. As the answer to this enquiry is plainly in the negative, one necessarily returns to the proposition that as Fleming gave the art a new instrumentality and as that instrumentality without inventive changes or additions will oscillate as well as detect, he is entitled to this feature although unknown to him.

The next question is: If the two element valve will certainly and reliably oscillate in common and well known detector circuits of Fleming's day (Marconi or P.N. circuit), but will not certainly and reliably oscillate in the precise circuit shown in the Fleming patent without a condenser, is Fleming entitled to the benefits of the device as a generator of oscillations?

The valve was made to oscillate without a condenser although the action in this regard is not certain and reliable; but this latter is immaterial.

The main case has really disposed of this point because this court and the Circuit Court of Appeals have held, *inter alia,* that Fleming's contribution was the device *per se,* which could be used in any circuits and with any instrumentalities then known to the art.

Bell Telephone Case, 126 U.S.1.

Indeed, the case on analysis is much simpler than when first presented.

On preliminary impression there is reluctance to extend the patent to an unexpected characteristic only observed after a considerable lapse of time by the highly skilled men who are students in the art. Yet, after all, it was Fleming who made this remarkable contribution of a wholly new device which, of itself, and in its development has done so much toward the practical advance of this great art.

The case is fully as meritorious as *Western Electric Company v. La Rue*, 139 U.S. 601, 605, which, as nearly as may be, presented an analogous question.

Under the authority of that case it is clear that where there is a capacity of reversibility with the same instrumentality, the courts will not restrict the claim to one attribute to the exclusion of the reversible attribute; and, for that matter, this case is stronger than the La Rue case because Claim 1 *supra* is broadly for the instrumentality.

It is concluded, therefore, that the so-called oscillion of defendant infringes and that the decree heretofore filed should be extended thereto with costs.

Submit decree accordingly not later than July 11, 1919.

July 7, 1919.

District Judge.

Stray Waves

THE AMATEUR POSITION.

SOMEWHAT to our surprise and greatly to our regret the British radio amateur still remains suspended in space, nearly a year after the signing of the Armistice with Germany. He is, to put the matter in a thermionic nutshell, in an uncomfortable position between the filament and the grid. He cannot obtain a licence, and even with the "special permission" which is obtainable he may not transmit. Even when he succeeds in convincing the authorities that he is a fit and proper person to be allowed to receive wireless signals, his aerial is cut down to a minimum which will certainly not satisfy the needs of an ambitious worker. We cannot but regard the whole affair as an attempt to keep amateurs out of the radio field, and, even bearing in mind the points which the Post Office must safeguard, we think that far too strong a line has been taken. Under the existing conditions it looks as though the raw beginner stands no chance whatever. There certainly is a ray of hope for him coming from the direction of the Wireless Society of London, but we advise the amateur community in general to combine forces, to interest Members of Parliament in their case and to urge, by every means at their disposal, that the whole question be fairly thrashed out. If officialdom is allowed to wield the bigger trumpet the amateur will find himself so restricted that he will have to seek another hobby, and that, it would seem, is precisely what is desired of him, and precisely what must not happen. We do not know whether the Wireless Society's officials see eye to eye with us on the question, but we hope that in their dealings with St. Martin's le Grand, they will not remain silent on its broader issues which concern not only the skilled research workers but a growing army of intelligent, scientific-minded boys and youths, deeply interested in aether-wave phenomena, who desire to amuse themselves with wireless apparatus—a desire which should be fostered as carefully as any other bent which keeps the hands and minds of the rising generation engaged with scientific work and reasoning.

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SUPER-RADIO.

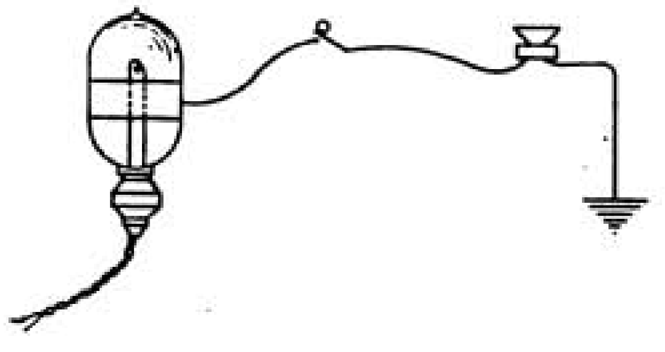
A note in *Electrical Industries* refers to a letter recently received from Mr. F. L. Ranson in connection with his latest book. It appears that Mr. Ranson is leaving England for a six months' lecture tour through the United States and Canada, where, he says, "they are far more advanced in matters of this sort than we are here." Apparently the "matters" referred to are the following :—"From the natural science point of view, thought is a high-tension current right above the Marconi wave, and every sin and every disease has its own cell in the sub-concious mind. If the cells are clean, nothing can cause them to vibrate. For instance, if the anger cell is clean, no angry thought can possibly make that man angry, and even a million people could not hypnotise him into being angry. If the cell is not clean, that is, has small electrical particles on it, they damp it down as pitch does a tuning fork, and the cell will vibrate and the man be angry. Good thoughts are high vibrations and bad thoughts are low vibrations."

We should like to know what is the frequency of some of the thoughts expressed in the foregoing quotation!

* * *

THE "EDISON EFFECT."

From *La Nature* we take the following simple method of demonstrating the well-known "Edison effect." A strip of tin-foil is fastened around the outside of an ordinary metallic-filament electric-lamp and from this strip a connection is taken to earth *via* a telegraphic key and a telephone (see Fig.). When the lamp is lit by direct current the circuit is repeatedly made and broken by means of the key, and at each "make" a sound is heard in the telephone.



The interesting point about this experiment is that the emitted electrons are able to pass through the glass in increasing quantities as the temperature of the glass rises. On being plotted as a curve, micro-amperes against degrees of temperature, it is found that beween 100° C and 200° C, the conductive value of the glass rises to a sharp peak.

* * *

WIRELESS TELEGRAPHY BY INVISIBLE INFRA-RED RADIATION.

Messrs. J. H. Stevens and A. Larigaldie have recently communicated to the Paris Academy of Sciences particulars of a device by means of which they have obtained records of infra-red radiations over distances of more than 20 kilometres, the best results being obtained with a thermocouple. They used as a source of emission an arc or electric lamp projector, the luminous flux of which was absorbed by a filter screen, a black glass coated with manganese dioxide or gelatine. Such screens absorb 50% of the total energy but do not allow any rays which may affect the eye to pass. The perceiver is a parabolic mirror arranged to trap the maximum radiant energy, the thermopile being placed at the focus of the mirror. It is interesting to note that in September 1919, signals were exchanged between two stations 14 kilometres apart, the transmitting station in this case being provided with an arc projector of 1.5 m. Also in May, 1919, experiments were carried out between two stations 7,500 m. apart, the transmitting station using a 4 m. mirror and an 800 watt nitrogen filled electric lamp and the receiving station a gilt mirror of 0.24 m.

* * *

WIRELESS TELEPHONE EQUIPMENT OF THE N.C.4.

Interesting details of the radio-telephone apparatus carried on the N.C.4 are given in the *Aerial Age Weekly* for June 9th, 1919. The set has succeeded in transmitting speech from an aeroplane in flight over a distance of 150 miles using a 600 ft. trailing antenna radiating a maximum aerial current of 2·5 amperes. The N.C. boats are also fitted with fixed emergency aerials which are stretched whilst the craft is taxi-ing or floating on the water. These sets permit of three different types of transmission (1) speech currents, (2) C.W. (3) Audio-frequency damped waves. Two wavelengths are in use, 16,000 metres on a trailing antenna of 600 ft. with a capacity of 0·0004 microfarad. Two large pliotrons requiring a filament potential of 18 volts and a plate potential of 100 volts are used.

The British Association Meeting.

BRIEF REVIEW OF PAPERS DEALING WITH WIRELESS SUBJECTS.

Section A.

REPORT OF THE COMMITTEE ON RADIOTELEGRAPHIC INVESTIGATONS.

OWING to the restrictions on wireless work only a few communications have been received during the past year. Special experiments were arranged in connection with the solar eclipse of May 29th, with a view to ascertaining the effect of the eclipse on signals passing across the central line. Stations at Ascension and the Azores transmitted continuously whilst the shadow passed across the Atlantic, which it did in a direction from west to east, appearing first on the South American coast at dawn and traversing the Continent in half an hour. The speed of the shadow when near the equator was about one-third of a mile per second; this speed increased on the shadow crossing Africa. The eclipse finished at sunset near Madagascar. The effects of the moving umbra were examined under three heads:—(1) Strays, (2) Signals not crossing the denser parts of the shadow, (3) Signals crossing through or near the umbra.

Strays.

These were severe on the day of the eclipse and also on the preceding day in Europe, North America and the temperate latitudes of the Atlantic Ocean; they were severer in Central and South America and in Central Equatorial Atlantic. The meteorological conditions in Central America were exceptional, there being less rain on that day than on nearly every day of the preceding three weeks. A preliminary examination of the results obtained throughout the part of the globe from Constantinople to Rio de Janeiro indicates that no particular change in frequency or intensity of strays resulted from the passage of the shadow.

Signals not Traversing the Dense Shadow.

Arc signals of 4,700 metres wavelength transmited from the Azores were observed in Northern Europe and America at points extending from Berling through Holland, France, Italy, Spain and Great Britain to stations near the Atlantic coast and the United States. No unusual variations in the strength of these signals were noticed.

It was suggested that the well known "twilight" effect, that is, that at sunset or sunrise the twilight band when at one side of a transmitting station appears to strengthen as if by reflection waves received at a station on the other side of a transmitting station, might occur during an eclipse. Certain stations on the south of the central line of the eclipse were detailed to observe signals from a station which was also south of the central line. Stations at Durban and Port Nolloth found no trace of the said effect and in fact the observers at Durban concluded that the signals from Ascension grew worse after the eclipse began. Similar conclusions were arrived at by experiments on the northern side carried out by one of the stations at Malta and also at Rosyth, which listened to Cairo.

Effect on Signals passing across the Central Line.

Special signals were transmitted from the Darien Station for observation by several stations in South America. These stations did not succeed in picking up the signals and the report from the Falkland Islands has not yet been received. Although fluctuations in the strength of signals occurred there was no steady increase or decrease in strength, whereas ships at sea within the penumbra, report an increase of strength of all signals during the eclipse. At Meudon and Rousillon (near Lyons) the signals from Ascension were received practically only while the eclipse was in progress and both Malta and Teneriffe found that the eclipse greatly improved the strength of signals. On the other hand, Darien failed to pick up Cairo, but Aden was picked up at greater strength than normal. Taken as a whole records show that an improvement in signal strength reached its highest value long before the umbra intervened between the stations and this value persisted after the umbra had passed. If the cause of the change in signal strength is an ionising process the results seem to indicate that this process is practically completed in a given region of space before the arrival there of the umbra.

DISCUSSION ON THERMIONIC VALVES.

This was opened by Dr. W. H. Eccles with a paper entitled "The 3-Electrode Thermionic Vacuum Tube and the Revolution in Wireless Telegraphy." In this paper he traced the development of radio-telegraphic practice from the days of spark transmission and reception by crystals or magnetic detectors. Parallel with this he dealt with the changes which antennæ had undergone, pointing out that whereas originally long-distance stations were forced to employ very large aerials it is possible to-day to use very much smaller antennæ for transmission and to receive practically without an antenna at all. He pointed out that in the thermionic valve is exemplified a method of obtaining electricity from matter without the use of machinery, and that a further development of this process may eventually lead to what will be the great need of the future, the obtaining of electrical power direct from fuel without steam boilers, engines or dynamos. He also discussed various well-known emitters of electricity and traced the development of the 3-electrode valve or triode and its applications in every branch of wireless telegraphy and telephony.

C. L. FORTESCUE urged the need for research of an organized and industrial nature and for research of the unorganised and spasmodic type, as carried out by the genius, and pointed out that for the physicist the valve offers fields for research of both these types. He discussed the filament of the valve in relation to the emission of free electrons, and dealt with the question of the efficiency of various materials as emitters. The remainder of this contribution to the discussion included references to various forms of the grid electrode and various processes involved in the manufacture of valves.

B. S. GOSSLING discussed a number of phenomena besides actual thermionic emission, and the effects of a mutual repulsion of the emitted electrons which are observed to enter into the action of the valve. These include the Maxwell distribution of velocities amongst the electrons, the contact potential between the filament and the grid, the composite electric field produced near the filament by the grid and anode and by the difference of potential between the two ends of filament, and also the orbits described by the electrons in the neighbourhood of the grid wires.

DR. R. WHIDDINGTON drew attention to the possibilities of using the Thermionic Valve in physical laboratories.

SIR OLIVER LODGE considered the possibilities of employing radioactive processes to bring about the emission of electrons in valves and also discussed the question of the utilisation of atomic energy by processes which might come to light as the result of our knowledge of electronic emission.

DR. W. MAKOWER also discussed the subject of bringing about electronic emission by means of radioactivity.

S. G. BROWN, with special reference to Dr. Eccles' remarks concerning lime-coated filaments, described some experiments which he made with a view to diminishing the difficulties encountered in this branch of valve manufacture.

WIRELESS IN THE ROYAL FLYING CORPS.

By Major T. Vincent Smith, R.A.F., M.C., M.I.E.E.

Dealt with the wireless work of the R.F.C. on the western front, covering the first three years of war.

WIRELESS METHODS OF MEASURING THE RATIO *e/m*.

By R. Whiddington, M.A., D.Sc.

Described the use of the Thermionic Valve in a new method of making this important measurement.

Section G.

DIRECTIONAL WIRELESS WITH SPECIAL REFERENCE TO AIRCRAFT.

By Capt. J. Robinson, R.A.F., M.Sc.

Described the system in vogue at the beginning of the war for the determination of bearings, which were (a) single coil, (b) method of the Bellini-Tosi system, (c) Telefunken clock. Described, further, the methods of determining position by the employment of bearings found by wireless which are: (a) transmission by aircraft to direction-finding ground stations, which take bearings on the aircraft and communicate same to a central station from which the position is transmitted when worked out; (b) the ground stations act as transmitters and are D.F'd. by the aircraft.

This paper also described the R.A.F. system of direction-finding.

A METHOD OF USING TWO TRIODE VALVES IN PARALLEL FOR GENERATING OSCILLATIONS.

By W. H. Eccles, D.Sc., and F. W. Jordan, B.Sc.

In the usual method of generating electrical oscillations with a thermionic valve, the oscillations in the closed ("flywheel") circuit are sustained by uni-directional pulses through the tube's external circuit. If two or more tubes are connected in parallel for the same purpose the output is not twice that of a single tube unless exceptional care is taken in the selection of the tubes and in the regulation of their grid voltages. Again, if the coupling is close there is a danger of producing asymetrical oscillations. The paper described an improved means of connecting two valves in parallel, whereby the "flywheel" circuit is influenced by a three-electrode valve and a H.T. battery symmetrically in every half-period. This can be accomplished by joining the grids of the valves by a coil which is connected to the oscillating circuit by its mutual inductance, by which means the resistance of one valve is caused to increase as that of the other decreases, with a definite phase relation to the oscillations.

A TRIGGER RELAY UTILISING THREE-ELECTRODE THERMIONIC VACUUM TUBES.

By W. H. Eccles, D.Sc., and F. W Jordan, B.Sc.

"In a well-known method of using a triode for the amplification of wireless signals an inductive coil is placed in the filament-to-anode circuit, and another coil magnetically coupled with this is introduced into the filament-to-grid circuit. This "back-coupling," as it is sometimes conveniently called, if it is arranged in the right sense, greatly exalts the magnification produced by the tube in any alternating E.M.F. applied to the grid; for the induced E.M.F. passed back to the grid is in correct phase relation to add directly to the original alternating E.M.F. applied there. If instead of using inductive retroaction of this kind we attempt to use resistance back-coupling, then the retroactive E.M.F. applied to the grid is exactly opposite in phase to the original alternating E.M.F., and the amplifying action of the triode is reduced. Since, however, one triode can produce opposition in phase in the manner indicated it is clear that two or any even number of similar triode-circuits arranged in cascade can produce agreement in phase. Hence we conclude that retroactive amplification can be obtained by effecting a back-coupling to the first grid from the second, fourth, and so on, anode circuit of a set of triodes arranged in an ohmically-coupled cascade.

It is possible to take advantage of the fact above stated for obtaining various types of continuously-acting relay."

The paper described a one-stroke relay, which, when operated by a small triggering electrical impulse, undergoes great changes in regard to its electrical equilibrium, and then remains in the new condition until re-set.

THE THREE - ELECTRODE THERMIONIC VALVE AS ALTERNATING CURRENT GENERATOR.

By Prof. C. L. Fortescue.

The first part dealt mainly with the work done during the war in the Wireless Telegraph Department of H.M. Signal School at Portsmouth. It traced the history of the Admiralty's early work and experiments with valve transmitters and referred to the names and performances of the various tubes used. The second part was a fairly simple account of the action of the valve as an alternating current generator, considerable use being made of hydraulic and mechanical analogies. In the third part the author went into the matter of the design of circuits and the fourth and concluding part embodied a description of certain valve transmitting sets as used by H.M. Navy.

INTER-IMPERIAL COMMUNICATION THROUGH CABLE, WIRELESS AND AIR.

By Sir Charles Bright.

In this paper the author discussed the general question of the Empire's communications, and urged the necessity for the introduction of the aerial mail, especially to Australia. In some instances the aeroplane can beat both the mailboat and the telegraph, and for the purpose of rapid communication between London and other important centres in England, where congestion of telegraphic traffic is likely to occur, the air route offers especial advantages. Treating of cable delays, Sir Charles referred to the national need for a modern high-speed British transatlantic line and stated that so far as working speed is concerned there is little to choose between a cable and an up-to-date wireless service. He might have added that there exists, in the Clifden-Glace Bay service, the British transatlantic high-speed line, the need of which he mentioned.

Sir Charles acknowledged the far-reaching and important technical developments of wireless communication, and expressed his opinion that these should be fully utilised in an all-British wireless chain without much further delay, and that all Imperial cable connections should be supplemented by wireless. Further, he advocated a highly-developed wireless news service " for the prompt and synchronous dissemination of news betwixt all branches of the Empire." Finally, he asked whether the inter-Imperial communication should not be put on the same footing with the Navy, Army and Air Force, inasmuch as it forms a most important strategic weapon.

Photo Topical Press.

The Magnavox, by means of which huge crowds heard President Wilson's Victory Loan appeal spoken by an aviator flying at a height of 3,000 feet.

Notes of the Month

WIRELESS TELEGRAPHY IN PORT.

According to an announcement by the Ministry of Shipping arrangements have been made for wireless inter-communication between ships while in the ports of the United Kingdom. This will be greatly welcomed by shipowners who may now communicate with their ships in their own or other ports, employing for this purpose, ships lying in the owner's port.

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NEW WIRELESS STATIONS.

The Minister of Public Works of Peru informs the public that the new Wireless Station at the Port of Eten has been opened for business. This station is now in communication with the large W/T station at Lima (San Cristobal) and at Iquitos, a town situated on the Amazon river. The Eten station is open day and night.

• • •

We understand that the Finnish State Council has approved of the erection of a Wireless Station of 35 kws. at Sandham, near Helsingfors, which should be completed in a few months. It is intended that its range shall be about 1,240 miles, thus permitting communication with London, Paris, and Berlin.

• • •

Several new long-range Wireless Stations are to be constructed by the Canadian Government on the Yukon River. A radiotelegraphic service has been established between Canada and Bermuda and between San Domingo (Dominican Republic) and Guantanamo (Cuba).

From "Lloyd's List," we learn that there has been commenced the erection of a high-power Radio Station at Point Hueneme. The station has been ordered by the United States Naval Department, and is to be one of a chain of similar stations on the Western coast of America, from Alaska to the Mexican border, and are intended specially for the service of coasting vessels.

• • •

WIRELESS AND FLYING IN AMERICA.

It is announced by the American Flying Club that plans have been made for the erection of a chain of wireless stations across the Continent which will enable aircraft to be in communication with them at 30-minute intervals. The Club will work in conjunction with the Government which has already started a series of radio stations connected with the air mail service.

• • •

LECTURES ON VALVES.

A course of six lectures on Thermionic Detectors, Oscillators and Amplifiers in Telegraphy and Telephony will be delivered by Professor J. A. Fleming, M.A., D.Sc., F.R.S., University Professor of Electrical Engineering, on Wednesdays at 5 p.m., beginning Oct. 29th, 1919, at University College, Gower Street, W.C.1.

The course is open both to Members and Non-Members of the University. Fee: £1 11s. 6d.

LONG DISTANCE COMMERCIAL SERVICE TO SHIPS.

It is announced that Marconi's high-power station at Poldhu is now again open for traffic to ships which are out of range of any other British Coast Station. Telegrams may be handed in at any postal telegraph office in the United Kingdom, at Marconi House, Strand, W.C., or at 1, Fenchurch Street E.C. The rate per word is 2*s.* 10*d.*

* * *

WIRELESS CLUB NOTES.

THREE TOWNS WIRELESS CLUB.

The report of the meetings of the above club during August and September, is as follows:—

August 29th.

The chair was taken by Mr. J. Jerritt, the lecture on Detectors being given by Mr. Lock who first explained the Hertz detector and then the coherer of Branly and Marconi, and Marconi's Magnetic Detector, models of the last two being kindly loaned by the Chairman. Next the lecturer dealt with the Lodge Coherer, the Crystal Detector, the Electrolytic Detector, and the Fleming valve.

September 7th.

This meeting was spent in Morse practice. The letter from the Postmaster General stating that permission to do certain classes of wireless work would be granted to suitable applicants at a fee of 10/- was read by the Hon. Sec.

September 11th.

The chair was taken by Mr. Voss, late R.F.C., and Mr. Rose (Hon. Sec.), lectured on a Chaffee Arc of his own construction. He explained the working and construction of the instrument and advised members to try and make a mechanical instrument to take the place of valves. New members were enrolled at the close of the meeting.

September 18th.

Chairman, Mr. J. Jerritt. Mr. Voss lectured on telephone receivers, dealing in turn with the Bell telephone, the ordinary "watch" pattern, and the telephone made by S. G. Brown. At this meeting the club membership fee was reduced to 5/- per annum.

September 24th.

Mr. Burrows lectured on relays and landline working. Mr. H. R. Hitchcock, Divisional Director of Industrial Training, consented to become a Vice-President of the club, Major Maldon having resigned on his appointment to the War Office.

The Club is open to visitors, and applcations for membership should be made to the Hon. Sec., Mr. W. Rose, 7, Brandreth Road, Compton, Plymouth.

* * *

NORTH MIDDLESEX WIRELESS CLUB.

August 12th.

Sec. Lieut. A. W. Hulbert, late R.A.F., lectured on Aviation Instruments. After briefly reviewing the pioneer work of Wright Brothers and Sir Hiram Maxim, the lecturer gave a few facts illustrative of the rapid strides made in aviation during the last few years. As a point of historical interest he mentioned a paragraph in an old flying paper which commented on the flight in 1912 of a Farman biplane with Sunbeam engine, piloted by a certain Mr. Jack Alcock! He then gave a brief outline of how and why an aeroplane flies and showed the importance of various instruments for navigating and controlling the machine. Messrs. S. Smith & Sons (M.A) Ltd., the aviation instrument specialists, loaned a complete set of instruments,

The Amateur Position.

IN view of certain paragraphs which have recently appeared in the daily press indicating that a change has occurred in the amateur position, we give hereunder a complete description of the facilities at present available for amateur wireless work, brought up to date (Oct 21st).

(1) All amateur licences have been cancelled and new ones are not yet being issued.

(2) Special informal permission to use receiving apparatus is being granted, and the following is the official statement regarding this :—

EXPERIMENTS IN WIRELESS TELEGRAPHY.

AUTHORITY FOR THE USE OF RECEIVING APPARATUS.

CONDITIONS OF ISSUE, Etc.

Formal licences to conduct experiments in wireless telegraphy cannot at present be granted; but, pending the settlement of certain outstanding questions, the Postmaster General is prepared to authorise the use of wireless apparatus for the reception of signals on the following conditions :—

(1) The applicant shall produce evidence of his British nationality and two written references. (A certificate of birth should be furnished if possible; but this will not be insisted upon if the two referees testify of their own knowledge that the applicant is of British nationality. The references should be given by persons of standing, who are British subjects and not related to the applicant) ;

(2) There shall be no divulgence to any person (other than properly authorised officials of His Majesty's Government or a competent legal tribunal) or any use whatever made of any message received by means of the apparatus ;

(3) The installation shall be subject to the approval of the Postmaster-General ;

(4) The aerial shall not exceed the undermentioned maximum height and dimensions :—

Extreme height of aerial above ground	100 feet.
Total length of wire including leading-in wires.	100 feet for single wire aerial. 140 feet of wire where two or more wires are used (*e.g.*, total length of 70 feet of double wire.)

(5) Thermionic valves shall not be used without the special authority of the Postmaster-General ;

(6) The apparatus shall be open to inspection at all reasonable times by properly authorised officers of the Post Office ;

(7) A fee of 10/- shall be paid. (It is contemplated that an annual charge of 10/- shall be made in respect of each experimental receiving licence to cover the expenses of the issue of the licence and the inspection of the station.)

PROCEDURE TO BE FOLLOWED.

The applicant should furnish

(*a*) A formal acceptance of the foregoing conditions ;

(*b*) Evidence and references as described in (1) ;

(*c*) His full Christian names and particulars of his occupation ;

(*d*) A remittance of 10/- ;

(*e*) A description of the apparatus which it is proposed to instal, and, if authority is desired for the use of thermionic valves, a diagram of the circuits in which they would be used ;

(*f*) A sketch showing the form, height and dimensions of the proposed aerial (including leading-in wires) ;

(*g*) The address at which the apparatus would be installed.

If it is desired to purchase wireless apparatus for use under the prescribed conditions full particulars of the apparatus, and the name and address of the firm from which it is proposed to obtain it, should be furnished, in order that a permit for its purchase may, if necessary, be issued. Any receiving apparatus belonging to the applicant, which is in Post Office custody, will be returned to him as soon as authority is granted for its use.

N.B.—If the applicant is a minor, the authority to use wireless apparatus can only be issued in the name of his parent or guardian, who should comply with the requirements set forth above and state his (or her) full address and relationship (if any) to the applicant. Evidence should also be furnished, as indicated in condition (1), of the minor's British Nationality. There is no objection to a minor working the authorised apparatus as the agent of his parent or guardian.

(3) No licence or permission to transmit by wireless telegraphy is at present obtainable by amateurs, as the conditions under which this will be allowed are not yet settled.

We shall keep our readers fully informed of further developments.

including compasses, which materially contributed to the success of the lecture. The most interesting instrument demonstrated was the new Smith density meter. As all pilots know, the ordinary air speed indicator under-registers on height. The density meter is engraved with certain factors which show the correction necessary to obtain a true air speed irrespective of altitude and temperature. The lecture closed with a few references on the future of commercial aviation.

* * *

Wireless and Experimental Association.

In spite of the restrictions upon wireless apparatus retarding the practical side of the programme, a review of the activities for the past month of the Wireless and Experimental Association of 16 Peckham Road, S.E., is not at all displeasing. A series of very interesting and useful lectures have been delivered during the course of the month and among other things, the following may convey some idea of the general utility of the subjects chosen for the lectures. Induction and Induction Coils, Variable and Fixed Condensers, Valves, Detectors, Accumlators, W/T Headphones, Measuring Instruments (volt and ampere meters), Ebonite and brass-working and finishing, etc.

Several members have already been granted permission for reception work, and the Committee of Management hope to be in a position to commence experimental work and to erect a valve-reception Station on the Association's premises in the very near future.

By the time this notice appears in print, it is hoped that the workshop will be in full swing. It will be at the disposal of members every evening and a very interesting and profitable output is anticipated.

South London readers who are interested, are invited to make application for membership. The Secretary, Mr. F. H. Gribble will be pleased to welcome new comers any Wednesday evening between 7.30 and 10 and will be pleased to answer an enquiries by post, if directed to his address, 48 Surrey Square, S.E.17.

* * *

Wolverhampton Wireless Telegraph and Telephone Association.

Wolverhampton readers will be interested to hear of the formation of a Wireless Telegraph and Telephone Association in that district.

Intending members should communicate at once with Mr. Arthur Lawton, Essington House, nr. Wolverhampton, who is acting as Secretary pro tem.

* * *

WIRELESS SOCIETY OF LONDON.

The Wireless Society of London, we learn on going to press, had intended holding their Annual General Meeting early in October, but the Railway Strike caused unforeseen delay. However, the meeting, from what the Secretary informs us, promises to be an important one, and, in addition to the ordinary business, and the future policy of the Society, which will come under discussion, there is to be an Exhibition of Wireless Apparatus, so that those who have been out of touch with Wireless Telegraphy during the war will have an opportunity of seeing the seeing the strides that have been made in this Science during the past five years. One of the most important matters that will come under discussion is the practicability of affiliation between Provincial Societies and the

Wireless Society of London, and in this respect, the Secretary tells us that on a recent visit to the "Powers that Be" at the General Post Office, the suggestion met with whole hearted approval.

In spite of the fact that there has been considerable delay in the granting of permits, the Secretary of the Wireless Society was assured that the Post Office in no way intends to limit the energies of the amateur or experimentor, providing always that reasonable care is taken in the use of thermionic valves for reception. Indeed, where an applicant shows that he has any knowledge of the apparatus he is intending to use, a permit to use valves has in all cases been given.

The International Communications Committee had before them (early in October) the definite proposals from the Postmaster-General as to conditions under which transmitting and receiving licences should be given, and possibly by the time this is in our readers' hands, these conditions may be approved.

The Advisory Committee of the Wireless Society, consisting of Mr. A. A. Campbell-Swinton, F.R.S., Professor G. W. Osborn Howe, D.Sc., M.I.E.E., Professor Ernest Wilson, M.I.E.E., and Dr. Eccles, M.I.E.E., have been accepted by the Secretary of the Post Office to advise on the suitability of applicants for transmitting licences, and members desirous of making application for such licences would be well advised to get in touch with the Secretary (Leslie McMichael, 30 West End Lane, West Hampstead, N.W.), giving particulars which will enable him to place their application before the Committee for recommendation.

The Society has recently been honoured by the addition of Admiral of the Fleet, Sir Henry B. Jackson, G.C.B., K.C.V.O., F.R.S., to their already distinguished list of Vice-Presidents. Sir Henry Jackson is, fortunattendance in Commttee, and has been ately for the Society, able to give his present at many recent meetings.

Club rooms in a central district have been practically decided upon, and here the apparatus belonging to the Society will be installed, and it is hoped a licence obtained in the near future.

The Presidential Address will take place in January and further particulars as to this will be given shortly.

A NEW ERA IN WIRELESS

By J. E. Catt.

Professor Chunder Bose has discovered that plants receive and respond to wireless waves.

By way of the dahlia
Comes news from Australia
Of the death of a famous D.D.;
While the sensitive aster
Relates that disaster
Has befallen a liner at sea.

In far Patagonia—
So says the begonia—
They're having political jars.
But the plant to attract us
Will be the first cactus
That picks up a message from Mars.
(H. J. H., in the *Daily News.*)

The term "Wireless Plant" has long been used, but in view of the recent discovery that certain flora are sensitive to the longer æther waves, as used in wireless telegraphy and telephony, enterprising seed specialists may be tempted to add to their catalogues a section as follows:—

GROW YOUR OWN WIRELESS STATION.

ELECTRON, ION & CO.

Specialists in tested seeds for Wireless Plants.

Climbing French Beans.

These attain a height of six feet and are very useful as aerials. TRY OUR SPECIAL 5, 6 or 7 "spud" AMPLIFIERS.

ONION SETS.

As it is only recently that onion growing from sets has become popular, it may perhaps be as well to explain that the "set" is a small, specially-ripened bulb and may therefore be called a single-bulb transmitter. These sets, although very small, have an exceptional range owing to their good radiation. They should not, however, be used in the vicinity of a visual receiver as a bad damping effect will be experienced in the eyes.

DETECTORS.

Chrysanthemum Segetum Grandiflorum.

Super-sensitive, replaces carborundum and needs no potentiometer. Being a hardy annual it only needs to be set once in the best ground earth.

Cyclamen Persicum.

Can be used as a substitute for Zincite-Bornite or Silicon-Carbon.

Galega Officinalis.

Substitute for Galena. A good detector for amateurs.

Mimosa Pudica (better known as the sensitive plant).

A very popular plant which has earned its name by its sensitivity.

MISCELLANEOUS.

India-rubber Plant.

A stock of these should be kept for insulating purposes.

Convolvulus.

This plant is very useful for winding inductances.

Sweet Peas, Afterglow. Violet and electric blue with shading of rosy amethyst, quite distinct, or

Glow-worm. Lovely shade of salmon pink.

Both very useful as radiation meters.

Banana. Noble foliage plant.

The leaves of this plant are used for making condensers.

Beet.

Unsurpassed for the reception of continuous waves.

Leeks, various.

For use with grid condensers.

Capsicum Chili.

For heating valve filaments.

Spring Onions.

For suspending detectors. Very good shock absorber.

Iris (Kaempferi).

Popularly known as "Flags." These plants can be trained to receive and translate wireless signals into "iddy-umpti" or semaphore. They should not be used near the set, transmitting, onion, for use of, 1.

Eschscholtzia,
Lynchnis Arkwrightii,
Calceolaria Veitchii,
Habrothamnus Elegans,
Xeranthemum.

A few of the above plants should be kept at hand for Morse practice.

Viscaria Oculata Azurea.

The last word in wireless sets. Very useful at séances owing to its ability to detect waves from other worlds.

Funkia Sieboldii.

Only a few of these transmitters are left. They make good souvenirs, having been captured from the Huns on the Western front.

Aircraft Wireless Section

Edited by J. J. Honan (late Lieutenant and Instructor, R.A.F.).

These articles are intended primarily to offer, as simply as possible, some useful information to those to whom wireless sets are but auxiliary "gadgets" in a wider sphere of activity. It is hoped, however, that they may also prove of interest to the wireless worker generally, as illustrating types of instruments that have been specially evolved to meet the specific needs of the Aviator.

AIRCRAFT WIRELESS SETS.

Spark Transmitters.

SPARK TRANSMITTERS.

THE 52A.

THE 52A was fitted to the Vickers - Vimy machine that flew across in June, but it got no chance, as the wind-screw blades of the alternator were sheared off shortly after taking the air.

This emphasises the importance of care in making the initial installation, and of skilful handling thereafter. A wireless set has to be adapted to each bus, much as a suit is fitted to a man. It is hopeless to expect efficient results from aircraft sets unless skilful attention is given to fitting and maintenance.

The 52A has been used to a considerable extent on war work, and, given proper attention, has proved itself an efficient instrument within the limits of short-range work. As will be seen from the outline diagram shown in Fig. 19, the arrangement is very similar to the No. 1 Transmitter with the exception that the make and break is replaced by an alternator driven by means of a wind screw placed in the slip stream of the propeller; otherwise the principle of the set is the same as the No. 1.

The alternating current flowing in the primary of the closed-core transformers when the key is depressed induces corresponding high voltages in the secondary, which being applied across the condenser break down the spark-gap, and so form a high-frequency oscillating circuit comprising the gap, the condenser, and that part of the inductance tapped off by the clip A. The open or radiating circuit is auto-coupled to the closed circuit by means of the adjustable clip B. The inductance is of the helix ribbon type, as will be seen in the photograph, Fig. 20.

The closed circuit is set to any given wavelength by means of the clip A, the inductance helix being calibrated as in the No. 1 set. The degree of coupling is determined by the position of the clip B.

The alternator is self-exciting, and generates 200 watts at 20 volts, giving a range with good crystal reception of between 30 and 40 miles. It is designed to generate the required output at a speed of 4,500 revolutions per minute, giving with an eight-pole machine a note frequency of 600 per second.

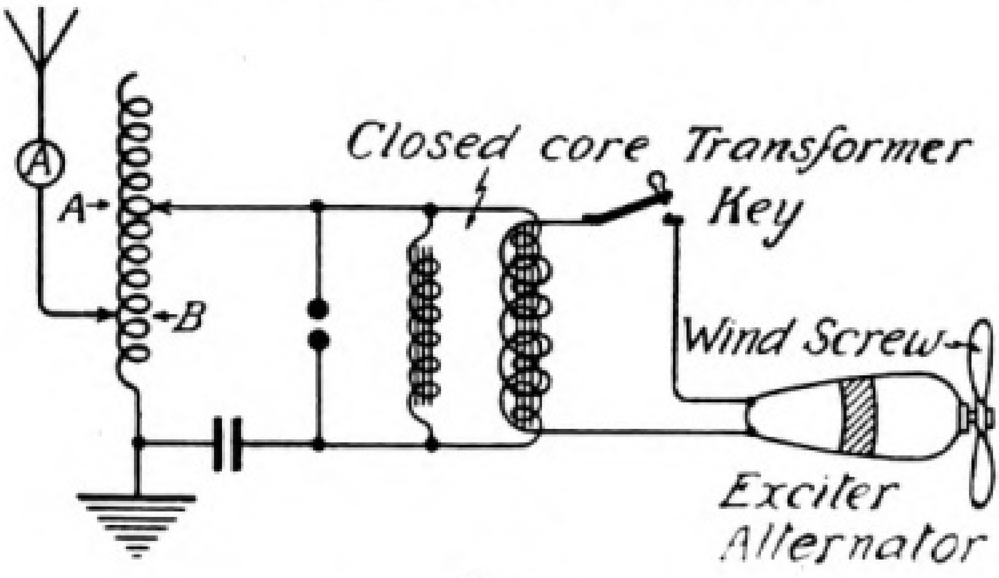


Fig. 19.

The size of wind screw that should be fitted will depend upon the normal air-speed of the bus in question. A certain amount of "regulation" to meet periods of abnormal speed can be secured by adjustably mounting the alternator so that the direction of the wind-screw axis can be varied relatively to that of the slip stream.

Though the transmitter is of small power, yet the aerial voltage reaches a value quite sufficient to justify a certain amount of care in the investigation of any irregularities whilst in the air. If a predilection for sitting on the key and " sleuthing " for faults cannot be overcome, the use of leather gloves will be found to minimise any consequent irruptions of blue smoke and heated language.

A further point of interest may be mentioned in connection with the wind-screw. As the key is depressed to send a " dash," the load placed on the alternator tends to slow it down, and thereby cause a "droop" in the note received in the phones. In order to prevent this, it is necessary to see that the wind-screw blades are of sufficient length to give the necessary reserve of power to maintain a speed of 4,500 revolutions per minute whilst under load.

This can only be satisfactorily determined by actual trial in the air, but the point should be borne in mind when installing the set in any particular type

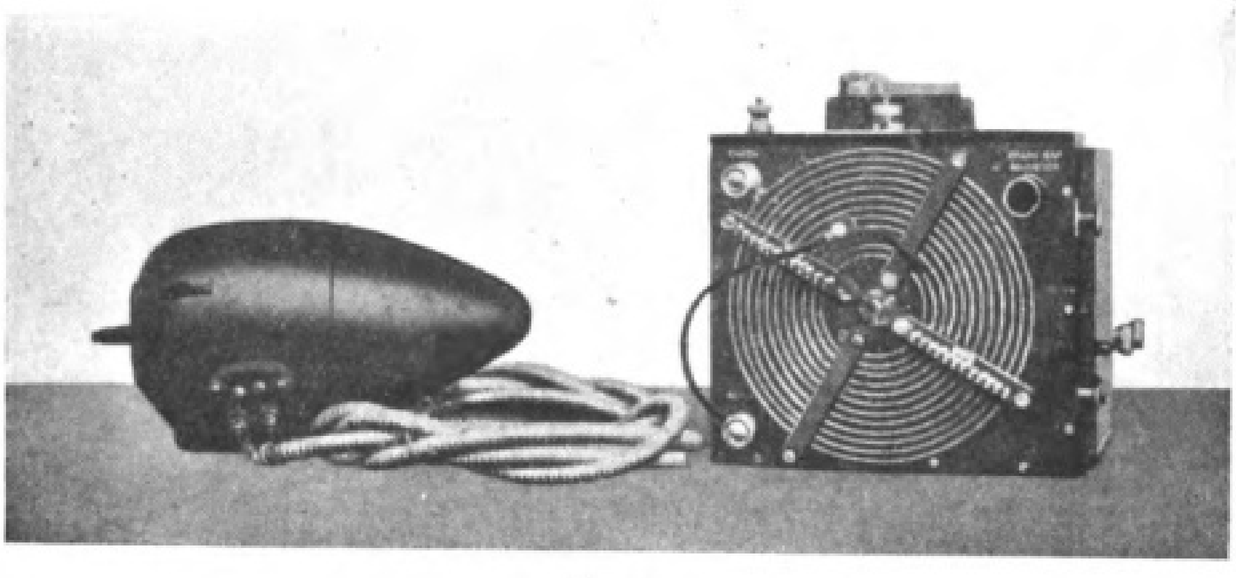


Fig. 20.

of bus, as it will probably save one or more superfluous testing flights.

EXCITER-ALTERNATOR.

The alternator is contained in a stream-line aluminium casing and weighs about 8lbs. It is excited by means of a small direct-current shunt-wound dynamo, the armature of which is mounted on the same shaft as the rotor of the alternator. Both stators are fixed to the stream-line casing. The two power leads and the two exciter leads are brought to a four-way socket to which connection is made externally by a corresponding plug. One brush of the exciter, and the negative lead of the rotor winding, are earthed.

WEIGHT.

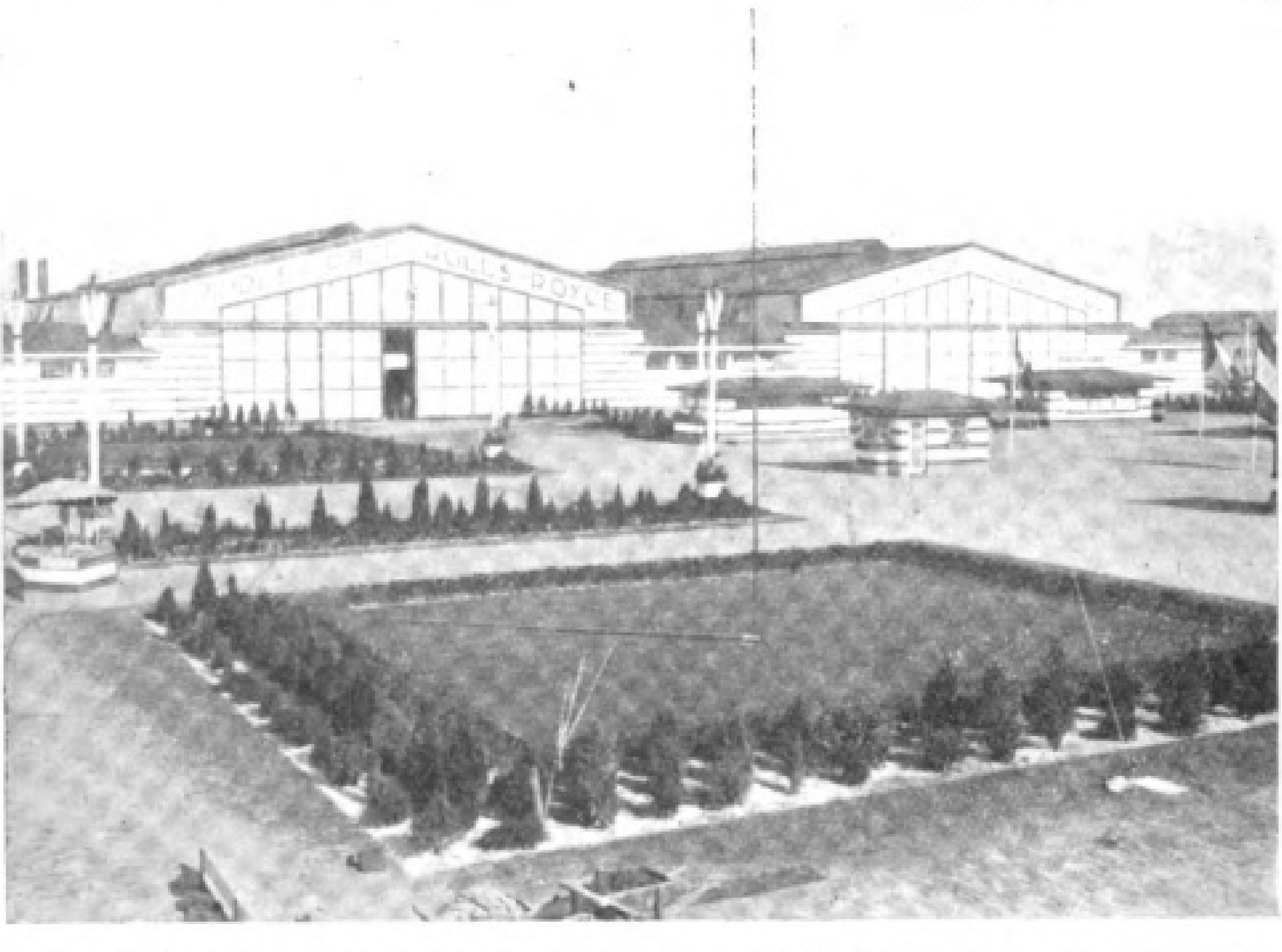
The outstanding merit of this set is its compactness and lightness. The whole set, including the generator, weighs only 30lbs. It is one of the earliest of the air-driven alternator type, and is perhaps the most efficient light-powered spark transmitter yet designed for aircraft work.

(To be continued.)

The Amsterdam Aircraft Exhibition.

The first Dutch Aircraft Exhibition which closed on September 14, was an undoubted successs, and the British exhibits in particular were representative of all sections of aircraft production from large passenger-carrying machines to the smallest accessories connected with aircraft in general.

The Marconi Company had a large number of instruments on view, and these were particularly well displayed on a commodious stand which faced the



The Wireless Mast will be observed in the foreground, while in the open space to the right of the picture the Marconi Wireless Telephone Station can be seen.

main entrance to the Exhibition Hall. The stand was in charge of Mr. J. M. Poyntz, and to quote *Flight,* it was "one of the most interesting in the Exhibition."

The chief features of the Marconi display was the new Aircraft Telephone. This instrument, which is the most powerful of its kind yet produced, was subjected to a series of demonstrations on both Dutch Army planes and Dutch Navy seaplanes with complete success. In the grounds of the Exhibition a Marconi Ground Telephone Station was erected, and this provided a link between the ground and the various machines in flight.

Conversations were exchanged by leading officials in the Dutch Army, Navy, and Air Force, including the War Minister, various Generals and Admirals.

On the occasion of the visit of the British Airships R.32 and R.33, complimentary messages were exchanged between the ships and the Dutch War Minister.

The general results of these exhibitions went a very long way to impress on the Dutchmen the possibilities of the Wireless Telephone and the fact of its being a very valuable asset to any type of flying machine, for linking it with the ground during flight.

A large Handley Page flew from Cricklewood to Amsterdam shortly after the Exhibition opened. This machine was equipped with both the Wireless Telephone and the Marconi Direction Finder. It was hoped to give the public an insight into the working and use of these appliances in flight, but unfortunately the Exhibition Aerodrome proved too soft for this type of machine, and on landing her wheels stuck and she tipped on her nose. In view of the state of the ground she was almost immediately flown back to England and the Direction Finding Exhibitions had to be abandoned.

The Exhibition Authorities are to be congratulated on the results of their efforts, and the success of the British Section in particular was due to the untiring work of the London Organizing Manager, Mr. Van der Steen.

Interior of the Marconi Exhibition Wireless Telephone Ground Station.

Aviation Notes

REGULATIONS FOR WIRELESS COMMUNICATION WITH AIRCRAFT.

IT is interesting to note that this matter is at last receiving the attention of the powers that be.

The actual form of licenc necessary for the use of Wireless to and from Aircraft, and the precise conditions under which licences will be granted, have still, however, to be determined. But in the meantime temporary and provisional authority for the installation and use of wireless apparatus in aircraft can be obtained, in approved cases, from the Secretary of the Post Office.

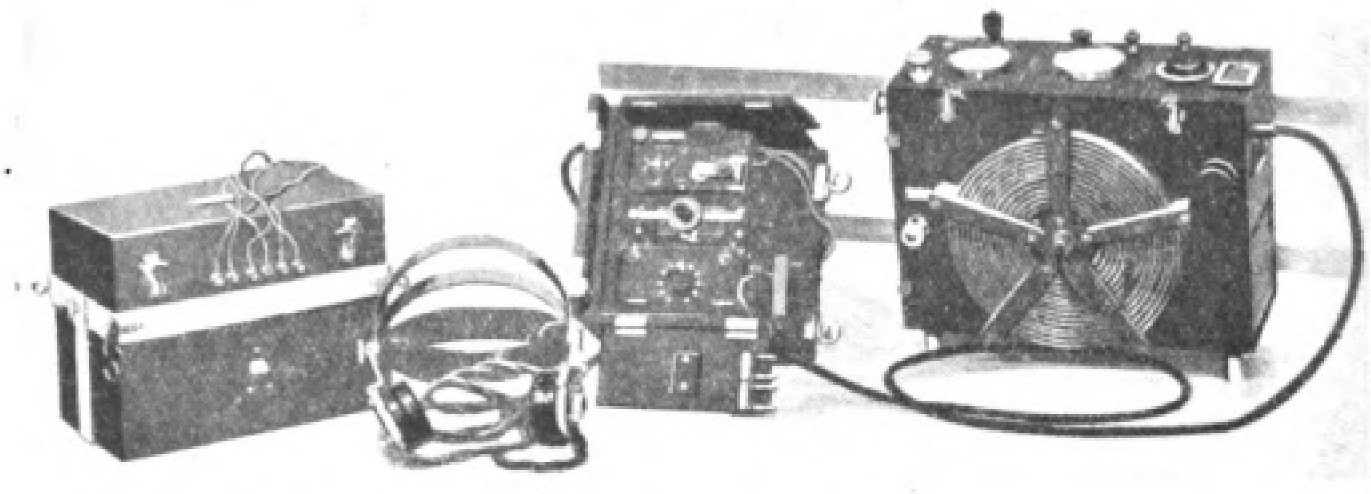
For the present the wave-length suggested for telephony work is 480 metres, which is the length employed for aircraft work by existing Air Ministry W/T stations.

For the information of designers, and other interested persons, it may be stated that the P.M.G's licence, when available, will probably contain the following conditions.

Transmitters.

The sending apparatus installed at any aircraft station shall be constructed so as to be capable of using waves of 600 metres " interrupted continuous wave," and 900 metres continuous wave. But the following wave-lengths namely, (a) 220, 300, 450, and 800 metres " interrupted continuous wave," and (b) 200-550 metres, 650-950 metres, 2,000-3,000 metres continuous wave may also be used for transmission under the written authority of the Postmaster General.

The use of the wave of 600 metres is to be confined to Tonic Train, or " interrupted continuous wave " and the 900 metres wave-length must be used only for continuous wave or Wireless Telephony.



Type 52 Transmitter (early battery-driven model) combined with Tb Receiver and Brown's Relav for Aircraft Work.

Receivers.

The range of wave-lengths for which the receiving apparatus may be constructed is not limited, but the apparatus must be capable of receiving on 600 metres and 900 metres. It must also be made to embrace any other wave-length for which an authorized transmitter is installed.

POWER.

The input of power to licensed apparatus, measured at the terminals of the power generator or battery, must not exceed 100 watts. However, when valves are used either in sending or receiving apparatus, the power employed for heating the filaments is not included in computing this maximum unit.

* * *

DIRECTION FINDERS FOR AIRCRAFT.

In a paper read before the British Association at Bournemouth last month, Captain J. Robinson, R.A.F., gave an interesting account of the development of modern direction-finding apparatus as applied to aerial navigation.

CAPT. J. ROBINSON, M.B.E., PH.D., M.SC.

After reviewing the wireless installation for determining aerial bearings that were known at the beginning of the war, such as the single-coil, and Bellini-Tosi systems, he pointed out the inherent difficulties of such minimum methods where engine noise and magneto "clicks" prevented the attainment of the necessary accuracy in determining the zero signal point.

It was to obviate this disadvantage that he devised the Service system of using a main and auxiliary coil, mutually at right angles and rotatable about a common axis.

In operation, one coil is first used alone as a "searcher," and when this is giving approximately maximum signal strength, *i.e.*, is roughly in the plane of the advancing wave, the auxiliary coil is switched in, first in opposition to, and then in series with, the searcher coil. By swinging the system through a small arc under these conditions, and continually reversing the switch from the auxiliary coil, a well-defined point can be ascertained at which the auxiliary coil, when inserted either in series or reverse, makes no difference to the signal strength received. The searcher coil is then accurately in the plane of the incident wave, and consequently pointing towards the transmitting station.

Two methods of installing the set were employed. In one, both coils were mounted on a pivot in the fuselage to rotate independently of the machine. In the other system both loops were fixed rigidly to the wings and structure of the machine, the plane of one coil being set at right angles to the plane of the other. With this arrangement the aeroplane itself must be "swung" during flight in order to ascertain the bearings. In practice, many long distance bombing machines carried both installations, the latter system being particularly convenient for " homing " or flying directly towards a given beacon station.

Reference was made to the means employed for cutting out "magneto noise," arising from the interference of short electromagnetic waves emitted by the magneto of the engine.

Quadrantal error, due to re-radiation from the metal work of the metal work of the aircraft, is determined by a preliminary "swinging" of the machine, much in the same manner as compass deviation is corrected in the case of a ship.

A further trouble arises from obscure refraction effects which vary with atmospheric conditions from day to day.

In spite of these many difficulties, Captain Robinson pointed out that excellent results have been obtained with the service system of wireless navigation.

In a particular test flight from the Biggin Hill experimental station to Paris, and back from Paris to Brighton, the machine was kept well above the clouds for most of the journey. In addition, the navigator was so placed that he could not look out of the machine The course taken was therefore made entirely dependent upon the bearings taken by means of the wireless installation. The result was entirely satisfactory. The navigator was not only able to determine the force and direction of the wind, and set an accurate course, but succeeded in forecasting the hour of arrival at his destination within two minutes of the actual time taken.

* * *

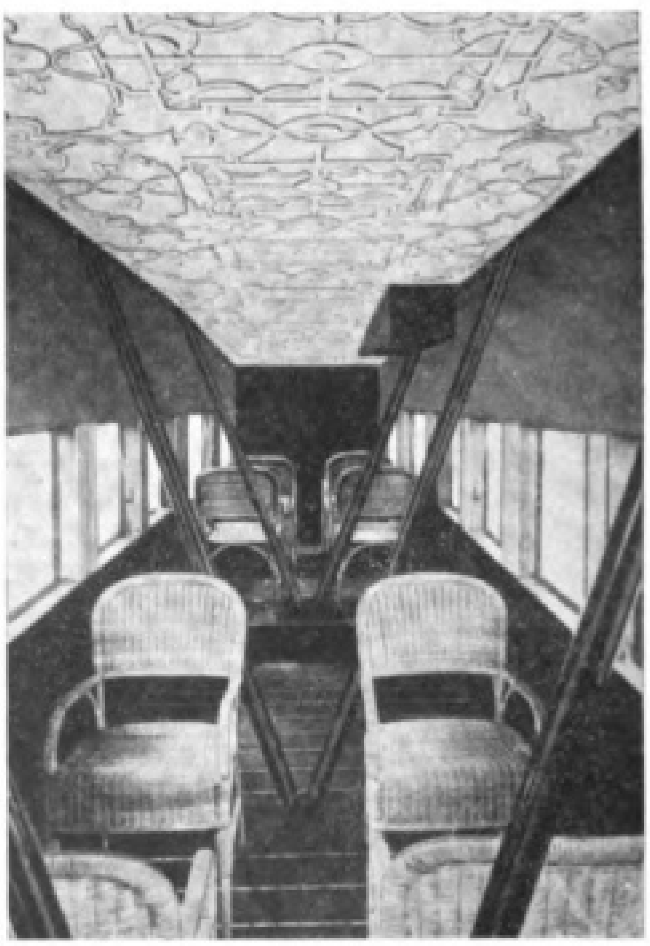
THE AIRWAY AND THE STRIKE.

The wonderful manner in which road locomotion was organized and rapidly adapted to meet the awkward situation created by the sudden Railway strike was, perhaps, the outstanding feature of that little episode.

But the part played by aviation in the sudden deficit of ways and means of conveyance was by no means negligible. The youngest transport service pulled itself together in good style, considering all the circumstances and succeeded in playing quite a useful part in the emergency.

In particular a regular postal delivery system was carried out from the Hounslow Aerodrome, linking up the Metropolis with Glasgow (5 hours), Newcastle ($3\frac{1}{2}$ hours), Manchester ($2\frac{1}{2}$ hours), Birmingham ($1\frac{1}{2}$ hours), and Bristol ($1\frac{1}{2}$ hours).

The charge made for letters and parcels was the ordinary rate plus two shillings an ounce. Rather stiff, considered merely as Cupid's mail, and calculated, perhaps, to cramp the flowing style



Interior of Two-engined Handley Page Machine showing the comfortable passenger accommodation.

favoured by the ardent lover. But reasonable enough, as evidenced by the amount carried, in the case of important business correspondence where thousands of pounds may depend upon the safe and prompt delivery of a single letter.

One single Handley Page machine on the fourth day of the strike took 1,400 pounds of postal matter to Brussels for Holland and Norway, and made the return journey with a similar cargo of 2,000 pounds.

Passenger service by the airway was extended in all directions. In spite of the cost of this method of transit, many more craft could have been employed in this work than were available for service.

* * *

THE LONDON FLYING CLUB.

Another sign of the times is to be discerned in the establishment of this new organization for the flying man. Its Headquarters are at Hendon, and its main object is to provide a definite and organized centre for all interested in aviation.

The Club hopes to prove itself a useful factor in promoting the cause of the aerial traveller generally, whilst primarily maintaining all the essential features of a social and sporting institution.

The premises are most commodious and comfortable. Tennis courts, a shooting range and gymnasium, swimming-bath, ice-rink, and golf course, promise sufficient side recreation, whilst the lucky possession of his own bus will not only secure garaging facilities, but will also be able to make arrangements to have the main object of his affections carefully tended and kept in running order.

A school for tuition in flying will be available, and a selection of buses for hire. The formation of an institution of this kind augurs well for the future of flying, and it is to be hoped that the initiative shown by its promoters will meet the general support that it merits.

* * *

AERIAL WARFARE À LA FOKKER.

M. Fokker, the Dutch aeroplane expert, who proved himself so useful to the Huns during the late trouble, has, after chewing the cud of reflection for some time, disclosed the following gem of German aspiration.

Referring to the possibilities of aerial warfare, he declares that he and Fritz would have so employed the aeroplane as to make all our gunners look old-fashioned.

The idea was to build a very cheap aeroplane with a still cheaper engine guaranteed to last four hours, train this contraption to fly under the control of wireless radiations, load it up with T.N.T., and send a squadron out in charge of one pukka bus, which would carry the wireless control transmitter and one perfectly good pilot. This fortunate individual would convoy his flock whither he listed, and would drop them as required upon selected targets.

The scheme was based upon the notion that the old-established artillery firm was much too expensive an institution in the circumstances to carry out the extensive distribution of high explosive and metal required. So with characteristic economy the alternative was formulated. There may be more in the conception than calls for mere ridicule. But however well laid, the egg was not hatched out, though it may "come up to scratch" in the forthcoming war under the management of M. d'Annunzio.

The Library Table

THE PRINCIPLES UNDERLYING RADIO COMMUNICATION.

SIGNAL CORPS, U.S.A.

Washington : Government Printing Office, pp. 355. 55 cents (1919).

THIS book has been prepared by Dr. J. H. Dellinger, Dr. F. W. Grover, Professor C. M. Smith, Professor G. F. Wittig, Dr. A. D. Cole, Dr. L. P. Wheeler, Professor H. M. Royal of the Bureau of Standards for the use of the Signal Corps of the U.S. Army. Essentially it is an instructional book rather than an exhaustive text book, aiming at presenting briefly merely the elements and basic facts of electricity and magnetism such as are requisite to lead up to Radio Communication. In order to render the work suitable for the training as operators of students having little or no initial electrical knowledge, the opening chapters deal with the elementary facts of the electric circuit and the magnetic effects of the currents. With this aim in view also, the mathematical portions of the book have throughout been reduced as much as possible, and explanations given in many cases by the help of mechanical and other analogies.

There are six chapters dealing respectively with Elementary Electricity, Dynamo - Electric Machinery, Radio Circuits, Electromagnetic Waves, Apparatus for Transmission and Reception, and Vacuum Tubes in Radio Communication.

The bulk of the treatment of the subject is of a particularly clear kind, and of an easily readable type; while the majority of the figures are also clear, although very diagramatic. Owing, however, to its having been written primarily for the use of the U.S. Army Signal Corps the book deals essentially with radio from the American point of view, and in most cases the apparatus and instruments described are restricted to those of American manufacture or design. In this connection, too, a number of expressions and phrases naturally appear somewhat strange to the English reader, and the American nature of the book requires to be borne in mind by a student to avoid gathering somewhat erroneous ideas considered from the British standpoint of the meanings of certain words and phrases. A number of references to other works are given throughout the book, but naturally these are also nearly all to American books or U.S. Government publications. In the last chapter dealing with valves, a brief mention is made of Radiotelephony, but the methods given are limited to one circuit diagram showing a modulating and generating valve. Useful features in the appendix are a list of suggested experiments illustrative of the matter dealt with in the book with brief working instructions and lists of mathematical and diagram symbols used throughout the book.

A POCKET DICTIONARY OF AERONAUTICS.

By F. T. Jane.

London and Edinburgh : Sampson Low, Marston & Co,, Ltd. pp. 64. 1s. 6d.

To practically every calling in life there is attached a more or less profuse vocabulary of technical terms, or shop slang, the appropriate employment of which constitutes an invaluable support to the proper dignity of the expert in his dealings with the uninitiated.

How much pleasure would be lost to the fond owner of a new motor bike if he were denied the privilege of obscure—and frequently over-loud—discourse upon the interior economy of his machine during the morning's train journey up to town. Similarly half the charm of golf would disappear with its awe-inspiring slang.

Aeronautics is no exception to the general rule. In fact, owing to the obtruse nature of the principles involved in construction and the many special auxiliary gadgets concerned, the airman has quite an unusual amount of terminological ammunition with which to cow the amateur into a becoming humility.

This book, however, comes to the rescue. It comprises most of the learned technicalities of the craft briefly, but carefully, explained with the help of four excellent diagrams illustrative of the pusher and tractor types of plane.

Its price is regarded as excessive for the privilege of being able to maintain an intelligent expression during a conversational outburst concerning "aerodonetics," "colonette bolts," "monosoupapes" and "slip ratios."

Nor is the lighter side overlooked, and the purchaser will be enabled to estimate the precise value of the ubiquitous "gadget" as contrasted with the "doo-hickey," the "gilguy" or the "quiff."

Moreover, the book is of a convenient size to enable it to be stealthily produced from the pocket should mental crisis occur.

A short glossary of English and French synonyms is given as an appendix.

The interpolation of pages of advertising matter within the domain of the dictionary proper is confusing, and tends to irritate the reader. A small point, but worth avoiding.

* * *

THE HANDY ELECTRICAL DICTIONARY.

By W. L. Weber, M.E.

London: S. Rentell and Co., Ltd., pp. 224. 1s. 3d.

This is a recent edition of a fairly well-known, useful little book. It contains several thousands of carefully-compiled definitions and seven pages of illustrations showing the conventional diagrammatic forms of electrical instruments, the whole work covering more ground than any dictionary of the same price (or thereabouts) that we have seen.

It is to be regretted that the compiler has with one or two exceptions omitted to include "wireless" terms, even wavelength being absent; electrical literature nowadays is generally so profuse in references to radio practice that the failure of this book to cope with the nomenclature of what is now a fairly established branch of electrical engineering is not a trifling defect.

With regard to the definitions themselves they are full and accurate, though, as an exception, an electron is described as follows:—"A word signifying amber, not obsolete, *but seldom used.* An alloy of gold and silver. *The throwing of electric particles from the cathode of a high vacuum-tube.*" The italics are ours.

Finally we wonder why the compiler includes "Damped Vibrations" and omits "Logarithmic Decrement," why he defines "Coherer" but not one of the numerous family of thermionic valves, and why he includes "Pith" but makes no mention of "Coupling" or "High-frequency resistance."

Correspondence

To the Editor of the WIRELESS WORLD.

THE AMATEUR POSITION.

After reading your article under this heading in the July number of the WIRELESS WORLD, and drinking to the full your optimistic words, I was immensely bucked up, but to-day have had a serious relapse on reading in an evening paper "D.O.R.A. for 12 months yet."

To me this is a terrible shock and I know will be to thousands of others who glory in this delightful hobby and have looked forward to winter evenings in our homes listening to other parts of the world speaking, and trying to penetrate deeper the hidden mysteries of W/T.

Before 1914 I knew nothing about the subject, but the war changed most lives, and mine it changed to an enthusiastic follower of Marconi. How many of my late fellow R.N.V.R. friends are awaiting on the threshold of expectancy for D.O.R.A. to die, it is impossible to tell, but out of the vast number, I believe somewhere in the neighbourhood of 10,000, there are hundreds, and we have all held in our breasts more secrets than most people realise, why therefore should the Government not trust us now, so that we may still keep fresh in our minds the knowledge we have learned at our Country's expense, and have it at hand should she call us in the future.

Wishing your paper every success,

Yours faithfully,

G. HART HORWOOD,

Late R.N.V.R.

To the Editor of the WIRELESS WORLD.

SIR,

Has it occurred to any of your readers that an aerial that has become sufficiently charged up with "static" to produce a succession of sparks across the Earth-arrester or Anchor-gap is radiating plain aerial impulses while so doing?

Such impulses would produce x's (of the type known as "clicks") quite strong enough to be detected by receiving stations many miles away from the cause of the "static."

On several occasions I have detected a series of clicks which could not be tuned out, but which appreciably strengthened up on a particular adjustment. My own impression at the time was that they were caused this way and that they roughly tuned up on the natural wavelength of the aerial producing them.

Yours faithfully,

WILLIAM D. OWEN.

To the Editor of the WIRELESS WORLD.

SIR,

I have read with interest in this month's WIRELESS WORLD the narrative by Lieutenant Durrant of his voyage in the R34.

I notice that he obtained 250 miles range with his spark transmitter which from the description appears to be the Service Type 52M Transmitter, 150 Watt.

I have also obtained a record with a similarly built set of a slightly larger power, viz., 230 watt, which I think will equal the above.

Whilst making a voyage on a "Motor Launch" (M.L.) from Dundee to Poole, I was exchanging signals with Dundee (Carnoustie R.A.F. W/T Station) at a distance of 320 miles on a wavelength of 330 metres. My last signal to Carnoustie was one giving my position as 90 miles S.45E. of Flamborough Head. At this time I was working under great difficulties. My Filament Battery for my Valve Receiver (Type T.F.) was so low that I had to take out the two amplifying valves and receive direct. Also my 18 volt Transmitting Battery was only giving 15½ volts and I had some difficulty in getting a fair spark. I was in communication with Flamborough Head up to a distance of about 130 miles, and was receiving Carnoustie (Dundee) at over 400 miles later on as we were passing Dover. It was about 3.30 p.m. on April 6th when I last communicated with Dundee and we arrived at Yarmouth Seaplane Station close on midnight.

On the next day (April 7th) I took my accumulators to be charged and was congratulated by the W/T Staff of Yarmouth, who expressed their opinion that I had obtained the record for the British Isles with this particular type of transmitter (52B Coil Set).

I would like to describe the Aerial I was working with. It was a "Four Wire Straightaway" 38 feet in length, one end being 30 feet and the other 48 feet above Sea Level.

With the aid of extra Inductances I was able to get several high power stations quite easily. I took the time signals from POZ regularly at 12-00 G.M.T. every day and took Paris press and time, also Poldhu weather report regularly throughout the voyage.

There is one question I would like to ask. Can you offer any explanation why in a Valve Receiver unlike the Crystal Receiver better results are obtained when the Detector Circuit is directly coupled to the Aerial Circuit instead of Inductively Coupled?

Yours truly

CYRIL E. BARNES,

Sgt., Mech. W/T.

The Construction of Amateur Wireless Apparatus

This series of articles, the first of which was published in our April number, was originally designed to give practical instruction in the manufacture of amateur installations and apparatus, and arrangements had been made with Marconi's Wireless Telegraph Co., Ltd., to supply complete apparatus to the designs it was intended to detail. The restrictions on amateur work, however, have remained in force, and the author is compelled to proceed on general lines only. Please see the special notice at the end of this article.

Article Eight.—THE REACTION PRINCIPLE.

THE REACTION PRINCIPLE.

BEFORE entering into a brief discussion of the methods of receiving continuous wave signals and the generation of continuous oscillations by means of the three-electrode valve, it is necessary that the amateur should have a clear idea of the reaction principle and the method of applying it in practice.

In Fig. 1 we have illustrated the elementary high-frequency magnification circuit already explained. The tuned circuit *A* connected in the grid-filament circuit of the three-electrode valve, having induced in it the oscillations it is desired to magnify, the circuit *B* is provided to receive the magnified counterpart of these oscillations in the plate circuit of the valve. Now let us assign a figure to represent the magnifying power of the valve, the value of this constant being taken to indicate the ratio of the magnified current in *B* to that of the original or trigger current in *A*. In practical cases the numerical value of this constant may vary between very wide limits, being controlled by the design and mechanical construction of the valve itself. For the sake of this discussion we will assume that the value of the constant is ten. By this we mean that if a current of one microampere is induced in the circuit *A*, then ten microamperes will be found to be flowing in *B*. Now it is clear that so long as we maintain the steady oscillatory current of one microampere in *A* the current in *B* will also remain steady at ten microamperes, so that there is no objection to us using a portion of the *B* current to supply the energy for the *A* current. The method of doing this is illustrated in Fig. 2. It will be observed that a small coil *R*, is inserted in series with the inductance of the circuit *A* and that this coil is coupled magnetically with the inductance of *B*. Energy can now be transferred from *B* to *A* *via* this coupling, and it is obvious that, provided the coupling is adjusted to be in the right sense and of the right value the whole circuit will maintain itself

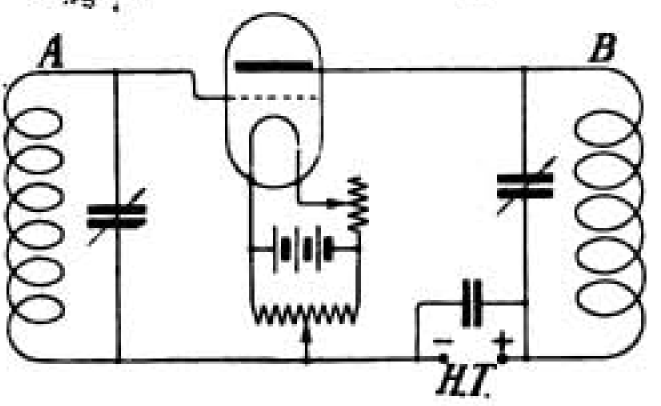


Fig. 1.

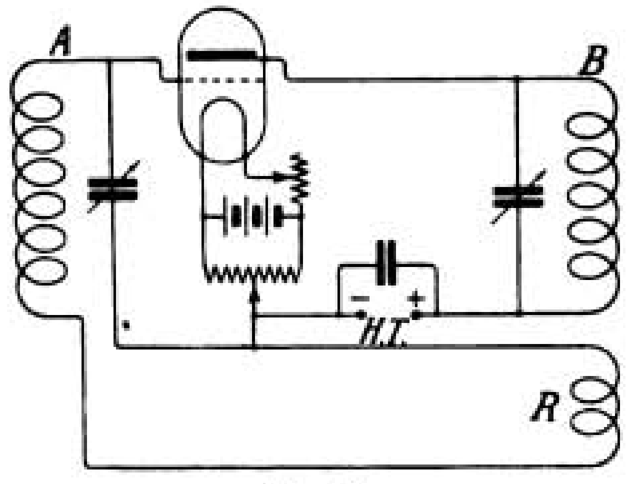


Fig. 2.

in a state of continuous electrical oscillation, one microampere flowing in *A* and nine microamperes in *B*. Of course, the amateur will understand that the actual phenomena occurring in an oscillating valve circuit are of a very complex nature; the above explanation is only offered as an aid to the clear understanding of the principle involved in reaction methods.

The first application of reaction occurs in the reception of spark signals. For this purpose we arrange the circuit so that a part of the magnified current can be transferred to the grid circuit and be employed to "boost up" the incoming signals. A spark circuit arranged in this manner is shown in Fig. 3. The circuit is identical with the crystal magnifier described in the last article with the exception of the addition of the reaction coil *R*. The arrangement is a very important one as it is one of the best that have ever

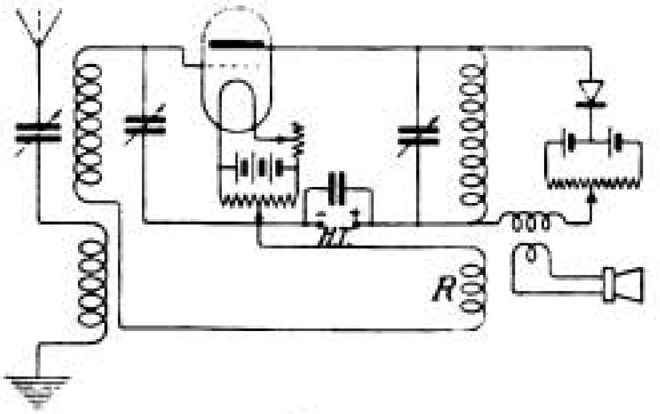


Fig. 3.

been devised for single stage valve magnification. By accurate tuning of the circuits and a critical adjustment of the coil *R* a very high order of sensitivity can be obtained, and the amateur will, in general, find it all he requires for his spark receiving work. We have indicated the telephone directly connected in the crystal circuit *via* a telephone transformer; but of course, single or double note magnification can be added if it is desired. Note magnification does not largely increase the sensitivity of the arrangement, but has the effect of making signals which are too weak to read comfortably into strong, easily readable Morse. Note magnifiers have the grave disadvantage of magnifying signals of medium strength to a greater extent than very weak ones, with the result that atmospherics may become deafening crashes during bad periods. These very strong *x*'s have the effect of momentarily paralysing the ear and rendering it insensitive to weaker sounds, with the result that the general readability of the signals is reduced. It will therefore be seen that a high magnification (particularly low frequency) is not an unmixed blessing, and in practice one always employs the least amplification to render the signals readable. High note magnification is almost entirely used for the purpose of recording automatic sending at high speed.

Continuous Wave Reception.

The simplest and best method of receiving signals of this type is by the production of beat tones by means of the three-electrode valve. We shall not enter into the theory of the method, the reader must consult a suitable textbook for a description of the principle involved. (See "The Oscillation Valve," by R. D. Bangay.)

In Fig. 2 we illustrated a simple

circuit, showing the manner in which the three-electrode valve can be made to sustain continuous oscillations in suitable circuits. In Fig. 2 it will be observed that we have shown both the *A* and *B* circuits tuned to the desired wave-length. In practice it is found that it is sufficient if *either* the *A* or *B* circuit be tuned. The remaining circuit then merely becomes a reaction coil without any condenser across it. For continuous wave reception the grid circuit must be tuned and coupled to the aerial; the plate circuit then consists of a reaction coil in series with a telephone transformer and the high tension battery. Such a circuit is generally known as a "self-heterodyne," the valve performing the three functions of rectifying, magnifying and "heterodyning" by the production of local oscillations. Fig. 4 shows the exact arrangement which may be used. The reaction coil R must, of course, be made adjustable in order that the right strength and sense of coupling may be obtained.

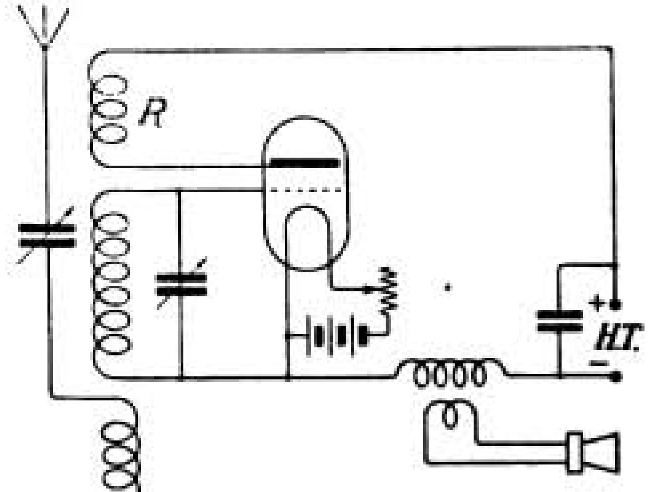


Fig. 4.

The incoming signals cause an oscillatory current to flow in the tuned grid circuit which is superimposed on the local current maintained by the valve; the compound current is then magnified and rectified by the valve and is heard in the telephone connected in the plate circuit. The practical working of the receiver is very simple. The reaction coil is adjusted until the circuit is oscillating, then the tuning condenser is turned until the characteristic whistle of a C.W. signal is heard. Of course it is necessary to follow any variations of tune by suitable adjustment of the aerial wave-length; but rough tuning of the aerial is only required in order to pick up a station, then the coupling can be weakened and accurate adjustment performed. We have described this arrangement as for the reception of continuous waves, but the amateur will find it very simple and useful for spark signals as well. Of course the pure note of the spark is lost, but the extreme sensitiveness of the circuit makes up for any loss of readability on this account. A little practice will enable the amateur to tell at once if the circuit is working properly from the sound of atmospherics. Immediately the circuit begins to oscillate, even if the aerial tune is a little out, a slight fizzling noise is heard. This sound is due to the magnification of small *x*'s and is quite characteristic. It is a good plan to adjust the reaction coupling by listening to this noise. The coupling should be such as to cause the circuit to oscillate freely, but should on no account be too tight, or the strength of signals received will suffer. It is not necessary to keep the grid tuning condenser very small; for waves of 2,000 metres and over the condenser may be ·003 mfd. or more.

A simplified circuit of the same type is shown in Fig. 5. In this case the grid circuit of the valve is connected directly across the aerial tuning inductance, adjustment of wave-length being obtained by means of the shunt condenser. For short waves the condenser may be placed in series with the aerial

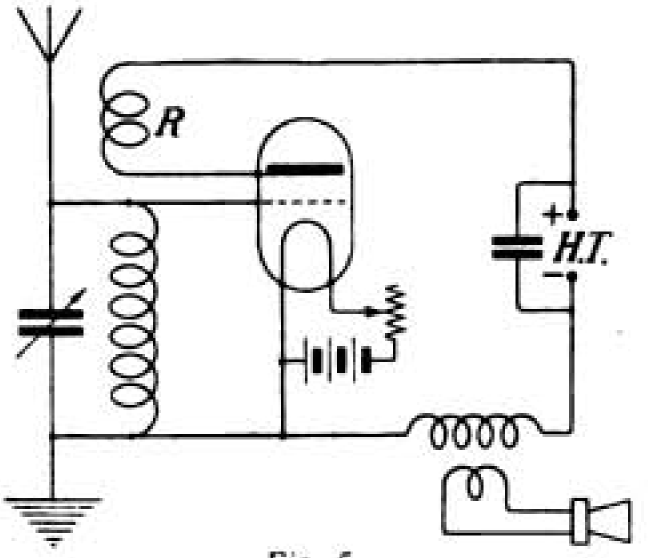


Fig. 5.

instead of across the inductance if desired. The chief advantage of the circuit lies in the fact that it is very easy to pick up any station since there is only one tuning adjustment to be made, that of the single condenser. There is sometimes a little difficulty in following the tune with both circuits when using the arrangement shown in Fig. 4. Of course, in common with all other direct coupled circuits, the receiver is very susceptible to jamming. The amateur can devise for himself an arrangement of switches to change over from circuit 5 to circuit 4 if he wishes, when circuit 5 becomes a convenient stand-by.

It will be noticed that we have shown no potentiometer in the last two figures, the bottom end of the grid circuits going directly to the negative end of the filament battery. When using most valves it will be found that by a suitable adjustment of the plate voltage, the best working potential for the grid can be made to coincide with the negative end of the valve battery and thereby the necessity of potential adjustment is avoided. This point also applies to all the valve connections we have illustrated and may be of importance to the amateur.

Continuous wave signals can also be received by the method of separate interference. The circuit we give below for the production of continuous waves can of course be used for the local oscillator.

Production of Continuous Waves.

We have already pointed out that the fundamental reaction circuit shown in Fig. 2 can be made to oscillate by either tuning the grid or the plate circuit, and that for the reception of continuous wave signals it is only necessary to tune the grid circuit. Now when the arrangement is used for the production of oscillations for transmitting purposes we wish to get the maximum amplititude of oscillation possible with a given valve. The source of the high frequency energy is obviously the high voltage battery connected in the plate circuit of the valve, hence it is clear that the correct place to connect our tuned circuit is in series with the plate battery.

The first oscillation valve transmitters were connected as shown in Fig. 6. In this case the aerial is a separate tuned circuit and is coupled magnetically with the valve oscillatory circuits. We

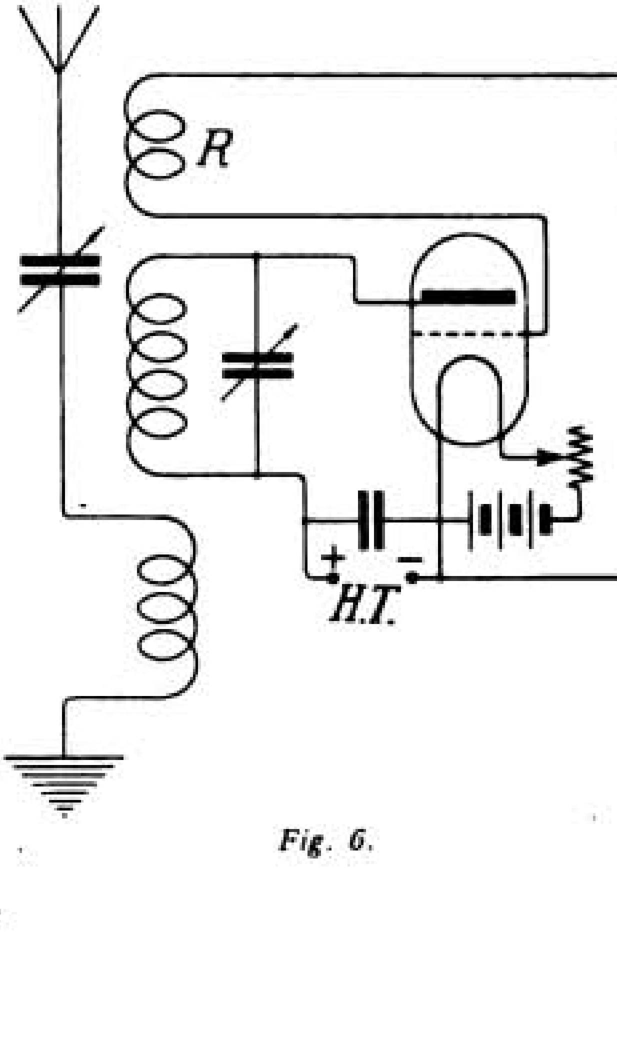


Fig. 6.

do not recommend the connection to the amateur. It is difficult to manage in practice and liable to be unstable. The simplest circuit is the direct coupled one illustrated in Fig. 7. In this case the aerial is maintained in continuous oscillation directly by the valve. The condenser *C* is a reservoir condenser for the high voltage E.M.F. and also affords a path of low impedance for the oscillatory currents. Aerial insulation plays an important part in this circuit since the full voltage of the plate E.M.F. exists between the aerial and earth. Should there be any doubt as to the quality of the aerial insulation it is advisable to introduce a condenser in the position indicated by the dotted lines. A common circuit employed for transmission is shown in Fig. 8. We do not recommend this to the amateur, as a study of the figure will show that the valve filament battery, reaction coil and all associated apparatus have the full P.D. of the high voltage source between themselves and earth.

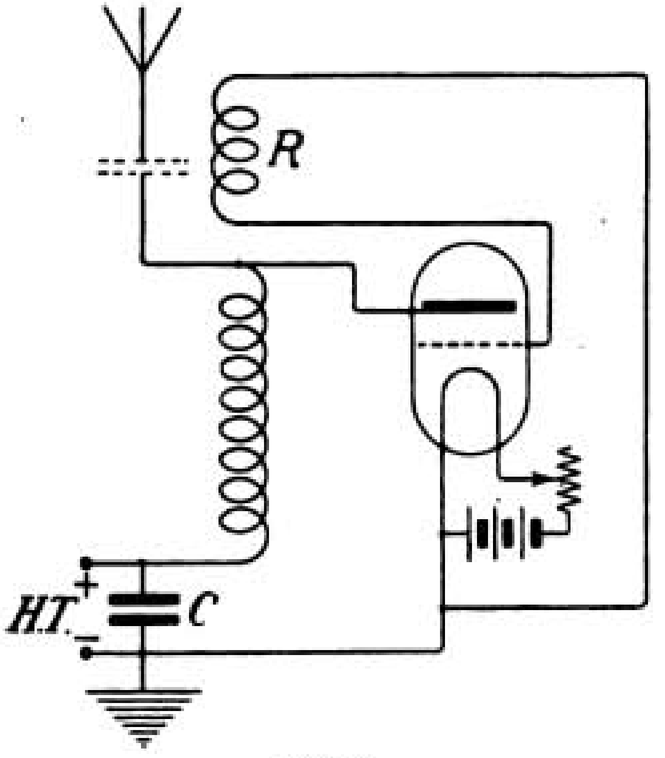


Fig. 7.

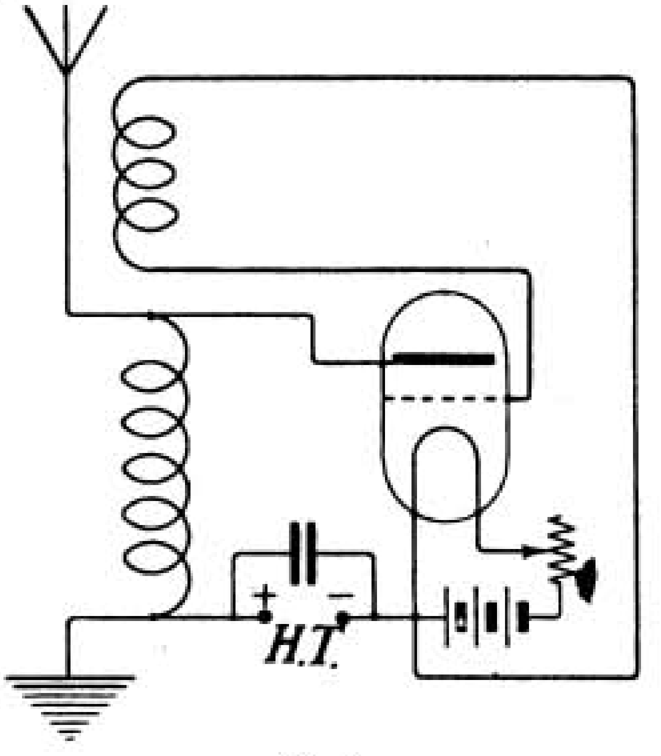


Fig. 8.

The type of valve to be employed, the source of high voltage supply, the sizes of windings and capacities of condensers must perforce stand over for discussion in a future issue. The reader will understand that we cannot enter into actual constructional details until the Government issue definite information as to the limitations they propose to apply to experimental work. In the meantime we shall endeavour to give the amateur general information which he will find of assistance in his work as soon as the issue of licences recommences.

SPECIAL NOTE.

Owing to the continued delay by the Government in deciding the lines upon which the wireless amateur will be allowed to work, we have been unable to execute our original plans of supplying detailed information for the manufacture of amateur wireless apparatus. Pending an announcement of policy by the authorities our contributor will continue the present series along the lines already laid down.

Patent Section

124,786. Wireless Signalling. Artom, A., 18, Corso Siccardi, Turin, Italy. March 27th, 1916. No. 4518. (Classes 39 (i) and 40 (v).)

Apparatus for determining the direction of incident wireless waves comprises two or more coils mounted to turn in a permanent magnetic field and traversed by rectified currents from the respective directive receiving-aerials, or by local direct currents set up by, and proportional to, the currents in the aerials. As shown in plan in fig. 2, two coils *A B, C D* are mounted freely on a vertical axis and are connected through rectifying-detectors *K, K*¹ to the directive receiving-aerials, which are placed in vertical planes at right-angles. Permanent or electro magnets *NS*, preferably one for each coil, create a strong magnetic field in the space occupied by the coils, the field being directed by a vertical soft-iron cylinder 1.

FIG. 2

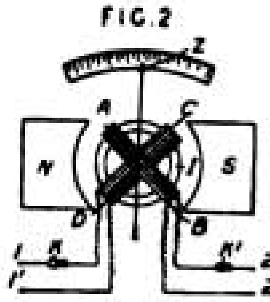
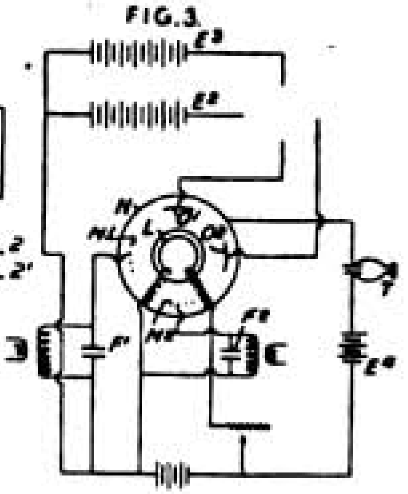


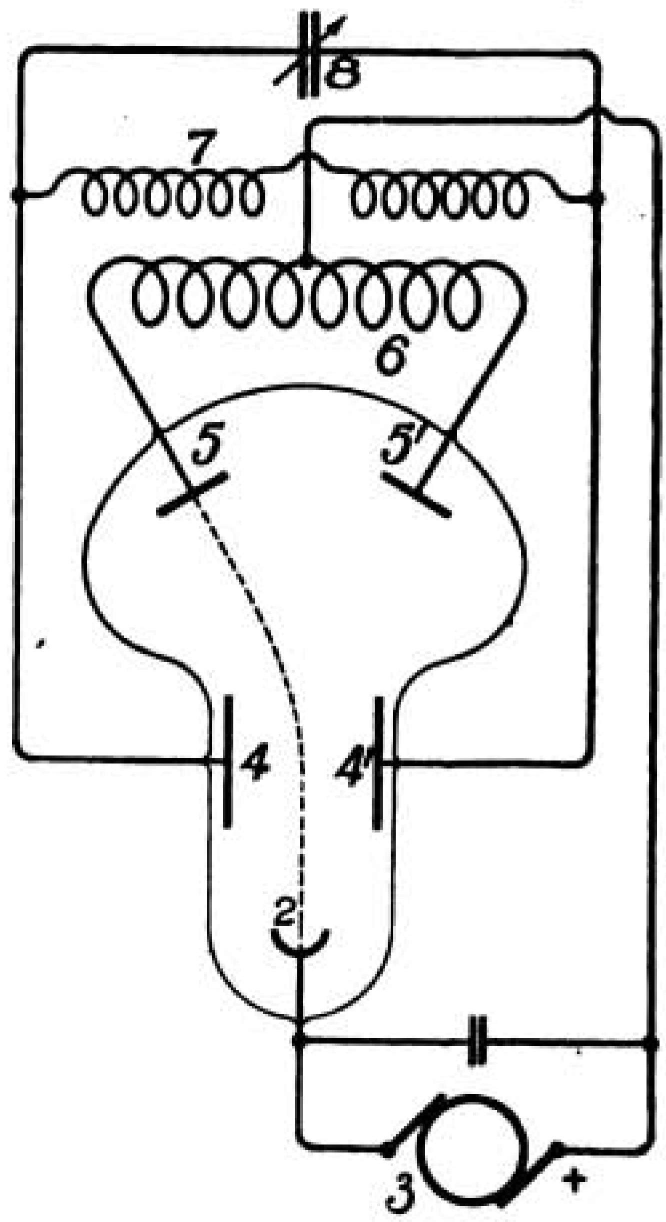
FIG. 3



A pointer *Z* moving with the coils indicates the direction of the incident waves on a scale, provided it is known from which quadrant the waves are arriving. The detectors may be of any type; for instance, hot-wire detectors in each receiving-aerial may influence thermocouples connected to the coils *AB, CD*. When electrolytic detectors are used, all the electrodes are immersed in a single vessel containing acidulated water, etc. In the form shown in fig. 3, the directive aerials are coupled to oscillatory circuits *F*¹, *F*² which are connected on the one hand to the filament *L* of an ionized-gas tube, and on the other hand to adjustable grids *M*¹, *M*². The coils *AB, CD* of the direction-finder are connected through the terminals 1, 1¹, 2, 2¹ to the filament *L* and to two plates o¹, o² within the tube, batteries *E*², *E*³ being placed in the respective circuits. A telephone *T* is connected through a battery *E*⁴ to the filament *L* and to a cylindrical plate *N* in the tube. Specifications 23488/03 and 19805A/06 are referred to.

126,019. Producing Electric Oscillations. Bethenod, J., 10, Rue Auber, Paris. October 26th, 1916. No. 15274. Convention date, November 5th, 1915. (Classes 38 (ii), 39 (i), 40 (iv), and 40 (v).)

Electric oscillations are produced by means of a vacuum tube having a cathode, two anodes, and an alternating electric field by means of which a cathode beam is oscillated from one anode to the other. The alternating electric field is produced by the action of the tube itself. In the arrangement shown, a vacuum tube 1 is provided with a cathode 2 and two anodes 5, 5¹ connected to the terminals of a transformer winding 6. Two plates 4, 4¹, connected to the terminals of a transformer winding 7 and forming a condenser, are placed adjacent to the cathode beam. The negative terminal of a generator 3 is connected to the cathode 2, and the positive



terminal is connected to the middle point of the winding 6. With the beam impinging on the anode 5, as shown, the current through the left-hand portion of the winding 6 causes the potentials of the terminals of the plates 4, 4[1] to shift the beam to the anode 5[1] when the potentials of the plates are again reversed to cause the beam to impinge on the anode 5, and so on, thereby causing undamped oscillations to be produced in the condenser circuit 8.

123,126. Vacuum tubes. Western Electric Co., Norfolk House, Victoria Embankment, Westminster (Western Electric Co., 463, West Street, New York, U.S.A.). January 8th, 1918. No. 411 (Class 39 (i)).

An electron-emitting cathode is made by coating a metal filament with a mixture of a thermionically active substance and a compound of a "noble metal," such as platinum, gold, or silver. Silver, if used, is volatilized before employment of the cathode. The noble metal compound is such as to be decomposed by heat, for instance gold or silver oxide, or ammonium chloro-platinate. Platinum increases the adhesion of the thermionic substance and the life of the filament. Two molecular parts of the platinum compound may be added to one molecular part each of barium and strontium oxides. Addition of calcium oxide further increases the life of the filament. Gold increases the electron emission; it may be used with a mixture of all three oxides, or with strontium oxide alone. Still higher emission is obtained by the use of silver, which may be employed in various mixtures; the filament can then be worked at low temperatures. The base filament, which may be of platinum or of an alloy thereof with similar metals is dipped in an aqueous paste of the coating substances in a moving trough and is then heated by currents. From three to five coats are thus applied, after which the filament is baked at 1000° C. for two hours when the coating contains platinum, or at 600-700° C. for 5-10 minutes in the case of gold and silver. Before use of the filament the silver is volatilized by passing current through the filament either in the completed vacuum tube or in a separate exhausted vessel.

Personal Notes

DEATH OF A WIRELESS PROFESSOR.

The death is anounced of Prof. D. Korda, Professor of Wireless Telegraphy and High-Frequency Machines at the Technical School, Zurich. The deceased was born in Hungary 55 years ago. He was associated with the construction of the first electric locomotive at the works of the Société de Fives-Lille, France.

* * *

NEW APPOINTMENT

Major Rupert Stanley, Fellow I.R.E., Professor of Electrical Engineering at the Belfast Technical Institute, who has been engaged in wireless work in the R.E. during the war, has recently been appointed the Principal of the aforementioned Institute.

* * *

WIRELESS MEN WIN DECORATIONS.

The following gentlemen, who served during the war in the R.N.V.R. (S.W. Section), have been awarded the Meritorious Service Medal. Chief Petty Officers H.C. Wills, A. Pink, E. Blake, A. E. Hill, G. H. Lambert, W. Pettengill, Petty Officer O. Tooth.

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DEATH OF A MARCONI ENGINEER

We announce with deep regret the death of Mr. Alexander Wilson, M.E. which occurred at Ilford on Thursday September 25th.

Mr. Wilson has seen many years service as an engineer, and held prominent positions at home and abroad before joining the Marconi Company in December 1899. During his twenty years connection with the Company, and especially in earlier years, his mechanical knowledge and wide experience were most valuable.

Mr. Wilson was a widower and leaves two daughters.

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 telegraphy. 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.**

N.F.E. (Warwick).—The diagram of connections shown in your first sketch is the best one for a three-electrode valve, with the exception that one side of the telephones must be connected to the side of the filament which is connected to the inductance coil. This will necessitate putting your filament battery on the other side of your filament circuit, *i.e.*, connect one side of battery to the resistance and the other side of the battery to the telephones.

You will probably find it much better to connect an adjustable tuning condenser across the secondary inductance. Do not make this condenser more than about .0003 mfd.

We notice that you include an aerial tuning condenser in series with your aerial. This will not be necessary unless you desire to receive wavelengths less than the fundamental wavelength of your aerial.

C.S. (Penrith).—It is not possible to give the strength of the magnetic field in the gap of a string galvanometer, as this figure is different for each make of instrument. The iron is, however, magnetised to a point past saturation point so that any small variation in the strength of the magnetising current will not effect the strength of magnetic field.

We do not think that an electrostatic string galvanometer could be used in conjunction with a rectifying crystal to measure high-frequency alternating voltages in the manner suggested. The resistance of the crystal being very high, it would in any case alter the calibration of the voltmeter so that the instrument would need re-calibrating. An ordinary high-resistance electro-magnetic string galvanometer may be used in series with a high-resistance crystal to measure H.F. voltages, if it is properly calibrated with the crystal with which it is to be used.

"SPARKS" (Dartmouth).—Asks: (1) If in a three-valve amplifier Ford ignition coils could be used as valve transformers? We think that Ford ignition coils could be used for this purpose if they are in good condition. The insulation resistance between the windings and between the windings and the core should not be less than about 200 megohms.

We expect, however that the ratio of the turns will not be the correct values, but it will make a good experiment to adjust these with the valves until the best result is obtained.

(2) What is the lowest voltage receiving valves will work with? Some valves work on quite low voltages of about 20 to 60, but possibly the majority of valves used at present work on about 100-150 volts.

(3) The price of a moderately good set as it has often been pointed out depends on the maker's ability and the means at his disposal. One man could make a set for a few shillings whereas the same set would cost another as many pounds.

(4) Small pocket lamp batteries can be used quite well for the H.T. battery for a valve. It is best to place the cells in a box, cardboard does quite well, and then pour melted paraffin wax round and over the tops of the cells. Another method is to put a layer or two of insulating cloth such as empire cloth round each cell. The advantage of this method is that any one cell can be easily replaced should it run down.

SHARE MARKET REPORT.

The market in the shares of the Marconi Group continues fairly active and prices are well maintained. Prices as we go to press (Oct. 15).

Ordinary £5 15s. od, Preference £5 5s. od, American £1 13s, od, Canadian 17/-, Spanish 12/6, Marine £3 1s, 3d

Company Notes

THE MARCONI WIRELESS TELEGRAPH COMPANY OF CANADA, LIMITED

Annual Report and Statement of Accounts for Year ending 31st December, 1918.

REPORT OF DIRECTORS.

The Directors herewith submit their Annual Report and Statement of Accounts for the year ending December 31st, 1918

During the period under review, gratifying development has been made in the equipment and operation of wireless apparatus on vessels of the Canadian Mercantile Marine. With the advent of the new merchant steamers operated by the Canadian Government Merchant Marine, Ltd., for which vessels your Company has secured the wireless contract, further development in this branch of our business is assured.

As a result of re-organization of our factory referred to in last year's report, the Company was able to cope with increased orders for wireless apparatus, and a favourable feature of the year's operations is the increased Works output and consequent improved revenue from our Factory.

Your Company had still to contend with adverse traffic conditions during practically the whole year, and Government restrictions on wireless working deprived the Company of much traffic revenue. After the signing of the Armistice on November 11th, 1918, a gradual relaxation of war restrictions took place. East Coast Stations, which had been closed down or taken over by the Canadian Naval Service Department, were turned back to the Company for operation and every effort made to rebuild a profitable service. During the concluding weeks of the year, revenue from this source showed great promise and your Directors look forward to increased returns in the future.

Immediately the Armistice was signed your Directors took prompt steps with a view to re-opening the Company's high-power Transatlantic stations at Glace Bay and Louisburg, and succeeded in securing permission from the British Admiralty to re-open stations on December 2nd, 1918. This sanction only permitted the Company to handle Press and Government messages and, although a fair volume of such traffic was secured, further pressure was brought to bear by the Directors, with a view to receiving authority to handle ordinary commercial traffic. After much negotiation, permission to accept commercial messages was obtained, but this authority was not secured from the Admiralty until March 10th, 1919.

Your Directors regret to state that, so far, no settlement has been arrived at with the Canadian Naval Service Department in respect of the Company's claim for compensation for the closing down of East Coast Stations for the period subsequent to August, 1916. Claim has also been presented against the British Admiralty for loss of revenue owing to the closing down of the Company's high-power stations at Glace Bay and Louisburg, and steps have been taken to press for an early settlement of same.

Mention is again made of the continued efficient services of your Company's trained employees in connection with the successful prosecution of the War. A considerable number of our skilled operators were employed on transports through the war zone, whilst many were loaned to the Canadian Naval Service for duty on East Coast Stations. Wireless sets for new vessels and special apparatus for the requirements of the Naval, Military and Air forces were designed, manufactured and installed by expert staffs in a manner creditable to your Company.

Respectfuly submitted,
J. N. GREENSHIELDS,
President.

THE MARCONI WIRELESS TELEGRAPH COMPANY OF CANADA, LIMITED.

BALANCE SHEET - 31st December, 1918.

ASSETS

CURRENT ASSETS			
CASH		$3,437.22	
ACCOUNTS RECEIVABLE—			
Sundry	$193,671.21		
Affiliated Companies	52,189.71		
	$245,860.92		
Less—			
Reserve for Bad and Doubtful Debts	15,000.00		
		$230,860.92	
INVESTMENTS—			
Dominion of Canada 5½% Victory Loan Bonds Subscription $11,500.00	4,660.00		
Dominion of Canada 5% War Bonds paid up	1,900.00		
French National Defence Bonds, Fcs. 16,100	3,290.18		
Port Burwell Telephone Company	10.00		
		9 860.18	
APPARATUS AND STORES ON HAND		112,594.47	
			$356,752.79
FIXED ASSETS			
High Power Stations	408,649.88		
Coast Stations	17,477.91		
Ship Stations	137,448.32		
Montreal Real Estate, Buildings, Machinery, School Equipment, &c.	105,590.33		
	$669,166 44		
Less Depreciation written off for year	18,216.89		
		$650,949.55	
PROPERTY RIGHTS, PATENTS, TITLES, &c.		4,991,881.03	
			$5,642,830.58
DEFERRED CHARGES			24,753.57
			$6,024,336.94

LIABILITIES

CURRENT LIABILITIES			
Accounts Payable, including accrued rent		$730,528.47	
Unclaimed Wages		21.01	
			$730,549.48
CAPITAL STOCK AUTHORIZED AND ISSUED			
1,000,000 shares of $5.00 each			5,000,000.00
SURPLUS ACCOUNT			
Balance at credit 1st January, 1918		198,413.99	
Add—			
Profit for year ending 31st Dec., 1918, before providing for Interest on Advances and Reserve for Depreciation of Ship Stations, etc.		138,647.98	
		337,061,97	
Less—			
Interest on Advances	$25,057.62		
Reserve for Depreciation of Ship Stations, etc.	18,216.89		
		43,274.51	
			$293 787.46
			$6,024,336.94

Approved on behalf of the Board, J. N. GREENSHIELDS and THOMAS ROBB, *Directors.*

We have examined and audited the Books and Accounts of the Marconi Wireless Telegraph Company of Canada, Limited, for the year ending 31st December, 1918. The Apparatus and Stores on hand have been entered at book value. No provision for depreciation has been made against the High Power Stations Equipment, which is carried in the accounts at cost.

Subject to the foregoing remarks, and to the reserve for doubtful accounts being sufficient, we certify that we have obtained all the information and explanations which we have required, and that, in our opinion, the above Balance Sheet as at 31st December, 1918 is properly drawn up so as to exhibit a true and correct view of the state of the Company's affairs according to the best of our information and the explanations given to us, and as shown by the books of the Company.

Montreal, 1st May, 1919. RIDDELL, STEAD, GRAHAM & HUTCHISON, *Chartered Accountants.*