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THE RADIO REVIEW

A MONTHLY RECORD OF SCIENTIFIC
PROGRESS IN RADIOTELEGRAPHY
AND TELEPHONY

VOL. III

JANUARY, 1922

No. 1

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THE RADIO REVIEW

VOL. III.

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Editorial.

Earthing Systems versus Insulated Counterpoises.—To earth or not to earth has been the question since the earliest days of radiotelegraphy and that it is still a burning question was shown by the discussion which followed the reading of Mr. T. L. Eckersley's paper on Transmitting Aerial Resistances at the Wireless Section of the Institution of Electrical Engineers on December 7th. The insulated counterpoise, or earth screen, certainly appears to be coming into its own. From the earliest days there have been those, notably Sir Oliver Lodge, who have supported its claims against the earthed antenna. Lodge in his Royal Society paper in 1909 said: "The present trouble is caused by the utilisation of the earth as one terminal of the aerial system both in sender and receiver. I do not expect this to be immediately admitted, but so it is—at any rate at land stations." "It is better to ignore the earth and work independently of it both at the sending and receiving end, taking care to keep everything insulated." Poulsen and Pedersen, guided by a true instinct, installed an insulated counterpoise at some of their arc stations, but it is only during the last year or two that the advantages of the valve transmitter, combined with the limitations in the power produced by a single valve, have forced upon radio engineers the fact that the range of a station does not depend on the power put into the aerial but on the current in the aerial and its effective height. Given these, the smaller the power the better.

It would be of interest to learn what proportion of the 3,600 kW which de Groot proposes to put into the Java arc is going to be radiated and how much is going to be utilised in heating the gorge in which it is installed.

As was mentioned in the discussion, Meissner has recently described at the Jena Congress* a method of decreasing the earth losses by an extensive system of small earth plates or stakes distributed in a proper manner and with wires running overhead to each. He stated that it was expected in this way to increase the radiation efficiency of the Nauen aerial from 7.5 to about 50 per cent. It remains to be seen whether these expectations will be realised, but it is interesting in that it appears to be something of a compromise between the counterpoise and the earthing system.

It is interesting to note that the Marconi Company have installed insulated counterpoises at Carnarvon and Clifden both of which have aerials of the inverted L type, designed to have directive properties. It was shown fairly

* See *Jahrbuch Zeitschrift für drahtlose Telegraphie*, 18, pp. 322—337, November, 1921.

conclusively by Hoerschelmann that the directive action of such an aerial is due to currents induced in the earth below the aerial. This is now confirmed by Mr. Eckersley's admission that the counterpoise has practically destroyed the directive effect of these aerials. It is an open question, however, whether the small amount of directive action actually obtained was ever worth the dissymmetrical design with its consequent increased losses as compared with a T aerial of the same total span.

The Paris International Conference.—Very little has been published concerning the proceedings of the Conference on radiotelegraphy which was held at Paris during the past summer. We do not know to what extent the proceedings were regarded as confidential and it may be that the members themselves have divergent views on this point. Italy was fortunate in having as one of her representatives Professor Vallauri of the Italian Naval College at Leghorn, whose work in so many branches of radiotelegraphy is well known. We have heard several of the delegates express the opinion that he was one of the outstanding personalities of the Conference and it is therefore with great pleasure that we publish a translation of a communication which he has sent to us giving not only an outline of the technical decisions arrived at but at the same time his own personal views and criticisms of many of the points.

In his introductory remarks he states that the Conference expressed the wish that the technical decisions should be published in order to invite collaboration and criticism. We are therefore furthering the objects of the Conference by publishing these notes.

In dealing with nomenclature Professor Vallauri laments the difficulties arising from the natural affection of any one for a term or phrase of which they regard themselves as the parent. The difficulties in any one language are great enough, and they are intensified enormously when one has to find a term which will meet with universal acceptance. When once an International Conference, however, upon which we are duly represented, decides upon a certain nomenclature, we feel that it is the duty of all writers and editors to adhere as far as possible to the decisions arrived at. It would prove a difficult task, however, to eradicate the use of the word "aerial" in favour of antenna as advocated, or to call every D.F. set a radiogoniometer.

Professor Vallauri's criticisms and suggestions on the subject of the definition of the equivalent decrement of an emission will prove of great interest. The conventional ideal resonance curve is based upon assumptions which do not apply to actual emissions and there is a certain latitude in the choice of the equivalent ideal. We agree with Professor Vallauri that much requires to be done in the development of methods of measurement before any serious attempt can be made to apply at all rigorously rules and regulations based upon the lines indicated. In dealing with the nominal range, the method adopted was that which we have previously employed in the RADIO REVIEW, namely, to calculate from the ordinary Hertzian formula, with the Austen-Cohen attenuation factor, the strength of the electric field produced at the receiving station and to specify a certain strength of field as standard for a given type of reception. In the present state of our know-

ledge the Conference were probably well advised to adopt this simple criterion of range. The latter part of the paper deals with the organisation of an international radiotelegraphic research association, a matter which had been taken up before the war and which arrangements are now being made to resuscitate.

The Opening of the New York Radio Central.

Radio Central is the name given to a high-power wireless installation which is now being erected by the Radio Corporation of America near Port Jefferson, Long Island, about seventy miles from New York. The station is designed for international wireless telegraphic communication, and has been planned by the engineers of the Radio Corporation of America, in con-

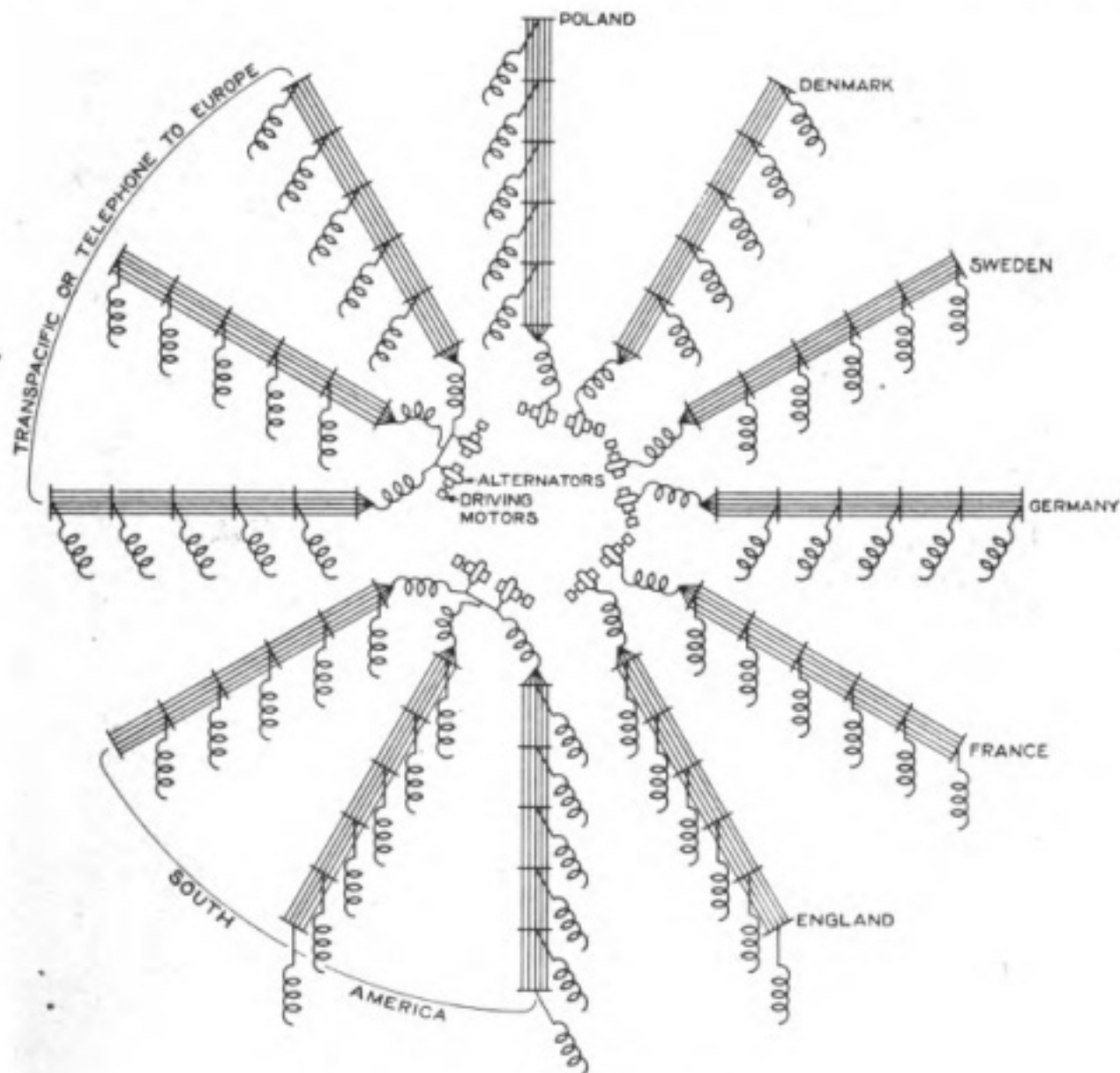


FIG. 1.—Plan of Antenna System.

junction with the General Electric Company of America. The station is designed to supplement the existing communication facilities from U.S.A. and to provide direct radio services with Great Britain, France, Norway,

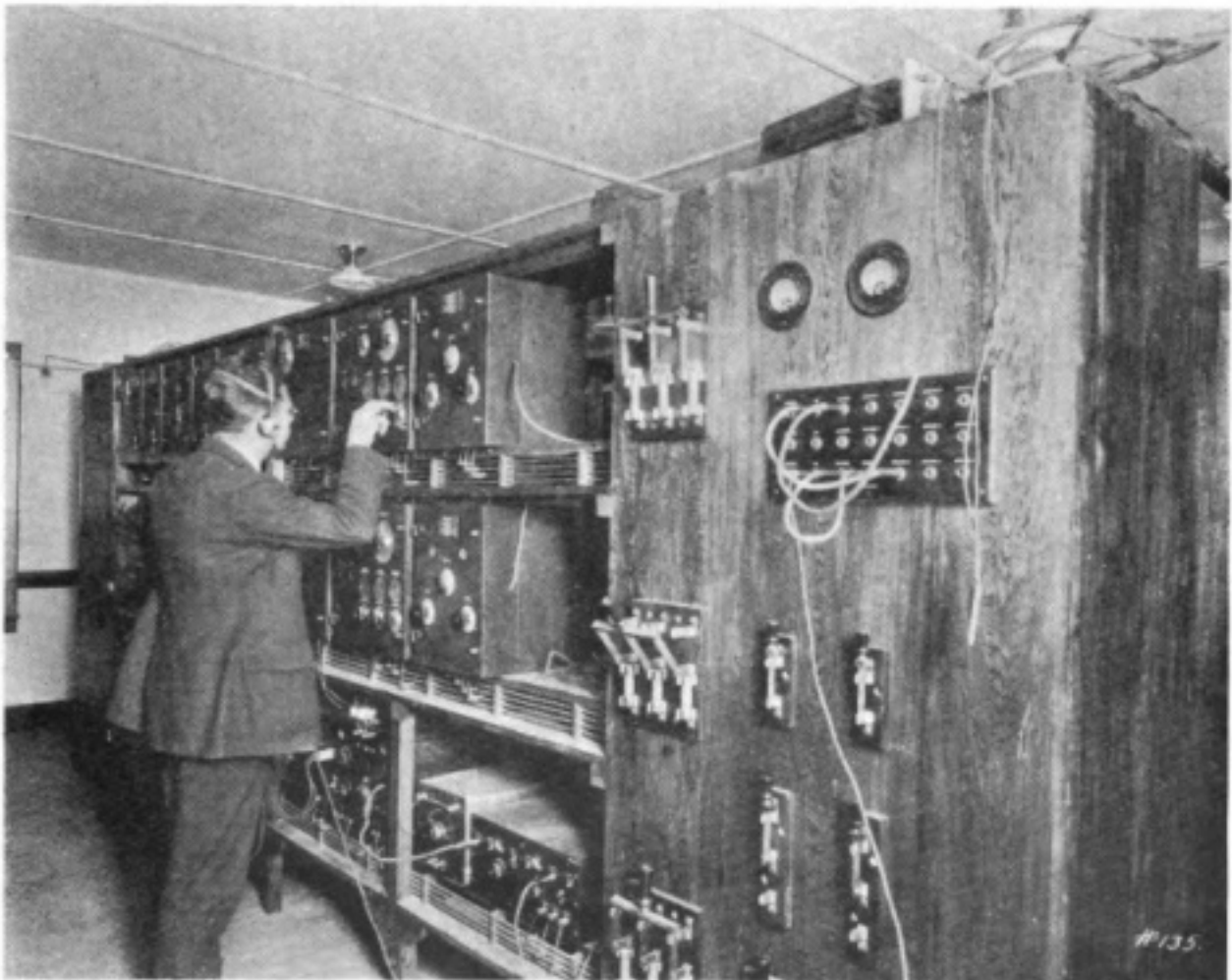
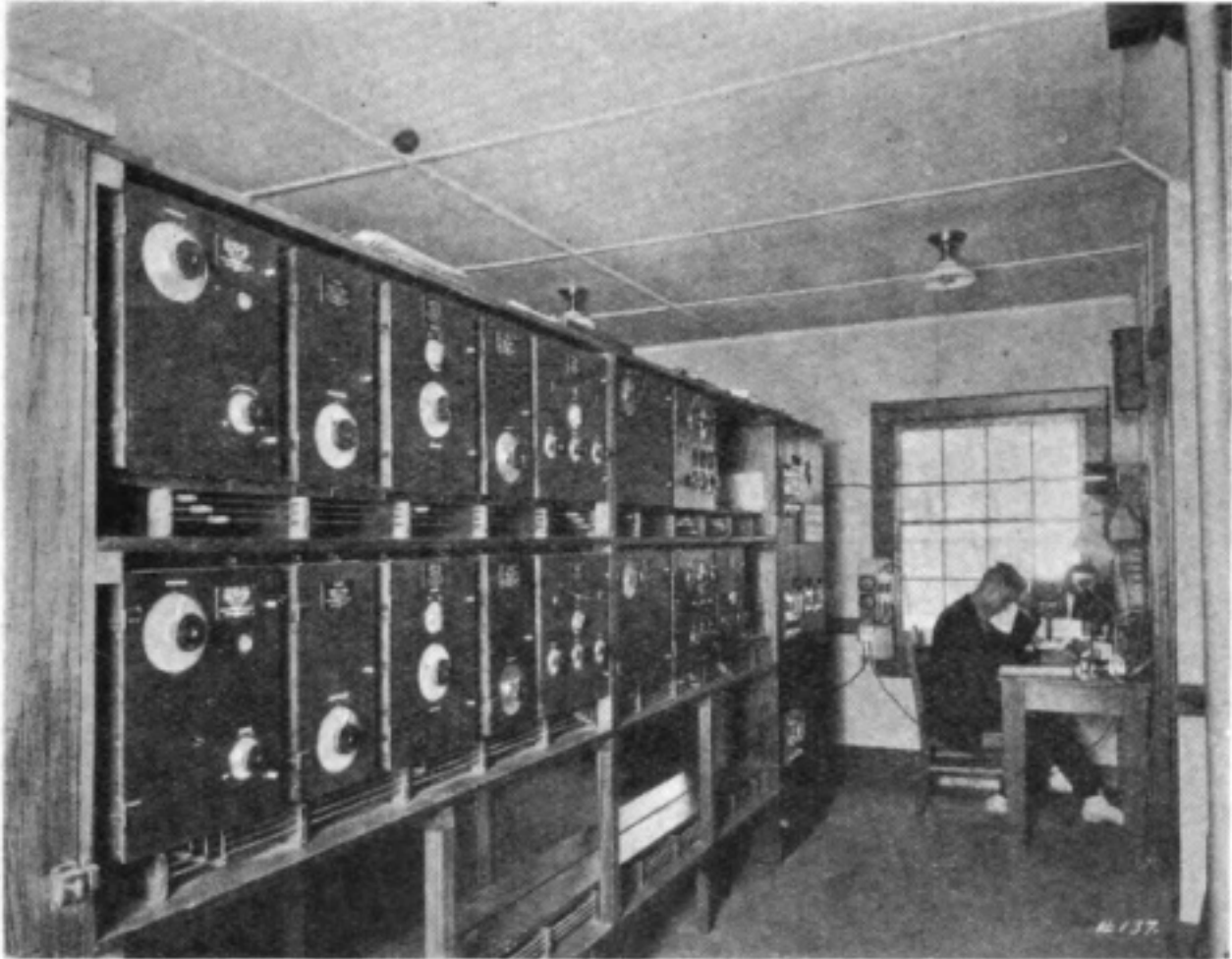
Germany and other European countries as well as to South America. The site of the station occupies an area of some 6,400 acres and the station will eventually consist of a number of separate antenna systems each provided with the necessary transmitting plant for simultaneous radio communication over a number of different routes (Fig. 1).

In the pioneer days of high-power radiotelegraphy a station functioned



FIG. 2.—Exterior View of Receiving Station at Riverhead, L.I.

alternately as a transmitter, a receiver and a telegraph office. This involved much loss of time and greatly reduced the traffic facilities, for a station had to stop sending while it received, and *vice versa*. It therefore became apparent that the ideal radio station should comprise three separate but closely connected units operated by remote control, these units comprising respectively the transmitter, the receiver and the central traffic office, the latter preferably in the heart of the business district in large cities.



FIGS. 3 and 4.—Two Views of the Receiving Apparatus at Riverhead Station. Each shelf contains all the units necessary to receive from one European station.



FIG. 5.—Operating Room at the Central Traffic Office, New York.



FIG. 6.—Bird's-eye View of Arrangement of Station.

In the case of the New York Radio Central, the first two of these units are located at Long Island and the third in New York City. The transmission plant is located at Rocky Point, some seven miles east of Port Jefferson, on the northern shore of Long Island. The receiving station (Figs. 2 to 4) is at Riverhead, L.I., about sixteen miles from the transmission plant, and has been so planned as to be able to receive simultaneously messages from

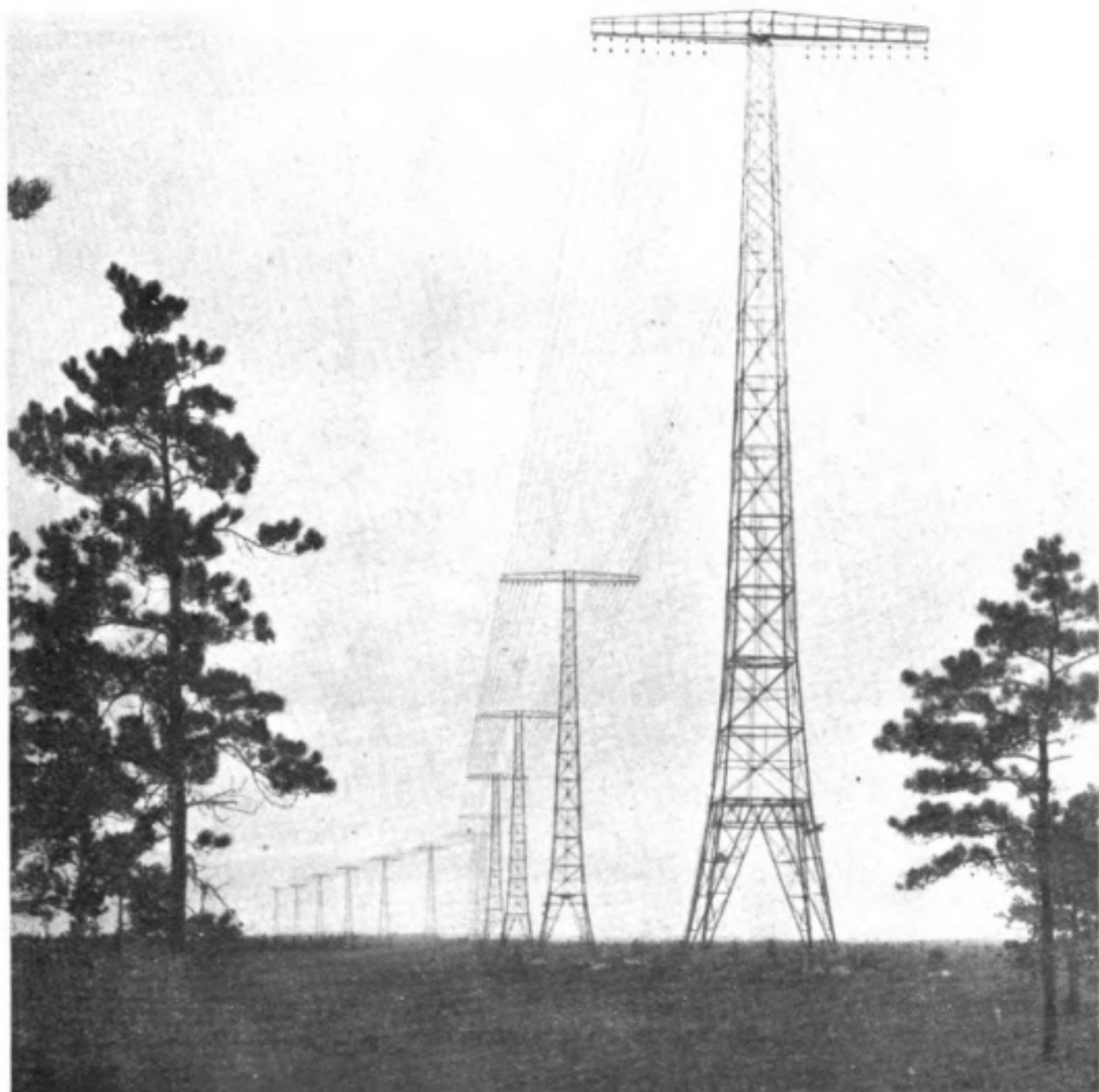


FIG. 7.—The First Twelve Towers of the Aerial System. The six in the foreground form Antenna Arm No. V., and the other six Arm No. XI.

as many countries as can be communicated with simultaneously by the transmitting station. The central traffic office at 64, Broad Street, New York City, is fitted with special remote control apparatus for operating the transmitters direct from that office. The incoming signals picked up at the Riverhead receiving station are also automatically transferred over the landlines to the central traffic office. The incoming signals can there either be transcribed by ear or automatically received on recording apparatus. The operating room in New York is shown in Fig. 5.

The construction of the Radio Central Station was commenced in July,

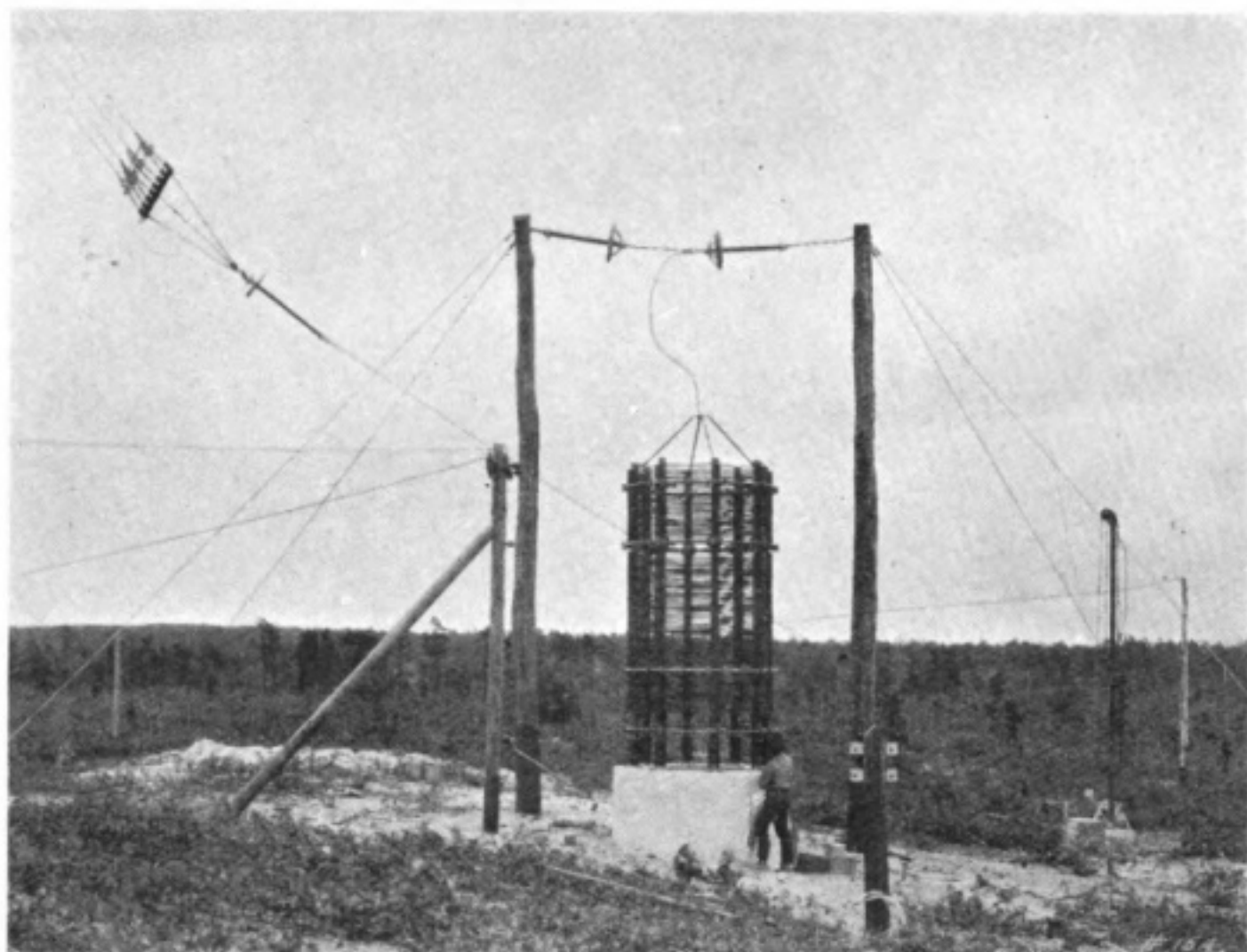


FIG. 8.—One of the Twelve Multiple Tuning Coils.

1920, and the first test signals from the first part of the station were sent out in October, 1921. This is considered to be a record in the building of high-power equipment, considering the great amount of work that has been carried out on the station.

The aerial transmitting system was originally planned to comprise twelve arms for the various communication routes, these arms radiating out from the central power house like the spokes of a wheel. A diagram giving a bird's-eye view of the station as originally planned is reproduced in Fig. 6. Up to the present two arms of the aerial system have been built, each arm having six towers 410 feet in height. The distance between adjacent towers is 1,250 feet, giving a total of nearly three miles from end to end of the line

of twelve towers already erected (Fig. 7.) Each tower required nearly 150 tons of steel, the total amount used in the twelve being 1,800 tons. The cross-arms from which the antenna wires are suspended on the top of each tower are each 150 feet long. The steel work incidental to the construction

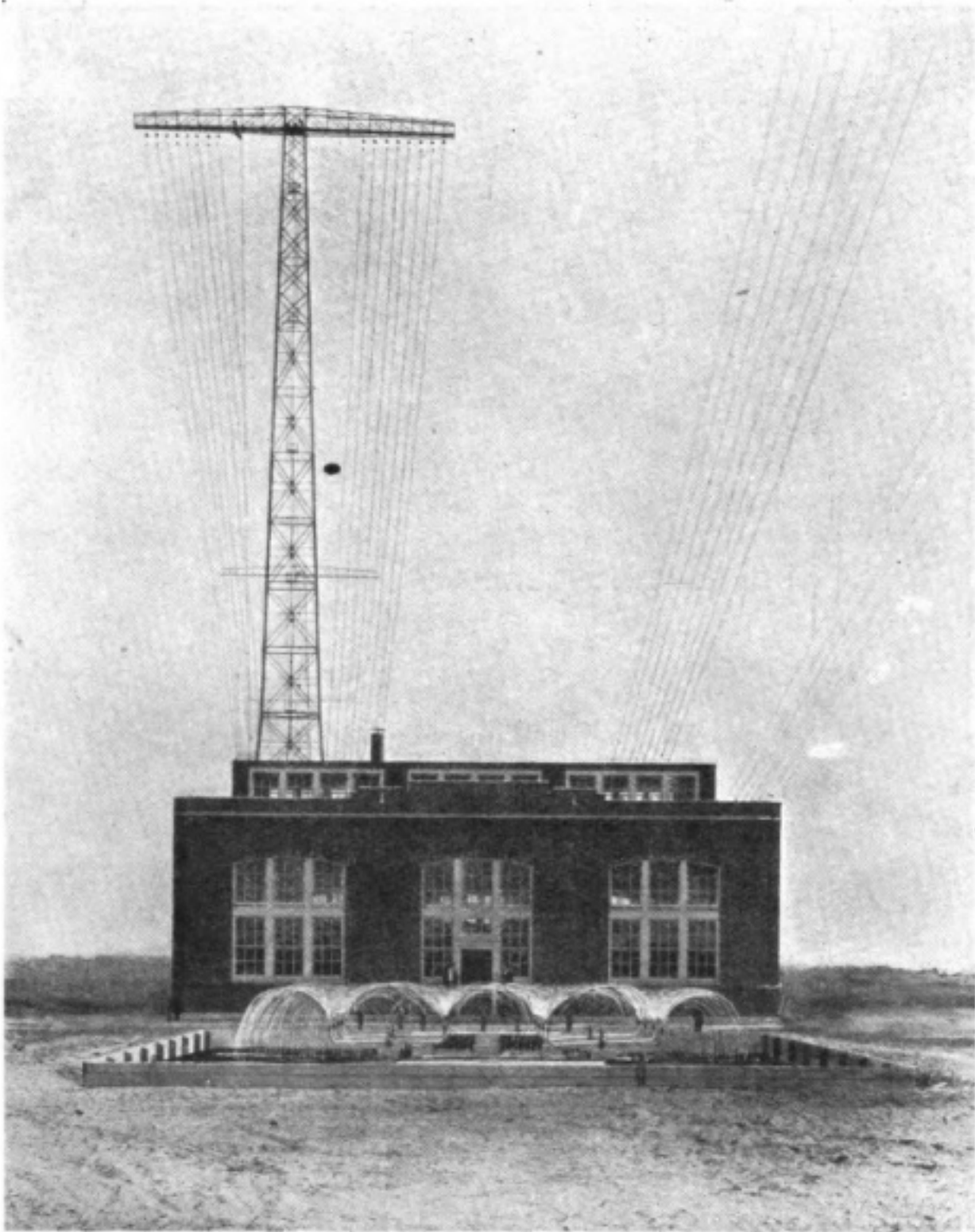


FIG. 9.—Front View of Power House, showing the Cooling Pond in the foreground.

of the towers and station buildings was erected by the American Bridge Company under the supervision of the J. C. White Engineering Corporation of New York. The 23,000 volt transmission lines by which energy is supplied to the station run from Port Jefferson, a distance of seven miles, and were erected by the Long Island Lighting Company. The control lines

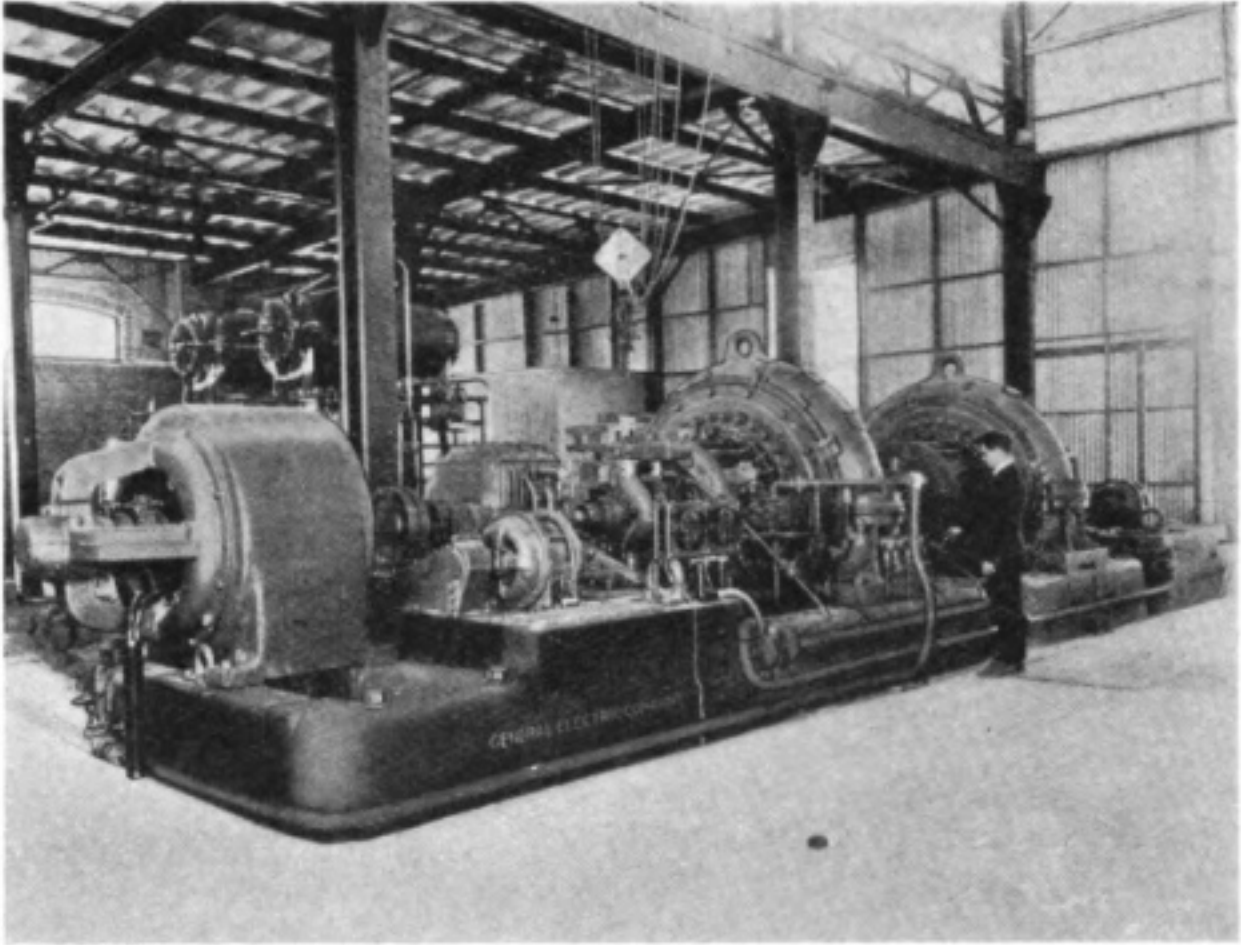


FIG. 10.—Two 200-kW Alexanderson Alternators.

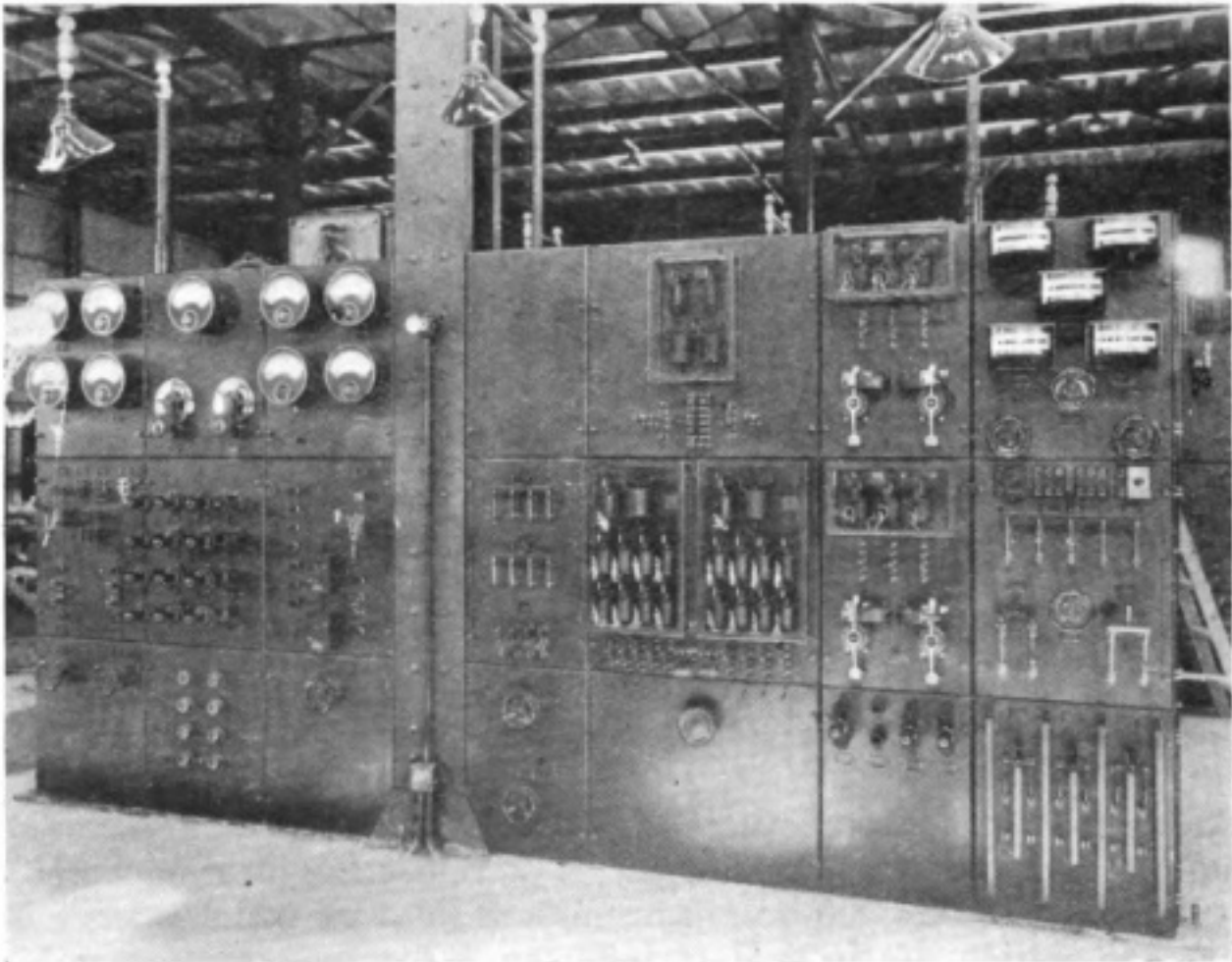


FIG. 11.—Switchgear and Control Panels in the Power House.

between the transmitting and receiving stations and New York City were erected by the New York Telephone Company.

Each antenna is of the Alexanderson multiple-tuned type—*i.e.*, it is provided with several earth connections along its length, each connection

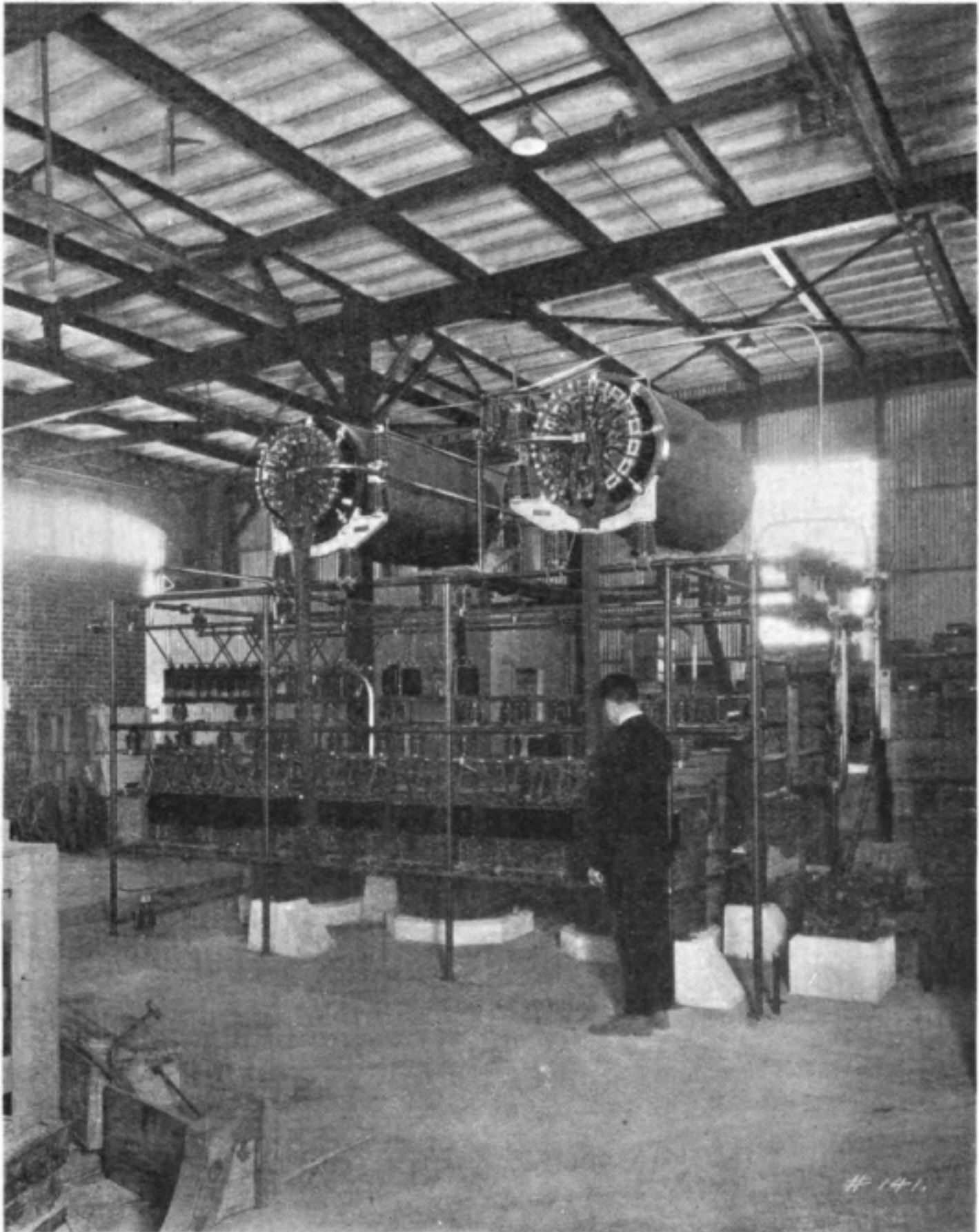





FIG. 12.—The Magnetic Amplifier and Transformer Rack.

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Warren G. Harding

November 5, 1921

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FIG. 13.—Reproduction of President Harding's Opening Message.

including a tuning coil. As may be seen from Fig. 8, these coils are set up in the open air.

The foundations for the twelve towers necessitated the use of 8,200 tons of concrete since the base of each tower leg is sunk 9 feet below the ground level and has a base area of 360 square feet.

For the construction of each arm of the antenna sixteen stranded silicon-bronze cables, $\frac{3}{8}$ inch in diameter, are used, fifty miles of this cable having been employed in the two above-mentioned antenna arms. Four hundred and fifty miles of copper wire have already been buried in the ground to form the earthing system. The erection of the remaining arms of the whole antenna system is now being proceeded with and will eventually comprise seventy-two towers.

The first power-house section is located in the centre of the tower line, shown in Fig. 7, and covers a space of 130 feet by 60 feet (Fig. 9). It accommodates two 200-kW high-frequency alternators with auxiliaries and equipment (Fig. 10). These machines, with the necessary switchboard, tuning coils, etc., were built by the General Electric Company of America, and each is capable of a continuous output of 200 kW at any wavelength between 15,800 and 20,000 metres.

The control panels and switchgear at the power station are illustrated in Fig. 11. Signalling is effected by means of Alexanderson magnetic amplifiers. These with their auxiliary condensers can be seen in the lower part of Fig. 12, which also shows the high-frequency transformers mounted on the upper part of the structure. Their use permits of a signalling speed of 100 words per minute for each of the transmitting units, so that the equipment at present completed is thus capable of despatching traffic at the rate of 200 words per minute.

The station was formally opened on November 5th by President Harding, who sent out a message addressed to every radio station in the world. The radiogram form showing the message is reproduced in Fig. 13. The reports of the reception of this opening message and of the preliminary test signals have shown that the range of the station is practically world-wide since its signals have been heard in all parts of Europe, in Australia, in South America and in Japan.

The Community House for the staff is a low one-storeyed building containing sixteen single rooms, an official suite, a large living-room and dining-room, as well as quarters for servants, the engineer-in-charge with a staff of fifteen assistants, comprising the *personnel* at present necessary to maintain the station in operation. The final installation will include ten Alexanderson high-frequency alternators which, when all operating together, will give a total power output of 2,000 kilowatts.

Notes on a Direct-reading Radio Direction Finder.*

By ALESSANDRO ARTOM.

1. General Considerations.

In these notes I intend to describe a new class of appliances which solve an interesting problem in wireless telegraphy and especially in radiomechanics. The aim of these appliances is to place in the radiotelegraphic stations, a pointer or index to show the direction from which the radiotelegraphic signal comes. In my earlier works on the direction finding of electric waves † I have described several methods and appliances by means of which the direction of the radiotelegraphic station which transmits the signals can be ascertained. But in these radiotelegraphic systems the indication of the direction is given by the observation of the greater or lesser intensity of the telephonic reception, so that their use requires operators of special ability.

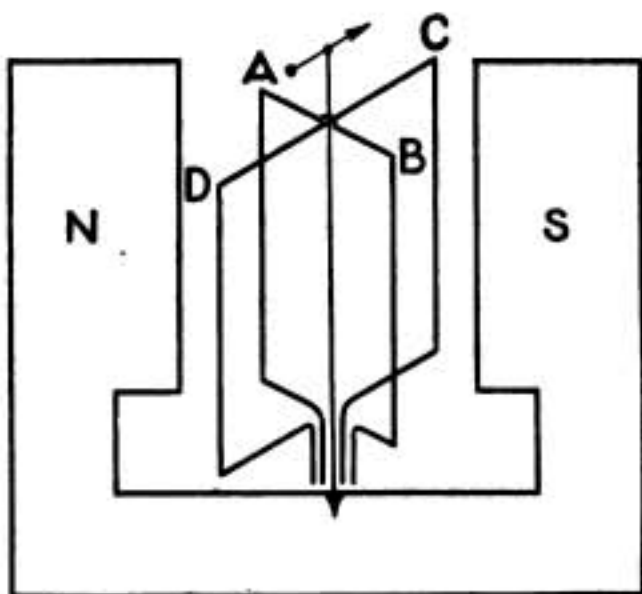


FIG. 1.

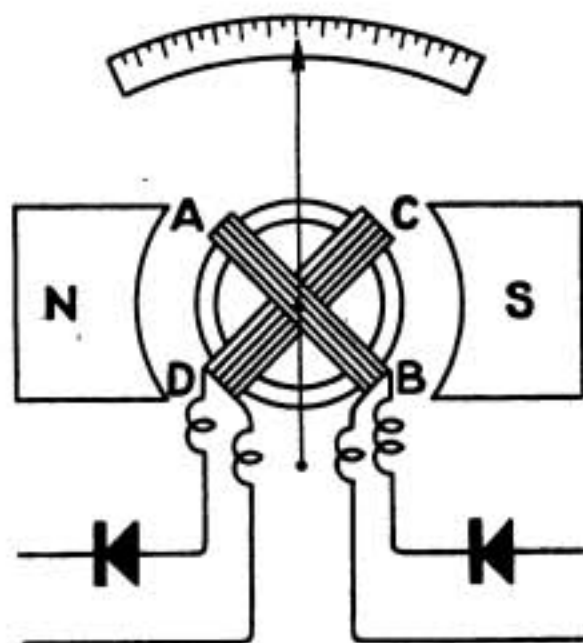


FIG. 2.

In the various appliances which are the subjects of these notes, ‡ the direction from which the signal comes is automatically indicated, by simply reading the deviations or movements of a pointer, without the need of special observations. Figs. 1 and 2 represent in plan and elevation one of the forms in which these appliances can be constructed. The received radio-

* Received August 15th, 1921.

† A. Artom, *Proceedings of the Accademia dei Lincei*, Turin, March 15th, 1903; February 5th, 1905; June 17th, 1906; January 3rd, 1915; January 7th, 1917. *Acts of the It. Electrotechnic Ass.*, 1908.

‡ *British Patent* of March 27th, 1916; *Italian Patent* of February 9th, 1917, and corresponding foreign patents.

telegraphic currents are picked up by two directive aerials or receiving frames, sometimes at a right angle but more generally at an arbitrary angle. These currents are rectified by means of one of the methods well known in radiotelegraphy, such as thermionic valves, crystal contacts, etc., and are sent into two galvanometer coils AB, CD, arranged either at right angles or at an angle equal to that between the directive aerials. The coils are electrically insulated, but mechanically connected to each other and attached to a pivot so as to constitute one single movable system which can rotate around a vertical axis. A sufficiently strong magnetic field NS, is provided, so that when the currents are flowing through the coils, there is a deviation of the movable system. Owing to the well-known properties of directive aerials, I shall demonstrate that the angle of deviation of the movable system of such an apparatus is a function of the angle between the direction of the incoming signal and the base of one of the receiving directive aerials. Apparatus based on the principles explained above can be constructed in different forms. One of these (Fig. 3) is particularly adapted for laboratory measurements, and is also adapted to the study of the theoretical conditions of working. It is somewhat analogous to the thermo-galvanometer of Boys and Duddell.

Both the galvanometer coils are provided with thermoelectric contacts TT, and the currents coming from the directive aerials are passed through two suitable resistances RR so as to act, by Joule effect, on the thermoelectric elements. In this way, currents proportional to the effective values of the intensities of the receiving currents are generated in the galvanometer coils. A magnetic field, NS, of sufficient strength causes the deviation of the movable system. The value of the angle of deviation of this movable system is dependent upon the direction in which the transmitting station is situated.

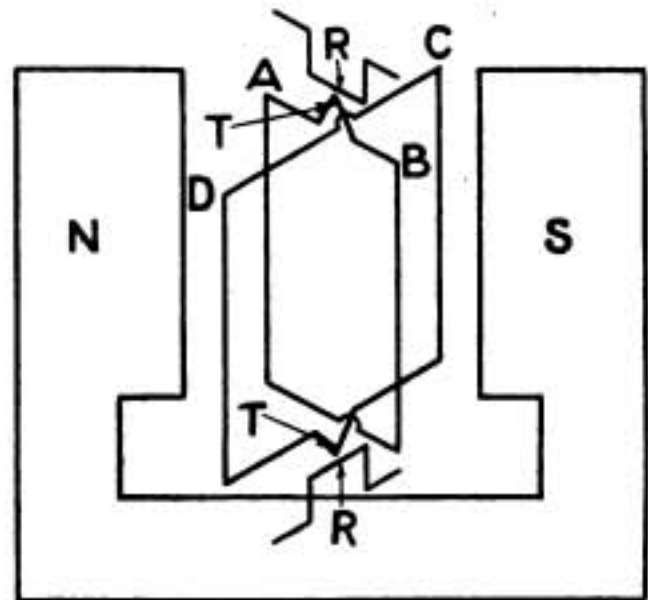


FIG. 3.

In fact, if we call i_1 and i_2 the currents of the orthogonal directive aerials, it is well known that if α is the angle which the junction of the point of intersection of the direction aerials makes with the base of one of them, whose projection we assume as axis of x , we obtain

$$\left. \begin{aligned} i_1 &= K_1 \cos \alpha \\ i_2 &= K_2 \sin \alpha \end{aligned} \right\} \dots \dots \dots (1)$$

If we call i_1 and i_2 the currents which by Joule effect circulate in the galvanometer coils and δ the deviation of the movable system under the action of the magnetic field, the equation of equilibrium is,

$$HS_1 i_1' \sin \delta = HS_2 i_2' \cos \delta \dots \dots \dots (2)$$

of this magnetic field, the movable system consisting of a double astatic needle of magnetic material is placed.

The physical fact of being able, by means of radiotelegraphic waves, to control at a distance even of many kilometres, the movement of a pointer in such a way as to cause it to be placed according to a determined direction, I hold to be fruitful of a practical application, as there is no doubt that these appliances can be rendered useful to navigation by sea and air, and in railway signalling.

R. Polytechnic of Turin.

Notes on the Technical Decisions of the Paris International Conference on Radio Communications (June—August, 1921).*

By Professor G. VALLAURI.

A technical committee consisting of American, British, French, Japanese and Italian delegates met at Paris during last summer to deal with a certain number of questions formulated during the preliminary conference at Washington in 1920.† The Committee expressed the wish that the more strictly technical decisions adopted by it should be made known through the scientific press and thus be submitted to the criticism of the specialists of every country whose collaboration in the study of the numerous problems still unsolved would be thus promoted. It appears opportune to fall in with the wish of the Committee and to explain concisely some of the more important questions dealt with, in the confidence that technical Italians will direct to them their study and continue it in such a way as to maintain, as they have hitherto maintained, a very notable position in the development of the science of radio communications. Of this desired collaboration it is also sought to give modestly an example in this note endeavouring to make here and there a critical examination of the arguments brought forward.

RADIOTECHNICAL NOMENCLATURE.

By the very necessity of drawing up an account of its deliberations the Paris Committee found itself face to face with the problem of nomenclature. It was not attacked completely as too much time and too much labour would have been necessary. However some agreements were reached, under the form of proposals that must be considered by the International Electrotechnical Committee which as is known has already been occupied from time to time with the problem of nomenclature.

(1) In place of "wireless telegraphy" and names derived from this, it is

* Received October 15th, 1921.

† *L'Elettrotecnica*, 8, p. 559, September 15th, 1921; *Bollettino Radiotelegrafico*, 2, No. 16.

proposed that the prefix *radio* be used, as well as the names *radiotelegraphy*, *radiotelephony*, *radiocommunicators*, *radiotechnics*, etc.

(2) For the so-called "parasitics," or "statics" or "X," and in general for all the electromagnetic phenomena which obstruct radiotelegraphic reception, and are not produced by other signalings but derived from natural causes the name *atmospheric disturbances* is proposed, which may be abbreviated to *atmospherics*. For the disturbances derived on the other hand from other signalings it was not possible to come to concordant decisions; it would appear however that the name of "interference" must prevail, and to indicate the greater or less ability of a given emission to disturb other receivers, that of "power of interference."

(3) For the terms "valve," "lamp," "audion," etc. the preference has fallen on the generic name of *electronic tube* which in the most common case of the usual tube with three electrodes becomes *triode*, to which can be joined, according to the three principal functions, the adjectives *rectifying*, *amplifying*, *generating*.

(4) For the methods of coupling between circuits are proposed the terms *coupling by resistance*, *by induction* (in some cases by *self-induction*) and *by capacity*; not excluding, it is understood, the possibility of mixed couplings that belong to more than one category simultaneously.

(5) For the apparatus that serve to determine the direction of propagation of the waves is recommended the name of *radiogoniometer*.

(6) For the conductor or the system of electric conductors utilised for sending out or for receiving the electromagnetic waves the name of *antenna* has been preferred to that of aerial. It is intended to exclude from the signification attributed to "antenna" the mechanical supports of the conductors.

(7) These mechanical supports are called *towers* if they are not protected against the wind, *pylons* or *masts*, if they are wind-protected (according as they are with lattice-work or not).

(8) For the antennæ with closed circuit (coil antennæ) the name of *frame antenna* or simply *frame* has been agreed upon.

(9) The half length of the dipole equivalent to a given antenna (with regard to the radiation in the superior hemisphere with respect to the surface of the ground) will be called *the radiation height* and the product hI of this height into the intensity of current at the base, will be expressed in metre-amperes using the symbol $m \times A$ (not mA = milliampere).

(10) If as is seen with regard to some points it has been possible to reach agreement upon concrete proposals it must be recorded that many other points of considerable importance for nomenclature have not been able to be defined. This is not surprising since in the matter of nomenclature many students are excessively preoccupied with scruples of purism and of the absolute suitability of the words selected, or even with questions of *amour propre*; and do not sufficiently take into account that the matter dealt with consists of conventional decisions, to be adopted for common convenience, but of which the sole value consists in their universal recognition. It is well to draw attention to some of the more important gaps not filled up by the

Paris Committee, especially with regard to the use of words of different meaning in different languages, used however to represent the same thing. To indicate oscillations and undamped waves the term made use of in English is "continuous waves," and in French the non-equivalent "ondes entretenues," while the adjective "persistenti" (persistent) much used by us corresponds neither to the one nor to the other. It would be convenient on the first occasion to come to agreement upon a single adjective which might perhaps be "continuous" (continue). Analogously it would be necessary to choose between "raddrizzatore" ("rectifici," "redresseur") and "rivelatore" ("detector," "detecteur") preferring probably the first. So again for antenna with closed circuit we have translated freely "antenna a telaio" (antenna with frame) against the discordant choice of "coil antenna" in English and of "cadre" (frame) in French. Long discussions took place with regard to the modern systems of "telegraphy and telephony at high frequency" (over wires), because, whilst such denomination was generally accepted, the American representatives manifested their preference for the English expression "line radio," which is not directly translatable and in fact seems not a very happy one because somewhat contradictory in its two terms. Finally, for the frequency, the Committee has, in our judgment inopportunately, left the choice between the expressions in "cycles" ("cicli") or in "periods" ("periodi")—with multiple relations—per second with the corresponding symbols c/s or else p/s.

Dealing with the idea of frequency there was an interesting discussion on the opportunity of substituting for the term to-day so much used of "wavelength" that of "frequency"; and as it was recognised that such substitution is in some cases to be recommended it was decided to publish and to recommend a conversion table for passing from the wavelength in metres to the frequency in thousand-cycles per second (Table I.) [not reproduced].

From what precedes it easily appears that in the field of nomenclature and in that not less important of the choice of symbols and of schematic representations, the work of the Paris Committee has been only a partial and preliminary work, and that it is extremely desirable that it be resumed and completed in the near future.

CLASSIFICATION OF WAVES—EQUIVALENT DECREMENT—INTERFERENCE.

The problem of classification comes into account with regard to the necessary distribution of the different frequencies (wavelengths) and of the diverse types of transmission for different services (movable, fixed, military, special). Attempts at a single classification, that should take account at once of the nature of the waves and of their power of interference showed themselves to be vain and it was agreed to make a double classification, taking account separately of the two criteria.

The classification according to the nature of the waves has led to the definition of two types A and B, of which the first is subdivided into three sub-types A_1 , A_2 , A_3 . The definitions proposed are the following:—

Type A. Continuous Waves.—Waves that in the permanent state are periodic, as well as such that their successive oscillations are identical.

Type A₁. Manipulated Continuous Waves.—Continuous waves of which the amplitude or the frequency vary under the action of a telegraphic manipulation.

Type A₂. Continuous Waves tuned to Audible Frequency.—Continuous waves of which the amplitude or the frequency vary according to a periodic law of audible frequency.

Type A₃. Continuous Waves modulated by Speech.—Continuous waves of which the amplitude or the frequency vary according to the characteristic vibrations of the spoken word (radiotelephony).

Type B. Damped Waves.—Waves composed of successive trains in which the amplitude of the oscillations after having reached a maximum decreases gradually. These definitions are completely independent of the type of apparatus used for producing the oscillations; they do not exclude, for example, from type A₁ the emissions produced by spark apparatus that may be capable of generating true continuous waves, nor from type A₂ the emissions of other spark apparatus capable of generating true continuous modulated waves. The classification proposed has not the pretension of being perfect or definitive, it is easy to see that there may be found some difficulty in including within it some special types (*e.g.*, bi-modulated waves with a modulation of frequency beyond audibility). However the types proposed offer in general a means simple and clear for giving information on the nature of the waves and permit also of defining ultimately the character of an emission, by having recourse to a breaking up of the subtypes according to the rapidity of manipulation, the use of stationary waves, the manipulation or modulation upon amplitude or upon frequency, etc.

The adoption of the criterion relative to the "power of interference" has led to another distinct classification, based on the definition of a conventional magnitude to which is given the name of *equivalent decrement*. This in its turn is defined according to the so-called *resonance curve*. It is known that if there is placed in presence of a circuit traversed by an oscillatory current another resonating circuit (containing capacity and self-induction and in which the causes of loss of energy are reduced to a minimum) and if the frequency proper to this last is made to vary, it is possible to plot as a function of such frequency a diagram of the squares of the induced currents that is called the resonance curve. The shape of this diagram depends it may be on the mode of variation of the primary current, it may be on the total resistance of the resonating or secondary circuit (and besides on the sum of the losses of energy that accompany the passage of the current in the secondary).

The Committee has considered first of all that it may be in general possible to eliminate the influence of the resonating circuit upon the form of the resonance curve, that is that there may be a possibility of rendering negligible the losses in the secondary or of correcting the resonance curve by eliminating the effects of such losses, and has based its definition on such a modified or "corrected" curve of resonance. Besides the Committee has decided that operating during an effective transmission it may be possible to attain a "mean" curve of resonance whose course will be influenced by many of

the causes by which a transmission made nominally upon a certain wavelength (or upon a certain frequency) tends effectively to disturb also the transmissions upon neighbouring wavelengths, occupying thus rather a zone or band of wavelengths than one particular wavelength. Amongst the causes that have influence upon the form of the mean resonance curve it is sufficient to cite the speed of sending and the system of manipulation, the variations of frequency of the generator during a signal, the amplitude and the frequency of modulation, the presence of the wave of compensation, the real decrement, etc.

To pass from the resonance curve to the equivalent decrement it was decided "conventionally" to make use of the following formula:—

$$\delta = \pi \frac{f_1 - f_2}{f_r} \sqrt{\frac{I^2}{I_r^2 - I^2}}$$

As is known this formula is only approximate, and of limited validity even in the theoretical case of purely exponential damping. It corresponds to a curve of resonance symmetrical with respect to the ordinate that passes through the abscissa f_r , to which corresponds the maximum ordinate I_r^2 , whilst f_1 and f_2 represent any pair of abscissæ, symmetrical with respect to f_r ($f_1 + f_2 = 2f_r$) for which the ordinate I^2 is the same.

The form of the conventional resonance curve that satisfies the equation adopted for some given values of δ is indicated in Fig. 1.

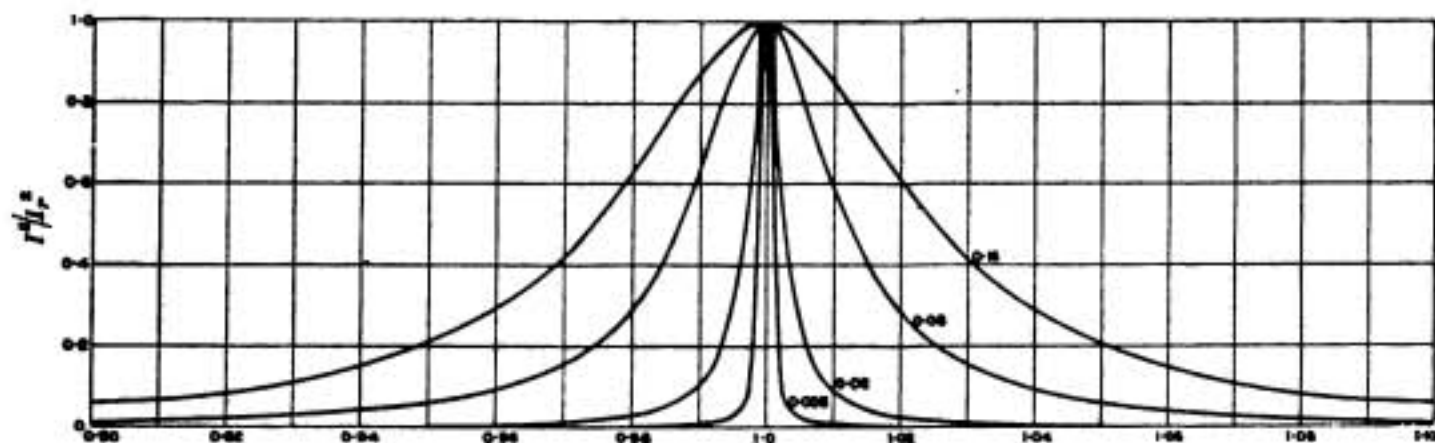


FIG. 1.

If the curve of resonance (mean and corrected for the effects of the losses in the measuring circuit) for a given transmission satisfies the adopted equation, that is, gives rise to a constant value of δ , this would be taken at once as its "equivalent decrement." But in general this will not be the case for the ordinary transmissions and then it is allowed, always conventionally, to assume as the equivalent decrement the maximum value that is able to be obtained from the formula given above, applying it to the resonance curve over a given range. The limits of this range have been fixed, indicating that the value of I^2 must not be greater than $I_r^2/2$ and the frequencies f_1 and f_2 must not be outside the interval from $0.9 f_r$ to $1.1 f_r$. To make precise the application of this rule it is agreed to say that I_r^2 shall be assumed to be the maximum ordinate of the curve of resonance; but as to f_r it is

not said if this must be assumed to be the abscissa corresponding to such a maximum ordinate, or rather (which is perhaps preferable) the value $\frac{f_1 + f_2}{2}$.

In any case the differences owing to this choice can only be very small.

It appears however that the search for the maximum value amongst such as may be calculated from different values of I^2 and from the corresponding pairs of values of f_1 and f_2 in the whole interval indicated, may turn out to be laborious. It would be therefore in our judgment desirable to modify slightly the definition of equivalent decrement, assuming for it a value that will be in general very little superior to that above defined, viz., the decrement that corresponds to the lowest conventional resonance curve that does not fall below the given curve in the whole range delimited by the inequalities * :—

$$I^2 \leq \frac{1}{2} I_r^2 \quad f_1 - f_2 \leq \frac{1}{10} (f_1 + f_2).$$

This last definition is illustrated by Fig. 2. In it the curves 1 and 2 represent

two mean resonance curves corrected for the effects of the resonator. The curve 1 is such that the maximum value of δ (equal to 0.0185) is obtained for

$I^2 = \frac{1}{2} I_r^2$, as appears from observing that the curve 1 remains

for $I^2 < \frac{1}{2} I_r^2$ always below the

conventional resonance curve corresponding to $\delta = 0.0185$.

On the other hand the curve 2, although giving for $I_r^2 = \frac{1}{2} I_r^2$ a value of δ

inferior to that from curve 1, permits of calculating upon lower ordinates values of δ sensibly higher. On examining the figure it is seen that only the conventional resonance curve corresponding to $\delta = 0.0205$ (tangent to

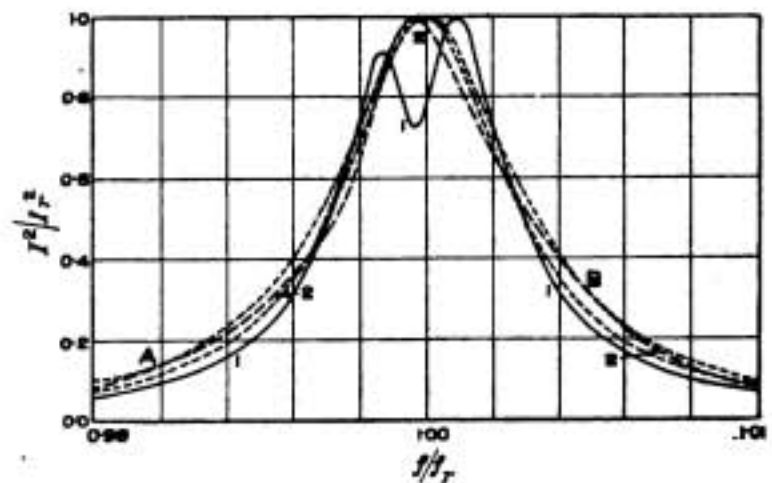


FIG. 2.

* The definition of this range over which the determination of the equivalent decrement is made might perhaps be readjusted, because the ordinates that correspond to the limiting values of the frequencies have magnitudes which differ much according to the value of the decrement. Hence it would appear to be preferable to refer both the limits of the interval to the magnitude of I^2 putting

$$\frac{1}{n} I_r^2 \leq I^2 \leq \frac{1}{2} I_r^2$$

and choosing, for example, $n = 100$.

the curve at A and at B) is maintained not lower than curve 2 for $I^2 < \frac{1}{2} I_r^2$.

Therefore the equivalent decrement of the first transmission should be 0.0185 and that of the second 0.0205, although rigorously according to the proposals of Paris the decrement of the second might turn out to be a very little lower.*

The determination of the equivalent decrements may be facilitated by distributing upon suitable graphs whole families of conventional resonance curves corresponding to different values of δ . These graphs might be transparent, and in such a case by superposing them on the drawing of the resonance curve for examination, it would be possible to deduce immediately the equivalent decrement. In order to be applicable to every case such curves should be traced by taking for the co-ordinates not indeed the absolute values, but rather the relative values f_1/f_r and I^2/I_r^2 , as has been done in the figures. In reducing to these relative scales also the experimental curves obtained from the emissions of which it is desired to determine the equivalent decrement, uncertainty with regard to the choice of the value to be attributed to f_r will present itself, this may be chosen as that corresponding to I_r^2 , either as the mean of a determined pair of values f_1 and f_2 corresponding to a given I^2 (e.g., to $I^2 = \frac{1}{2} I_r^2$), or as a mean of these means in a determined

interval. In any case the differences that can occur in the results through the effect of such choice are in ordinary cases quite negligible.

It may be deduced from the considerations set forth that a transmission will be characterised within its own type by its mean wavelength (or mean frequency) and by its equivalent decrement. In particular in the case, for example, of an emission of continuous waves, manipulated with a spacing wave, there is no need to indicate the two wavelengths employed, but only a mean wavelength; because the form of the resonance curve and the interference that the transmission may produce is already taken into account in the definition of the equivalent decrement (see, for example, curve 1 of Fig. 2).

The classification adopted to take account of the "power of interference," based on the equivalent decrement, contemplates four distinct classes:—

- Class 1. Equivalent decrement comprised between 0.000 and 0.005.
- Class 2. Equivalent decrement comprised between 0.005 and 0.02.
- Class 3. Equivalent decrement comprised between 0.02 and 0.08.
- Class 4. Equivalent decrement comprised between 0.08 and 0.16.

The conventional resonance curves corresponding to the limits between the classes are those traced in Fig. 1.

According to the Paris Committee the classes set apart for the admission

* The coincidence between the value obtained according to the definition proposed at Paris and that deduced according to the variation suggested above would occur only in the case when the two tangential points A and B of Fig. 2 correspond to two equal values of the ordinate.

of each type of emission and of the different series of wavelength (or of frequency) should be those indicated in Table II.

TABLE II.

RELATION BETWEEN THE VARIOUS TYPES AND CLASSES OF W/T WAVES.

Frequencies.	Wavelengths.	Manipulation.	Continuous Wave.		Damped Wave.
			Modulation.	Telephony.	
∞ to 300	0 to 1,000	Class 1	Class 2	Class 3	Class 4
300 to 105.5	1,000 to 2,850	" 1	" 2	" 3	" 4
105.5 to 37.5	2,850 to 8,000	" (*) 1 & 2	" 3	" 4	" 4
37.5 to 0	8,000 to ∞	" 2	(†)	(†)	(†)

The fact should be insisted upon that the classes indicated in the table are only limited classes, but that it is very desirable to extend the traffic depending on the transmission of classes with lower decrement than those indicated: thus, *e.g.*, for the emissions with damped waves (type B) there is in general the possibility of not surpassing class 3, except in the case of signals for help, to which, evidently, any restriction is not applicable. So again in the case of radiotelephony (type A₃) there should be a possibility in the case of the shorter waves of not surpassing class 2.

The conception of "equivalent decrement," introduced and defined in the way indicated permits as is seen of taking account between certain limits of the "power of interference" of a given emission. There are however other causes of interference that can render undesirable certain emissions yet not having an influence on their equivalent decrement. Amongst such causes of interference are specially important:—

(1) The slow variations of frequency (or of wavelength) due, for example, to imperfect regulation of the speed of the electromechanical generators.

(2) The excessive emission of energy upon frequencies different from the frequency of effective transmission (harmonics, etc.).

As regards this the Committee did not consider that it had at present sufficient data for fixing precise rules and has limited itself to recommending to the administrations to establish the maximum limits of tolerance either for the slow variations in frequency, or for the intensity of the electromagnetic field produced at a certain distance from the transmitting antenna and measured at frequencies outside the interval ($0.9f_r$ to $1.1f_r$), contemplated in the definition of the equivalent decrement.†

It should be decided also if these limits of the field due to secondary

* In the third line of the third column (type A₁) the class defined is 1 or 2 according as the manipulation is by hand or at high speed.

† For wavelengths above 8,000 m the Committee has resolved that there should be permitted only the emission of type A₁.

‡ If the variation referred to in note (*), p. 22, be accepted the same limits should naturally also be adopted for the measurement of the secondary emissions. Regarding the importance of the harmonics see *L'Elettrotecnica*, 6, p. 716, November 15th, 1919; 8, p. 226, April 5th, 1921; and *Bollettino R.T.*, 1, No. 6, p. 134; 2, No. 14, p. 38.

emissions shall be fixed in absolute value or in relative value with respect to the field produced by the principal emission, also if the distance at which the measurement must be made shall be expressed in kilometres or in wavelengths; in other words it should be decided whether the tolerance with regard to the secondary emissions should be independent or dependent upon the importance of the station. It would seem to us more rational to adopt the second alternative, because at equal distance it appears that there could be tolerated an interference somewhat greater on the part of a large station than of a small one. The Committee recommends that, either the measurements for the determination of the mean resonance curve, or those for the valuation of the field produced by secondary emissions, should be carried out possibly at a certain distance from the antenna, *e.g.*, of the order of a wavelength, with the object of eliminating from the results the effect of casual influences and local perturbations. All this calls for the development of a technique of measurement which is at present in its infancy; and precisely on this account the Committee has expressed the wish that numerous experiments should be carried out in different countries in order to aid the future International Conference in the fixation of the limits of the various rules, indicated only qualitatively up to the present.

(To be continued.)

The Amplification of Weak Alternating Currents.*

By H. BARKHAUSEN.

I.—THE ANODE CIRCUIT AND OUTPUT TRANSFORMER.

1. A General Law.

If an apparatus with an impedance Z_a be inserted in a system (*e.g.*, a circuit containing an A.C. generator) the current will be given by the equation

$$E_t = I(Z_t + Z_a),$$

where E_t is the open-circuit voltage, that is the voltage across the apparatus if its resistance were infinitely big or the circuit broken at that point. Z_t is the internal impedance of the system to an E.M.F. inserted in place of the apparatus. This can be easily determined by a short-circuit test, *i.e.*, by making $Z_a = 0$, when

$$I_k = E_t/Z_t;$$

it can also be determined in other ways, *e.g.*, by the Wheatstone bridge or by calculation. With alternating currents the magnitudes are vectorial, which is indicated by the symbols in heavy face type.

* Translated from a paper in the *Jahrbuch Zeitschrift für drahtlose Telegraphie*. See Abstract No. 2776 in this issue for references.

The power supplied to the apparatus is

$$P_a = |I|^2 R_a = \left| \frac{E_t}{Z_t + Z_a} \right|^2 R_a$$

where $|I|$ and $|E_t|$ represent the R.M.S. values of the alternating current and voltage. If the resistance of the apparatus be given different values, the power will be a maximum for that value of Z_a which is equal to Z_t . The maximum is not very sharply defined, however, and the exact equality of Z_a and Z_t is of little importance. This is shown by the following table and the curve in Fig. 1, wherein the ratio of the maximum power $(P_a)_{\max.}$ to the actual power P_a is given for values of R_i/R_a departing further and further from unity in either direction.

Although the case of non-inductive resistances only has been considered, the relations are very similar in other cases, apart from resonance phenomena. With a telephone one can only just detect a change of 25 per cent. in the current, i.e. a 56 per cent. change in the power. This corresponds to an error of 4 : 1 in the

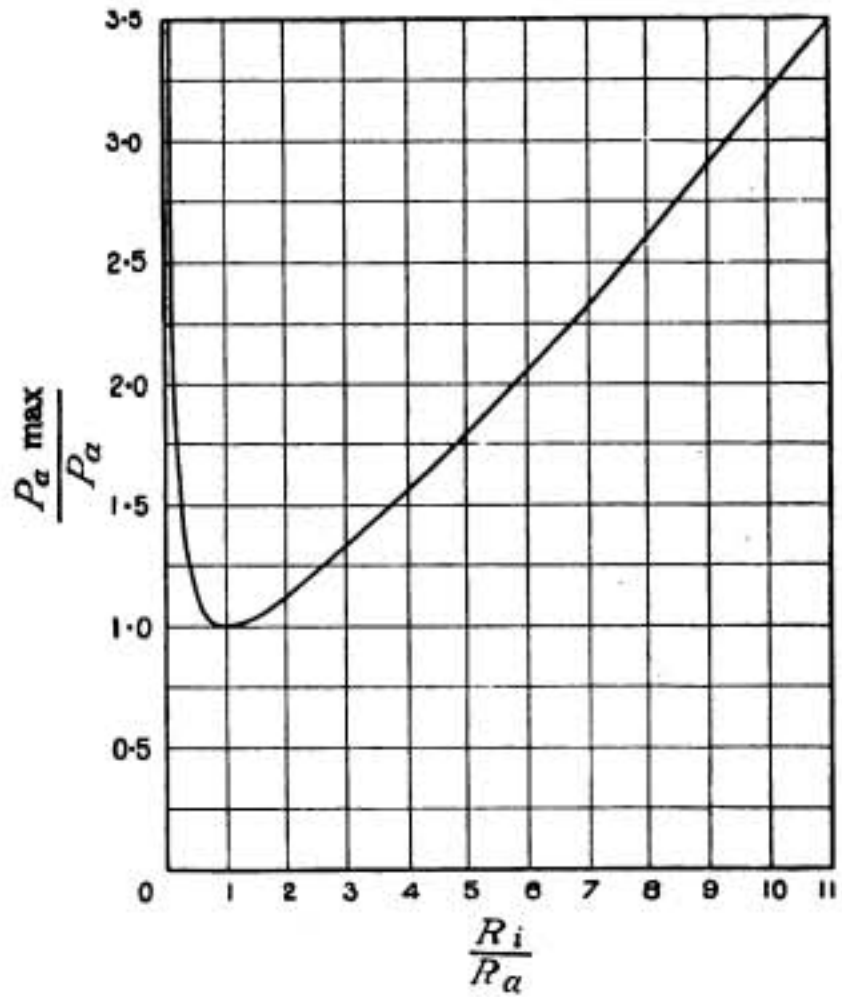


FIG. 1.

TABLE I.

R_i/R_a	$\frac{(P_a)_{\max.}}{P_a} = \frac{(1 + R_i/R_a)^2}{4R_i/R_a}$
1	1
1.5 or 2/3	1.04
2 „ 1/2	1.12
3 „ 1/3	1.33
4 „ 1/4	1.56
6 „ 1/6	2.04
10 „ 1/10	3.2
20 „ 1/20	5.5
40 „ 1/40	10.5
100 „ 1/100	25.5
1000 „ 1/1000	250

adjustment of R_a and R_i . It is only when R_a and R_i are of a very different order that much is to be gained by adjusting R_a nearer to its ideal value.

2. Power Supplied in the Anode Circuit.

(a) Circuits.

A three-electrode tube, to the grid of which an alternating P.D. of V_g volts is applied, acts in so far as the anode circuit is concerned as a generator of E.M.F. $E = \mu V_g$ with an internal resistance of $R_i = \mu/S$. S is the slope of the characteristic and μ the voltage ratio, i.e. $S = \partial I_a / \partial V_g$ and $\mu = -\partial V_a / \partial V_g$. R_i is entirely real, its value being about 100,000 ohms in normal single-grid tubes and about ten times greater or ten times smaller in double-grid tubes with protective or space-charge grids. These are very high resistances and it is not often possible to make the impedance of the receiving apparatus Z_A even approach so high a value. The impedance of a telephone, for example, hardly ever exceeds 10,000 ohms; and if the amplifier is to work on a telephone line the line impedance to be put for Z_A is certainly always less than 1,000 ohms.

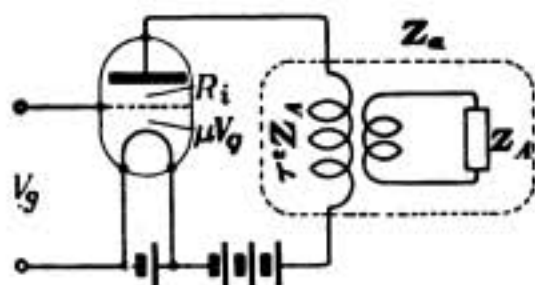


FIG. 2.

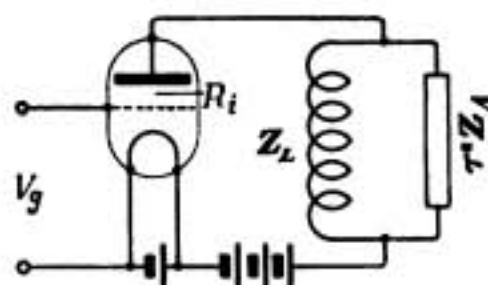


FIG. 3.

In such cases the adaptation can be made by the interposition of a transformer, Fig. 2. The effective primary impedance is then, to a first approximation, equal to $\tau^2 Z_A$, τ being the ratio of transformation which, in a transformer without leakage, is the ratio of the primary to the secondary turns. To a second approximation the magnetising current of the transformer must be included; the effect of this is to put in parallel with $\tau^2 Z_A$ the no-load impedance of the primary winding $Z_L = R_i + j\omega L$, as in Fig. 3. This again reduces the effective impedance Z_a and can certainly not be disregarded. Since, in any case, the transformer introduces losses, adaptation by means of a transformer is only suitable when R_i and Z_A are more than six times each other. (See Table I.)

In apparatus having a high reactance ωL and low ohmic resistance R , the effective external impedance Z_a can be substantially increased, even without a transformer, by connecting a condenser in parallel with it, as shown in Fig. 4.

The value of Z_a is then

$$Z_a = \frac{Z_L Z_C}{Z_L + Z_C} \doteq \frac{L/C}{\sqrt{R^2 + (\omega L - 1/\omega C)^2}}$$

which, as shown in Fig. 5, depends on the frequency ω and increases at resonance to $Z_a = L/CR = \omega L\pi/d$ since $\omega L = 1/\omega C$; that is to π/d times its value without a condenser, the increase being for example 6.28 times when the logarithmic decrement $d = 0.5$. The ratio of the alternating currents I_L and I_a alters in the same manner as Z_a ; at resonance the current in the apparatus I_L is π/d times as great as the anode current I_a (current resonance). This increase in I_L will, however, only be obtained when I_a is

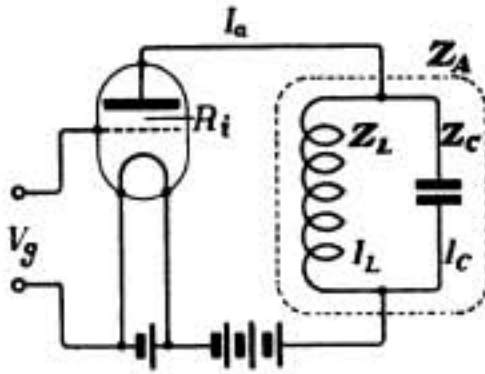


FIG. 4.

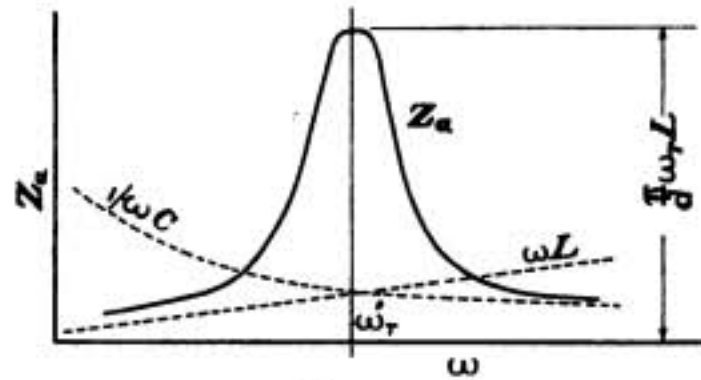


FIG. 5.

not altered by the parallel connection of the condenser, *i.e.*, when Z_a is small compared to R_i . If, on the other hand, Z_a is large compared with R_i , the resonant circuit diminishes the current I_a about d/π times, so that the current I_L in the apparatus remains the same as before. Intermediate cases are easy to follow; for example, consider the favourable case of exact resonance when $Z_a = R_i$; the current amplification of I_L is $\pi/2d$ times, thus only half as great. The increase, that is, the resulting resonance peak is so much greater the larger R_i is compared with Z_a . With small values of Z_a , a fixed frequency is therefore a particular advantage; with large values of Z_a one is tolerably independent of frequency.

Naturally when a transformer is connected to inductive apparatus the inductive current including the magnetising current of the transformer can be compensated by connecting a condenser on the primary or the secondary side. When on the primary side a condenser of τ^2 times the size is required; sharp resonance is only obtained when $\tau^2 Z_A$ is small compared with R_i .

A transformer is often necessary in order to protect the receiving apparatus from the direct current or the high anode potential. This can also be secured—as pointed out by Seibt—by connecting one or two condensers C in series with Z_A and a choking coil, L , in parallel with both (Fig. 6). If Z_A be nearly inductionless and equal to R_A the resonant impedance $Z_a = L/C(R_A + R_L)$ will be essentially greater than R_A with slight damping. By means of current resonance the current in R_A is increased in this case also.

The direct current pressure drop $I_a R_a$ can generally be neglected since I_a is usually less than 1 milliampere. Otherwise it can be allowed for by a suitable increase of the anode battery, in order that the most favourable working point on the characteristic may be reached.

If a weak direct current impulse is to be amplified, as for example a small

voltage V_g , transformers and resonance cannot be employed; the receiving apparatus (relay) must thus be directly connected. The steady current can be prevented from flowing through the relay by means of a sort of compensating arrangement, as shown in Fig. 7. The additional voltage E_z can easily be regulated by means of a potential divider so that the current in the apparatus, I_A , becomes exactly zero. The value of E_z then exactly equals the pressure drop IR . When the resistance R is great compared with R_A the effect of a small change in the grid potential V_g is to produce an alteration in I_a which is followed by a strong positive or negative current I_A , I remaining unaltered. In the particular case when $R_A = R_i$, R must be made large compared with R_i ; the pressure drop $E_z = IR$ is therefore not inconsiderable and the anode battery must be increased by this amount in order that the working point remains upon the steep part of the characteristic. R_A can very seldom be made so large as R_i (say 100,000 ohms), so that R and E_z remain small.*

(b) *The Anode Efficiency.*

A complete utilisation in the receiving apparatus of the maximum power $(P_a)_{max}$, which the tube can deliver will seldom be attained in practice. It is seldom possible to obtain a sufficiently high resistance in the receiving apparatus itself. At the best a transformer has not a particularly good efficiency, since it must be kept very small as regard size and cost, and since thin wires must be used on account of the great number of turns required,

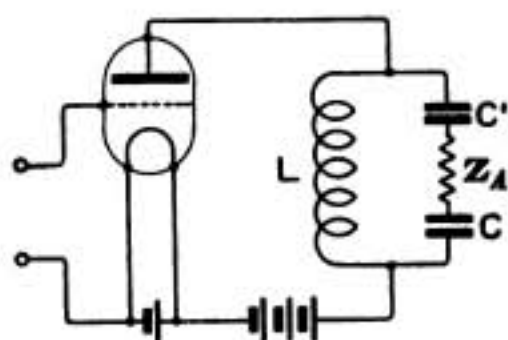


FIG. 6.

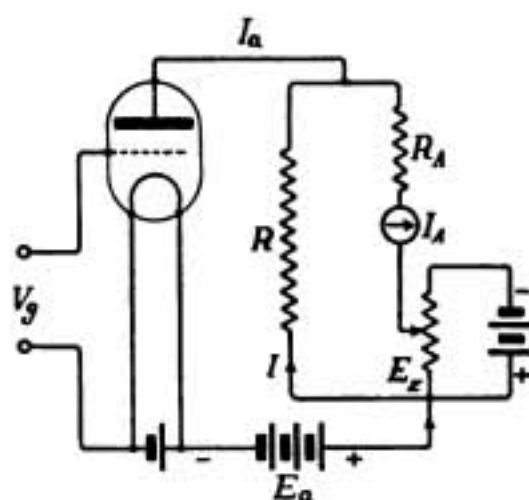


FIG. 7.

a considerable amount of the winding space being already taken up by insulation. In this connection methods of calculation and of measurement are still very backward. The most favourable adjustment of the resistances will be sought for by trial and error with existing apparatus, and is, therefore, not always found. Let the ratio of the effective power P_a used

* The connections are of particular importance for the audion receiver with relay operation. In this case owing to the rectifying action the mean grid pressure will alter and therewith the anode direct current I_a . Details follow later.

in the receiving apparatus to the maximum power $(P_a)_{\max.}$ obtainable from the tube be described as the efficiency η_a of the anode circuit, then

$$\eta_a = \frac{P_a}{(P_a)_{\max.}}$$

which will seldom exceed 60 per cent. If the receiving apparatus is strongly inductive and resonance is not possible, because of the great range of frequency to be amplified—as in the case of telephonic currents—the efficiency will fall still lower.

Particularly great difficulties arise with high frequencies. Here the capacity of the anode and its leads forms a shunt to Z_A which cannot be neglected (in Fig. 8 this effective capacity C is shown by dotted lines); C is of the order of about 10 cm. It follows that with 10^6 cycles per second ($\lambda = 300$ metres) the value of $1/\omega C$ is only 14,000 ohms. With $R_i = 100,000$ ohms the alternating anode potential difference is thereby reduced to $\frac{1}{8}$ of the generated E.M.F., so that an anode efficiency of perhaps 30 per cent. can be maintained. This may perhaps be improved by resonant tuning of C by Z_A or by a separately connected coil, by means of which the resistance, as seen from Fig. 5, will be increased π/d times, but only for the resonant frequency. Or an improvement may be made by the use of tubes with low internal resistance R_i , particularly double-grid tubes with space-charge grids. For greater wavelengths the conditions are more favourable.

Considerably greater difficulties are encountered in dealing with the grid connections. These will be discussed in the next section.

(To be continued.)

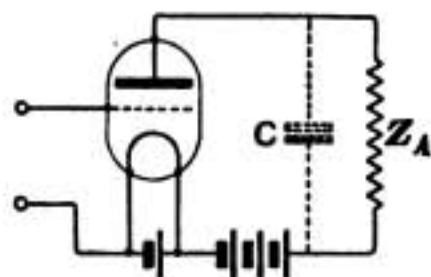


FIG. 8.

The Coming of Age of Long-distance Wireless Telegraphy and Some of its Scientific Problems.*

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

Dr. Fleming began his lecture by reminding his audience that it was just twenty-one years since Senator Marconi began to equip with wireless apparatus a station at Poldhu in Cornwall for the first attempt at transatlantic wireless telegraphy. Up till then only appliances of a laboratory type had been used to signal to distances of about 100 miles. This first attempt at long-distance working necessitated the conversion of these appliances into engineering plant, employing large power. The lecturer described in outline and with the aid of lantern slides the gradual development of high-power wireless stations and of the plant used in them. Dr. Fleming described with the aid of diagrams the general principles of the timed spark, arc, and thermionic valve continuous wave generators and their relative advantages and gave details of some of the recently projected gigantic wireless stations, such as those at St. Assise near Paris and Long Island, U.S.A., in which the high-frequency alternators of Bethenod, Latour, and of Alexanderson are to be employed. He also showed photographs of the first Imperial Wireless Station at Leafield, Oxfordshire, erected by the General Post Office to correspond with one at Cairo. He mentioned recent important installations of large valve

* Abstract of Fifth Henry Trueman Wood Lecture given at the Royal Society of Arts on Wednesday, November 23rd, 1921.

transmitters made by Marconi's Wireless Telegraph Company at Clifden, Ireland, and at their great Carnarvon station in North Wales.

After a discussion of the mode of propagation of E.M. waves, Dr. Fleming proceeded to explain that the presence of the highly conducting layer in the upper regions of the atmosphere, in which the component gases are hydrogen and helium, is probably due to electrified dust which comes to us from the sun, from which it is repelled by the radiation pressure against the gravitation attraction. He said that this dust came from the sun with enormous velocity and entered the higher levels of the atmosphere and rendered it conducting. This conducting layer guides the radio waves round the earth and prevents them from escaping into space.

The lecture concluded with some remarks on the effect of recent physico-mathematical speculations on relativity and especially the agnostic view now taken as regards the existence of a space-filling æther, on the theory of wireless telegraphy. It is clear that space is not a mere vacuum but has remarkable powers of storing and transmitting energy, but modern physical and astronomical discoveries have rendered necessary great modification in our ideas regarding the structure of space or the æther and no theory of radiation has yet been propounded which satisfactorily explains all the known facts.

On the Use of Anderson's Bridge for the Measurement of the Variations of the Capacity and Effective Resistance of a Condenser with Frequency,

and

Notes on Earth Capacity Effects in Alternating Current Bridges.*

By S. BUTTERWORTH, M.Sc.

An analysis of the effect of residuals and earth capacities in Anderson's inductance-capacity bridge was made, and it was shown that if balances are obtained

- (a) By balancing the bridge with *direct* currents ;
- (b) By making the alternating current adjustments by means of a small series resistance (s') and parallel condenser (C') in the condenser arm ;

then the changes required in s' and C' to hold the balance at different frequencies are equal and opposite to the variations of the effective (series) resistance and capacity of the condenser with frequency.

The assumptions made in obtaining the above conclusions were that the residual inductances and resistances of the "non-inductive" arms of the bridge are invariable with frequency and that the resistance of the inductive arm varies as the square of the frequency. No knowledge of the absolute values of the residuals, etc., is required for the method.

The method was illustrated by results obtained with a condenser of capacity $0.5\mu\text{F}$, and details were given showing how the chief experimental trouble, viz., drift in D.C. balance owing to temperature variations, could be overcome.

In the second paper it was shown that an earth capacity acting at any point in the arm of a bridge may be replaced by two earth-impedances acting at the ends of the arm together with an impedance in series with the arm. By integration the result was extended to small distributed capacities.

Two methods were given for the elimination of the error due to the end impedances. Complete elimination can only be obtained by the use of shields connected to the ends of the bridge arm.

* Abstract of papers read before the Physical Society of London, on Friday, October 28th, 1921.

An Investigation of Transmitting Aerial Resistances.*

By T. L. ECKERSLEY, B.A., B.Sc.

The paper describes an attempt that has been made in the course of some experiments carried out by engineers of Marconi's Wireless Telegraph Co., Ltd., to reduce to a minimum the energy losses in the neighbourhood of transmitting aeri-als. The efficiency of transmitting aeri-als may be increased in either one or two ways :—(1) Increase of the height at the expense of very costly towers. These at present are not practical above 800 feet ; and (2) reduction of the dead losses in the surrounding earth and wires so that they shall be small compared with the radiated energy. The second aspect of the question is the one dealt with in this paper.

For the first experiments, which were carried out at Broomfield in July, 1919, an inverted L type of aerial was used and a screen of wires parallel to the horizontal part of the aerial and insulated from the ground was employed as a balancing capacity. This balancing capacity acts as an earth screen to intercept the lines of force from the aerial to earth and to carry the return current through the screen wires rather than through the earth.

According to Maxwell's formula, an earth screen with wires 1 foot apart and 2 feet 6 inches above the ground will, if insulated, carry practically the whole current, less than $\frac{1}{10000}$ per cent. of the total current flowing through the earth.

The screen was accordingly designed on this basis and consisted of 64 wires 1 foot apart and 200 feet long supported on wooden posts at a height of 2 feet 6 inches from the ground. It covered all the space below the aerial and extended in all directions an amount at least equal to the height of the aerial (that is 15 feet) beyond the latter.

It was found by experiment that when the screen was placed in other positions than under the aerial, so that it did not shield the earth from the lines of force, the resistance of the aerial was much larger than when the screen was in its normal position.

The action of the screened aerial from whatever point of view it is regarded can be summarised as follows :—

- (1) The losses in the earth are produced by the agency of the horizontal electric force which, in its turn, is produced by the differential action of the horizontal currents in the aerial and screen.
- (2) Since there is necessarily a downward radiation from any aerial with horizontal wires, the loss in the earth cannot be completely eliminated except when the conductivity of the earth is perfect, or when there is a perfect reflector between the screen and earth.
- (3) The leakage electric force perpendicular to the surface of the earth and calculated on the quasi-stationary theory will contribute to any loss due to the presence of bad dielectrics at the surface of the earth.

Of the experimental results perhaps the most striking from the practical point of view is the reduction of the resistance of the screened aerial as compared with that of the earthed aerial. In the case of the particular aerial on which the measurements were made a fourfold reduction of resistance was found on all wavelengths from the natural wavelength of the aerial to about four times this wavelength. Thus with a screened aerial only a quarter of the power is required in order to obtain a given aerial current and signalling range, or if a definite power supply is available the screened aerial is equivalent to an earthed aerial of double the height.

The " added resistance " method of measuring the high-frequency resistances of the various aerial arrangements was the one adopted, the chief novelty being in the methods of obtaining the relative values of the currents before and after the insertion of the extra resistance. The relative voltages across the aerial loading inductance were the quantities actually measured to give the ratios of the current, the method used being that described in the *RADIO REVIEW*, pp. 303—307, June, 1921. It was found that an accuracy of at least 5 per cent. could be obtained in these measurements. The total resistance of the aerial circuit is made up of the radiation resistance, the ohmic resistance of the wires, the eddy current resistance, dielectric

* Abstract of paper read before the Wireless Section of the Institution of Electrical Engineers, on December 7th, 1921.

losses and leakage losses. A short mathematical analysis of the variations of these losses with the wavelength was given in the paper, together with the results of a series of experiments designed to confirm the theoretical results.

In order to set a limit to the number of screened wires necessary in any given case each of the 64 wires above mentioned was brought to a separate terminal so that any combination of wires could be used. It was found that if the wires were sufficiently few and far between the resistance was inversely proportional to the number of wires but that when they were crowded together so that the distance between them was less than their height above the ground, an increase in the number of wires did not appreciably reduce the resistance of the aerial circuit. A theory explaining this effect is worked out in the paper but the numerical values obtained by its use are about eight times the actual observed one, the discrepancy being due to the neglect of the currents in the aerial wires which acting in the opposite direction to those in the screen wires reduce the electric and magnetic force at the surface of the earth (and consequently the losses) about eight-fold. Further formulæ are also given for the theory of the earth loss taking the above effect into account.

Experiments were also carried out with a radial type of aerial consisting of eight 4-wire sausages radiating from a central 70 foot mast to eight similar masts equally spaced in a 200 foot circle, together with a radial form of earth screen of eighty-eight wires 4 feet 6 inches above the ground arranged like the spokes of a wheel. With this aerial numerous resistance curves were obtained and analysed into their component parts and it was found that the earth loss remained remarkably constant so long as the disposition and height of the wires in the screen were unaltered. Even when the aerial was lowered to half its original height no appreciable change was produced.

This might at first sight appear to contradict the theory given in the paper which attributes the earth loss to a differential effect between the aerial and earth, but it can be shown that so long as the screen effectively shields the earth from the aerial the loss is hardly affected by varying the distribution and height of the aerial wires.

The results of experiments to determine the magnitude of other losses such as leakage and surface dielectric losses are also given but it is pointed out that by careful design most of these can be eliminated.

The discussion of the screened aerial is not complete without mention of some curious effects which were first observed in circular types of aeriels, and later in inverted L and T aeriels. The effects first showed up as a very rapid increase in resistance at wavelengths close to the natural wavelength of the aerial, an increase which was much too rapid to be accounted for by any change in the eddy currents or radiation resistance. It was later discovered that at still lower wavelengths the resistance decreased again. The resistance curve, therefore, showed a peak in the neighbourhood of some wavelength near the natural wavelength of the aerial. It was natural to suppose that this peak was due to the presence of some oscillation of that particular period, and a short search resulted in the identification of this with the wires of the screen which have, for an end-to-end oscillation, a natural period of this amount.

One method of removing the losses due to the oscillations in the screen is to earth the point on the screen to which the aerial connection is joined. This method has been found fairly effective, but it does not reduce the resistance of the aerial circuit to its normal value in the neighbourhood of the natural period of oscillation of the screen wires. It has also two disadvantages which may in certain cases be serious—(a) it introduces the possibility of still another oscillation between the screen and the earth; and (b) the point on the screen to which the aerial connection is made will not in general be a natural node of potential for the oscillations in the aerial circuit and therefore to earth this point will introduce earth currents which it is the function of the earth screen to avoid. In an inverted L type aerial the earthing of this point generally leads to about 50 per cent. increase in the resistance. It has, however, been discovered that a point on the loading coil can be found which can be earthed without increasing the resistance.

This is a point of great practical importance as it enables the potentials of the whole system to be stabilised by earthing a definite point.

The currents carried by the wires of the screen should all be equal as oscillations in the screen are liable to occur if the length of the outer wires differs largely from that of the centre wires as in the case of a short broad screen. Again if the aerial is narrow and placed centrally over the middle of the screen it will tend to produce oscillating currents in the screen wires. Losses

due to this cause can be partly avoided by strapping together the ends of the screen wires, but this practice may introduce extra losses in the form of circulating currents round the closed circuits formed by these connecting wires.

The questions raised by the investigation have a very general bearing on wireless practice. We may, in fact, ask ourselves how far we may go on reducing the losses. The very favourable results so far obtained seem to augur a possibility of obtaining even better results in the future. There is still considerable room for improvement, for the earth losses in the cases already investigated still form a large proportion of the total resistance.

The lines along which further reduction in earth loss may be effected are indicated by the theory, which shows that a simultaneous broadening of the screen and aerial have the desired effect. Again, the dielectric loss may be reduced by spacing the wires more and more closely or by using a complete radial screen in which the edge effect is reduced to a minimum.

Screens have been employed successfully at large power stations, for example, at Clifden, and it now requires only one-sixth of the power to produce signals at Glace Bay equal to those formerly produced by the spark station. It is evident, therefore, that the practice of long-distance wireless telegraphy may be very considerably modified by these results.

Obviously, if perfect radiation efficiency can be obtained, the height, size and shape of the aerial will not matter so long as it radiates in the direction required; for all the power put into the aerial is usefully employed in radiation. But when a small or low aerial is used we are likely to experience other troubles. If, for instance, we halve the effective height we must double the current to produce the same range; in fact the currents required are inversely proportional to the heights. For this reason the currents with a low aerial tend to become excessive, and before long the voltage limit of the aerial may be reached. Take the same example again; if we halve the height we must double the capacity for the same maximum voltage in each case, and so on; lowering the aerial to half the height will in most cases hardly increase the capacity, so we shall have to spread the aerial to attain these results.

It is desirable to consider whether the resistance can be reduced in any other manner. Naturally the Alexanderson multiple-earth antenna suggests itself, and perhaps a rough comparison would not be out of place in this paper. By putting the earth losses in parallel, so to speak, instead of in series, the resistance is reduced in the ratio of $n^2 : 1$, where n is the number of earths; but this is emphatically not the case with the dielectric loss, which is left unaltered by this method of earthing and, as we have seen, forms the major portion of the loss on wavelengths which are long compared with the natural wavelength of the aerial.

Any reduction of the surface dielectric loss can be made only by suitably screening the earth. Of course, a combination of the two systems may be used and may in certain cases be preferable, as for example in the case of long, narrow aeriels; the multiple-earthed aerial suffers, however, from the disadvantage that it cannot be allowed to oscillate freely, since it has so many possible natural periods, but must be forced to respond to a machine or apparatus of definite frequency which cannot be easily reacted upon.

There is, however, no doubt that in the case of certain existing aeriels it is preferable to reduce the resistance by the Alexanderson method. This is especially so in the case of long, narrow aeriels. The screening of such an aerial may not reduce the resistance sufficiently and it is a matter of great practical difficulty to widen an existing aerial and reduce the resistance in this way. The only alternative is to make use of Alexanderson feeders and to put the various sections of the aerial in parallel instead of in series, which is, in effect, equivalent to a simultaneous widening and shortening of the aerial. But to get the best results from this method a suitably designed screen should be used to intercept the lines of force from the aerial and to reduce, consequently, the surface dielectric loss.

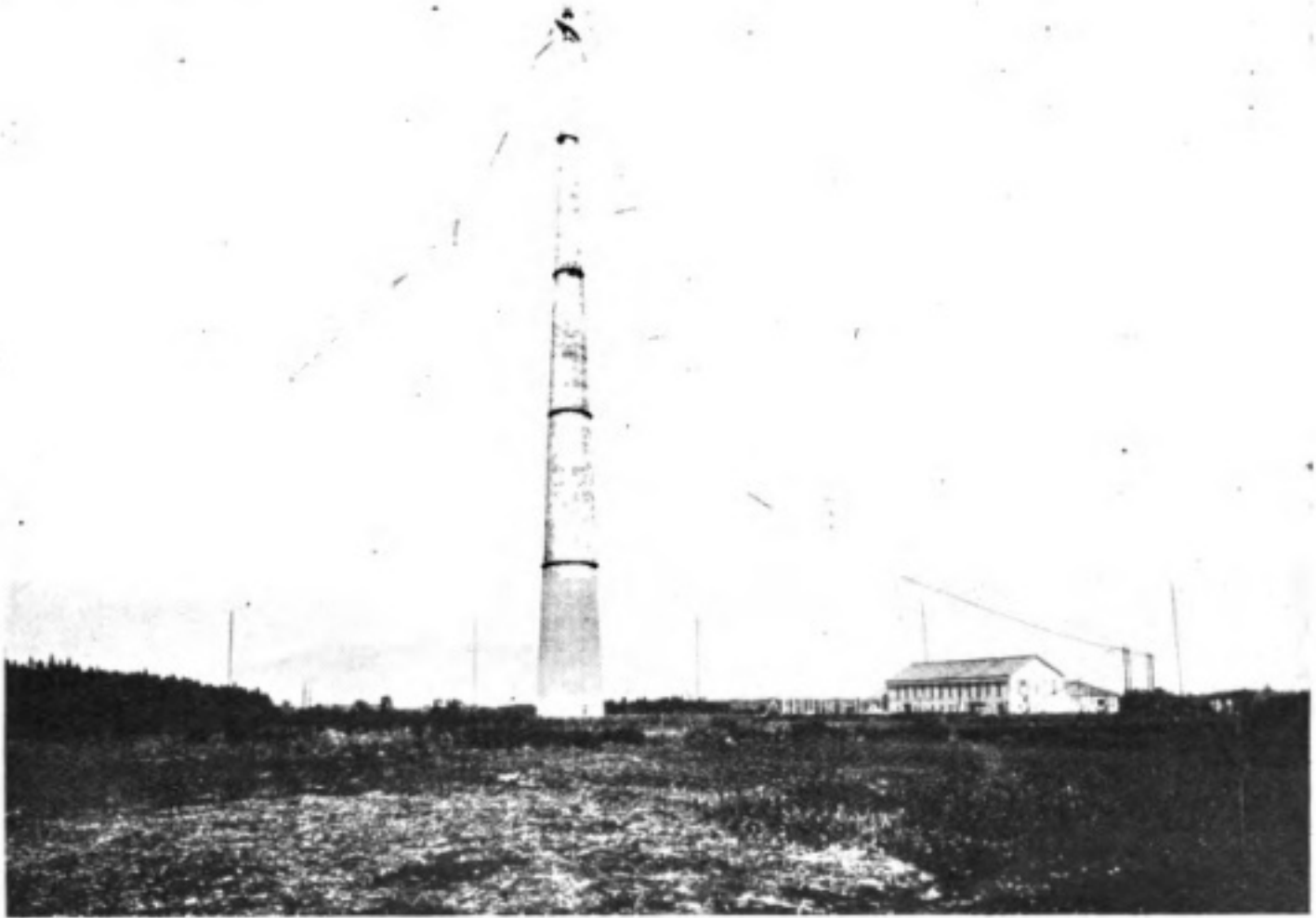
In conclusion, whatever the drawbacks of the screened aerial may be, it is certainly one degree nearer the ideal of perfect radiation efficiency.

Reinforced Concrete Towers for Wireless Stations.

We have received from the Radio Section of the Electrotechnical Laboratory, Japan, a few notes about the high-power radio station at Qwaki, near Tokyo, which was opened in March, 1921. The transmitting and receiving houses are about twenty miles apart, and the former contains arc and H.F. alternator apparatus of 400 kW capacity. The aerial, which is of the

umbrella type, is supported by one main tower 200 metres high, which, as may be seen from the accompanying photograph, is a self-supporting reinforced concrete structure weighing about 11,000 tons. This tower is surrounded by eighteen masts 60 metres high which are arranged in a circle round the central tower.

The station is employed for duplex transmission, with the Hawaiian stations of the Radio Corporation of America, but it is intended to utilise it later for direct European traffic.



Reinforced Concrete Tower to support the Umbrella Type of Aerial used at the Qwaki Wireless Station, Japan.

Notes.

Personal.

The *Telefunken Zeitung* for September, 1921, contains a biographical sketch and portrait of **W. Schlömilch**, who has just completed twenty years' service with the Telefunken Company. [3145]

Oskar Lorenz, a chief engineer of the Telefunken Company, with which he had been connected for twenty-one years, died suddenly on September 15th. The current number of the *Telefunken Zeitung* contains a description of the Königswusterhausen Station from his pen. [4427]

Mr. G. C. Mason, formerly Assistant Wireless Superintendent in the office of the Secretary of the General Post Office, has been appointed Wireless Superintendent in that office. [4491]

Legislation.

WIRELESS TELEGRAPH REGULATIONS IN AUSTRALIA.—Certain changes have been made in the regulations governing the use of Wireless Telegraph Apparatus in Australia by the autho-

city of the Governor-General acting on the advice of the Federal Executive Council, under date of September 14th, 1921, as set out below :—

The Navigation (Wireless Telegraphy) Regulations, 1921, are amended as follows :—

(a) By inserting at the end of paragraph (b) of sub-regulation (1) of regulation 13 the following proviso :

“ Provided that, where it is shown to the satisfaction of the Director of Navigation that a sufficiency of operators holding First or Second Class Certificates of Proficiency issued by the Postmaster-General and having at least one year's experience as an operator are not available in the Commonwealth, he may to the extent of the deficiency in numbers of such operators, by writing under his hand, permit of the employment, as Second Grade Operators, of persons holding First or Second Class Certificates of Proficiency but with less than one year's experience as operators, and such persons so employed shall be deemed to be Second Grade Operators for the purposes of these Regulations ; ” and

(b) By inserting at the end of the Schedule thereto the following proviso :—

“ Provided that, until otherwise prescribed, the times of watch for operators on Australian trade and limited coast-trade ships to which these Regulations apply may, in lieu of those set out in the Schedule, and at the option of the owner, be in accordance with the provisions of the agreement between the Commonwealth Steamship Owners' Association and others, of the one part, and the Radio-Telegraphists' (Marine) Institute of Australasia, of the other part, dated the 29th March, 1920, certified in the Commonwealth Court of Conciliation and Arbitration of 22nd September, 1920.” [4490]

Commercial and General.

THE RADIO CORPORATION OF AMERICA has purchased the assets of the International Radio Telegraph Company. Details of the transaction were announced on September 3rd by the Westinghouse Electric and Manufacturing Company in a statement reading in part as follows:—

“ The Radio Corporation of America has acquired from the International Radio Telegraph Company a group of patents relating to wireless telegraphy which the Radio Corporation found it necessary to make use of to enable it to give the public proper and efficient service.

“ The International Company had not embarked upon commercial work to any great extent and was confronted with important patents owned by the Radio Corporation, so that neither Company was able to give to the public satisfactory service without infringing upon the patents of the other. Under the circumstances it was found essential that the right to use the several groups of patents should be acquired by one corporation.”

The purchase was made, it is understood, with 1,000,000 shares of \$5 par value preferred and 1,000,000 shares of no par value common stock of the Radio Corporation. Under this arrangement it is understood that there will be a pooling of all radio patents owned by the Westinghouse Electric and Manufacturing Co., the International Radio Telegraph Co., the American Telephone and Telegraph Co., the American General Electric Co., the American Marconi Company, and the Radio Corporation of America. [4162]

AN APPLICATION BY THE INTER-CITY RADIO COMPANY of New York for an injunction to restrain the Department of Commerce, U.S.A., from revoking its licence to use wireless installations has been withdrawn and a satisfactory settlement made between the Company and the Department of Commerce. This agreement permits the Radio Company to operate its wireless business in New York, Cleveland, Detroit and Chicago. [4188]

NEW WIRELESS STATION.—A large wireless station has been erected near Moscow to enable communication to be made with all other countries. [4158]

WIRELESS IN RUSSIA.—The wireless network in Russia is covered by 597 wireless stations—about six times as many as in the British Isles. These provide efficient communication between Siberia and all other parts of the country including Turkestan. [4159]

WIRELESS IN MAURITIUS.—According to *The Times Trade Supplement* the Imperial Authorities have decided to discontinue the working of the wireless station erected at Rose Belle in Mauritius during the war. As the result of representations by the commercial community it is possible that this decision may be reconsidered provided that the local Government will assume financial responsibility for the station. [4064]

Review of Radio Literature.

1. Abstracts of Articles and Patents.

(F.) Thermionic Valves, and Valve Apparatus.

2776. **H. Barkhausen.** The Three-electrode Valve and its Technical Applications.—II. (*Jahrbuch Zeitschrift für drahtlose Telegraphie*, 16, pp. 82—114, August, 1920. *Radio-électricité*, 1, p. 1030, March, 1921.) For Part I. see *Jahrbuch*, 14, pp. 27—47.

A very thorough discussion of the application of the valve to the amplification of weak alternating currents. See pp. 25—30 in this issue for fuller abstract.

2777. **Siemens Schuckertwerke.** Electrodes for Electric Discharge Apparatus. (*British Patent* 144295, June 2nd, 1920. Convention date June 4th, 1918.)

Refers to the construction of a water-cooled electrode for thermionic valves.

2778. **General Electric Company, U.S.A. [British Thomson-Houston Company].** Thermionic Valves. (*British Patent* 150359, August 1st, 1916. Patent accepted September 9th, 1920.)

An addition to *British Patent* 15555/1915. A thermionic valve of the dynatron type is provided with an additional control electrode or grid.

2779. **General Electric Company, U.S.A. [British Thomson-Houston Company].** Electric Relays. (*British Patent* 154232, February 22nd, 1916. Patent accepted December 2nd, 1920.)

An amplifier consisting of a thermionic valve arranged as a negative resistance in parallel with an ordinary resistance.

2780. **Société Française pour l'Exploitation des procédés Thomson-Houston.** Relay. (*French Patent* 512139, April 10th, 1919. Published January 15th, 1921.)

The valve tube has a third electrode arranged so that for a certain range of electric pressure the current between the cathode and the third electrode varies oppositely to the pressure. See also *British Patent* 15555/1915, and Abstract 2778 above.

(G.) Transmitter Control or Modulation.

(1) GENERAL ARTICLES OR METHODS.

2781. **W. Noble.** The Long Distance Telephone Systems of the United Kingdom. (*Journal of the Institution of Electrical Engineers*, 59, pp. 389—426, April, 1921. *Electrician*, 86, pp. 350—352, March 25th; pp. 376—378, April 1st, 1921. *Technical Review*, 9, p. 79, May 3rd, 1921. *Electrical World*, 77, p. 1175, May 21st, 1921—Abstract.)

Includes descriptions of valve repeating and amplifying apparatus.

2782. **J. Scott-Taggart.** The Vacuum Tube in Radiotelephony. (*Radio News*, 2, pp. 865 and 898—904, June, 1921. *Technical Review*, 7, p. 183, November 9th, 1920—Abstract. *Science Abstracts*, 23B, p. 495, Abstract No. 939, October 31st, 1920—Abstract. *Revue Générale de l'Électricité*, 9, p. 257—259, February 19th, 1921—Abstract. *Radioélectricité*, 1, p. 710, December, 1920—Abstract.)

This article has already been abstracted from other sources. (RADIO REVIEW Abstract No. 1225, December, 1920.)

2783. **O. Reichenheim.** Apparatus for Wireless Telephony. (*German Patent* 316224, September 3rd, 1915. Patent granted November 22nd, 1919. *Jahrbuch Zeitschrift für drahtlose Telegraphie*, 16, pp. 385—386, November, 1920.)

A scheme of wireless telephony by means of damped waves of a group frequency different from the mean speech frequency. By means of a system of one or more resonant circuits the note of the spark frequency is prevented from reaching the telephone.

2784. **W. S. Lemmon.** Recent Development of Radio Telephones. (*Q.S.T.*, 3, pp. 7—11, June, 1920.)

2785. **R. V. Hartley.** Prevention of Signal Distortion. (*Wireless Age*, 8, pp. 16—17, June, 1921. *Science Abstracts*, 24B, p. 415, Abstract No. 848, August 31st, 1921—Abstract.)

To remedy the distortion occurring in a wireless telephone transmitter due to partial suppression of the side tones of the carrier waves to which the receiving circuits are not in tune, circuits are proposed for emphasising the amplitude of the higher frequency speech currents.

2786. **R. A. Heising.** Modulation in Radiotelephony. (*Q.S.T.*, 4, pp. 7—12, July, 1921; 5, pp. 9—15, August, 1921.)

Gives a general discussion of various modulation methods in radiotelephonic transmitters with a view to comparing their relative efficiencies. At the conclusion of the second part tables are given of the best constants for various types of circuit.

2787. **J. Scott-Taggart.** Two Practical Radio Telephone Circuits. (*Radio News*, 2, p. 518, February, 1921.)

2788. **A. S. Blatterman.** Notes on Modulated Tube Transmitters. (*Radio News*, 2, pp. 524—525 and 573—577, February, 1921. *Radioélectricité*, 1, p. 145D, June, 1921—Abstract.)

A discussion of the mode of operation of various modulation circuits with comparisons of their relative merits.

2789. **M. Wolf.** Determination of Percentage Modulation in Radiotelephony. (*Radio News*, 3, pp. 19 and 61—62, July, 1921.)

Describes how the effectiveness of the modulation of a radio telephone transmitter can be determined in any given case.

2790. The Vacuum Tube in Wireless Telephony. (*L'Électricien*, 52, pp. 396—398, September 1st, 1921.)

A brief description of various methods of modulation for wireless telephony using valves.

2791. **J. H. Hammond.** Wireless Signalling. (*British Patent* 166195, September 26th, 1918. Patent accepted September 11th, 1921.)

In a system of wireless signalling the signals are caused to vary the supersonic group frequency of trains of damped waves emitted from a transmitting station, or the beat frequency where continuous waves are employed. The group frequency is changed by means of a commutator or by a hand-operated switch. At the receiving station the incoming signals are rectified and combined with local oscillations for the production of audible beats.

2792. **A. H. Taylor.** Radiotelegraph and Telephone Transmitter and Receiver. (*Wireless Age*, 8, pp. 21—22, July, 1921.)

Describes an arrangement for effecting combined telegraphic and telephonic transmission from a single wireless station and aerial. Circuit diagrams for transmission and reception are given.

2793. **E. G. Velasco.** Problems in Wireless Telephony; The Causes of Speech Distortion. (*Energia Elect.*, pp. 153—154, July 25th, 1921.)

(2) SIGNALLING KEYS AND METHODS.

2794. **Gesellschaft für drahtlose Telegraphie.** Wireless Signalling. (*British Patent* 147429, July 7th, 1920. Convention date July 15th, 1915. Patent accepted August 4th, 1921.)

Methods of controlling the emission of signals in systems in which oscillations are generated by a retro-active thermionic valve. A key when depressed completes the usual grid circuit and in its back position connects the grid to the negative pole of a battery.

2795. **H. J. Round and W. T. Ditcham.** Wireless Transmitting Apparatus. (*British Patent* 158291, August 19th, 1919. Patent accepted February 10th, 1921.)

Relates to special keying arrangements in connection with rectifying and transmitting valves.

2796. **Gesellschaft für drahtlose Telegraphie.** Wireless Transmitters. (*British Patent* 147434, July 7th, 1920. Convention date October 20th, 1917. Patent accepted October 7th, 1921.)

A tone transmitter comprising a valve oscillation generator with its grid circuit influenced

by currents of audible frequency, such as may be derived from a buzzer. Alternatively the low frequency tone may be generated by the same valve oscillating at an audible frequency.

2797. **P. Boucherot.** Relays for Wireless Transmitters. (*British Patent* 160730, March 22nd, 1921. Convention date March 24th, 1920. Patent not yet accepted.)

2798. **J. H. Hansen.** Morse Transmitters. (*British Patent* 155162, March 31st, 1920. Patent accepted December 16th, 1920.)

2799. **E. F. Huth.** Wireless Transmitting Apparatus. (*British Patent* 148316, July 9th, 1920. Convention date October 21st, 1914. Patent not yet accepted.)

A Morse writer is actuated by the transmitting key for maintaining a record of the messages sent out.

2800. **W. T. Ditcham.** Wireless Transmitting Apparatus. (*British Patent* 162761, January 31st, 1920. Patent accepted May 2nd, 1921.)

For transmission with an oscillating valve, using an A.C. supply and a rectifying valve to supply the oscillating valve, the key is connected in parallel with a choke or resistance which is inserted in series with the A.C. supply.

2801. **W. T. Ditcham.** Wireless Transmitters. (*British Patent* 162762, January 31st, 1920. Patent accepted May 2nd, 1921.)

In inductively coupled transmitters, the key is arranged to short circuit the coupling coil, which contains a few turns only and is separated from the main inductance of the circuit to which it is connected.

2802. **W. H. Eccles and J. H. Vincent.** Wireless Signalling. (*British Patent* 163462, February 17th, 1920. Patent accepted May 17th, 1921.)

Signalling is effected by small changes in the frequency of the waves. At the receiver an indicating circuit is arranged to be influenced both by the incoming signals and by a local heterodyne. The deflections of the indicator show large changes for minute changes of frequency. Modifications are described to render the method applicable to transmission with an arc.

(3) AUTOMATIC AND HIGH SPEED APPARATUS.

2803. **D. A. E. A. Bontekoe.** High-speed Radio Transmitter. (*Radio Nieuws*, 4, pp. 16—21, January, 1921.)

An illustrated account of a transmitter of the Wheatstone type, presumably of Austrian origin.

2804. **W. H. Nottage and T. D. Parkin.** Wireless Calling Apparatus. (*British Patent* 161652, January 9th, 1920. Patent accepted April 11th, 1921.)

Relates to a vibrating balance wheel mechanism for automatic calling and for receiving the call. (See also *RADIO REVIEW*, 1, p. 293, March, 1920.)

2805. **W. Klaus.** The Kleinschmidt Automatic Transmitter. (*Radio News*, 2, p. 283, November, 1920.)

An illustrated description of the working of this perforator and transmitter.

2806. **H. Verch.** High-speed Wireless in Large Stations. (*Telefunken Zeitung*, 4, pp. 17—25, March, 1921.)

A well-illustrated article describing the various transmitting and receiving arrangements for high-speed working, including phonograph and telegraphone.

2807. **F. Banneltz.** Experiments and Tests of High-speed Wireless Telegraphy in the German Post Office. (*Elektrotechnische Zeitschrift*, 42, pp. 714—716, July 7th, 1921—Abstract. *Post Office Electrical Engineers' Journal*, 14, pp. 158—163, October, 1921—Abstract. *Jahrbuch Zeitschrift für drahtlose Telegraphie*, 18, pp. 136—137, August, 1921—Abstract.)

The original of this report has already been abstracted. (See *RADIO REVIEW* Abstract No. 1065, November, 1920.)



2808. **Wireless Wheatstone Trials.** Aldershot—Cologne. (*Telegraph and Telephone Journal*, 7, pp. 101—102, April, 1921. *Annales des Postes et Telephones*, 10, pp. 553—555, September, 1921.)

A short account of high-speed wireless transmission tests carried out between Aldershot and Cologne using the military wireless station. The trials extended over a period of three days and perfect transmission at 100 words per minute was obtained. Out of a total of 1,053 telegrams 93 per cent. were correctly received. A specimen of the Wheatstone slip taken at 150 words per minute is reproduced.

(4) VALVE MODULATORS.

2809. **P. P. Eckersley.** Wireless Signalling. (*British Patent* 146610, April 10th, 1919. Patent accepted July 12th, 1921. *Engineer*, 130, p. 170, August 13th, 1920—Abstract.)

A "quiescent aerial" type of transmitter in which the grid circuit of the power valve is continuously excited by feeble oscillations of the same frequency generated by an auxiliary valve.

2810. **L. de Forest.** Modulating Apparatus for Radiotelegraphic Transmitters. (*British Patent* 149272, July 14th, 1920. Convention date May 10th, 1915. Patent not yet accepted.)

Describes the use of a three-electrode valve connected in shunt to the antenna circuit of a C.W. transmitter for modulating the radiated output from that circuit. The transmitting microphone is connected to the grid circuit of the shunt modulator valve in series with a battery for giving the grid the necessary negative voltage.

2811. **General Electric Company, U.S.A. [British Thomson-Houston Company].** Wireless Transmitting Arrangements. (*British Patent* 149466, May 28th, 1919. Patent accepted August 19th, 1921.)

For modulating the output of a valve transmitter it is proposed to feed two valves connected in opposite directions from the currents derived from the modulating microphone. The two valves are arranged in opposite directions so that both half-ways of the modulating current are utilised.

2812. **E. F. Huth.** Wireless Modulating Apparatus. (*British Patent* 148801, July 10th, 1920. Convention date April 3rd, 1919. Patent not yet accepted.)

Oscillations produced by a thermionic valve are modulated by means of a shunt of variable impedance across the valve. This shunt may consist of an auxiliary valve having its grid potential controlled by the transmitting microphone.

2813. **S. Loewe.** Wireless Telephony. (*British Patent* 149214, July 12th, 1920. Convention date October 29th, 1918. Patent not yet accepted.)

In thermionic apparatus particularly applicable to wireless telephony the transmitting valve is in parallel with a control valve. The grid circuit of the control valve includes a transformer influenced by telephone currents produced in any suitable way, a condenser telephone in conjunction with an amplifier being mentioned as particularly suitable. The two valves may be combined in one tube having two grids, the control grid being near to the cathode.

2814. **J. B. Bolitho.** Wireless Telephone Apparatus. (*British Patent* 156876, October 6th, 1919. Patent accepted January 20th, 1921.)

For the modulation of oscillations produced by a thermionic valve having a retroactive coupling a control circuit is used containing another three-electrode valve and an inductance coupled with the oscillation circuit in such a way that the reaction in them opposes the retroaction in the generating circuit.

2815. **E. F. Huth Gesellschaft.** Wireless Telephonic Transmitting Apparatus. (*British Patent* 157924, January 10th, 1921. Convention date March 22nd, 1919. Patent not yet accepted.)

A modulating arrangement in which the microphone controls the valve filament temperature.

2816. **M. Latour.** Thermionic Oscillation Generators. (*British Patent* 147757, July 8th, 1920. Convention date August 16th, 1915. Patent not yet accepted.)

Modulation of the C.W. output may be obtained (1) by feeding the plate with A.C.; (2) by introducing a low frequency oscillation circuit in the D.C. supply circuit; (3) by using two oscillation circuits to produce audible frequency beats.

2817. **General Electric Company, U.S.A. [British Thomson-Houston Company].** Modulating Apparatus. (*British Patent* 155602, September 11th, 1918. Patent accepted February 30th, 1920.)

To control the energy supplied from an oscillating valve V_1 to the aerial circuit a modulating valve V_2 is joined up as indicated in Fig. 1.

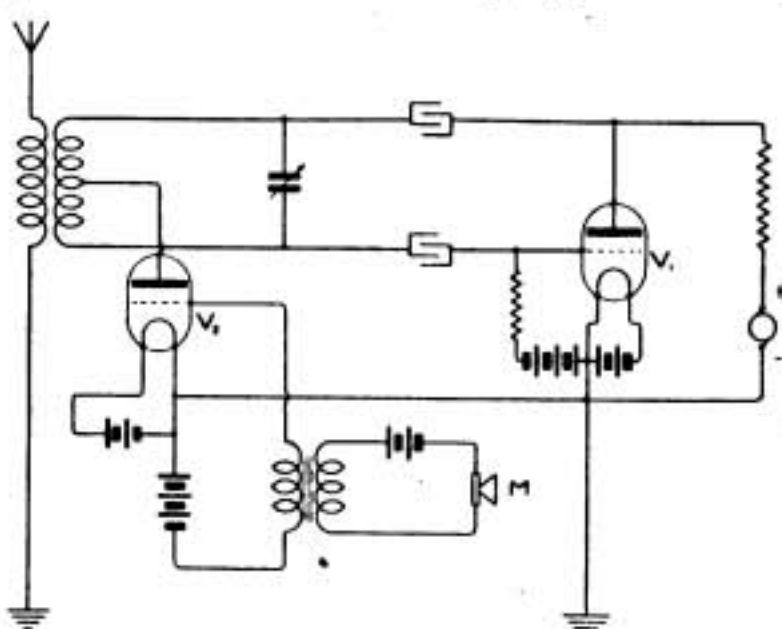


FIG. 1.

2818. **General Electric Company, U.S.A. [British Thomson-Houston Company].** Wireless Signalling Apparatus. (*British Patent* 144803, March 17th, 1919. Patent accepted June 17th, 1920.)

A modification of the shunt valve method of modulation in which the valve is coupled inductively to the transmitting aerial instead of being directly connected to it.

2819. **A. K. Macrorie and G. A. Irving.** Wireless Telephony. (*British Patent* 162781, February 3rd, 1920. Patent accepted May 3rd, 1921.)

Relates to a resistance coupled cascade amplifier arranged to amplify the microphone current and to modulate the output of the oscillating valve.

2820. **R. V. L. Hartley [Western Electric Company].** Valve Modulating Apparatus. (*British Patent* 151928, September 21st, 1920. Convention date September 29th, 1919. Patent not yet accepted.)

An addition to *British Patent* 102503 dealing with two valves arranged for modulating purposes.

2821. **Gesellschaft für drahtlose Telegraphie.** Wireless Telephone Transmitters. (*British Patent* 157407, January 10th, 1921. Convention date December 23rd, 1919. Patent not yet accepted.)

Modulation of a valve generator by means of a valve modulator controlled by a microphone. The valve modulator is connected in parallel with the valve generator plate filament circuit.

2822. **H. Vogt, J. Engl and J. Massolle.** Modulation of High-frequency Oscillations. (*British Patent* 157437, January 10th, 1921. Convention date April 7th, 1919. Patent not yet accepted.)

High-frequency oscillations for use as carrier waves are modulated by means of a photoelectric cell having one or more anodes or cathodes in an exhausted chamber. The cathodes are coated with an alkali metal.

2823. **Gesellschaft für drahtlose Telegraphie.** Wireless Signalling. (*British Patent* 154181, October 26th, 1920. Convention date November 11th, 1919. Patent not yet accepted.)

Microphone currents impressed on the grid of a thermionic valve vary its internal resistance. This varying resistance is utilised as a means of varying the amplitude of the oscillations produced by a valve generator by connecting it in series with the anode circuit of the oscillating valve.

2824. **W. T. Ditcham.** Wireless Telephony. (*British Patent* 164105, February 28th, 1920. Patent accepted May 30th, 1921.)

A wireless telephony transmitting arrangement wherein the aerial circuit is influenced by the resultant beat frequency of two superimposed oscillating circuits, one of which is modulated.

2825. **Société Française pour l'Exploitation des procédés Thomson-Houston.** Valves (*French Patent* 509928, December 31st, 1919. Published November 23rd, 1920.)

The specification describes a device for controlling alternating electric currents which consists of a hollow container having one or more main anodes and a vaporisable cathode, such as mercury, with an intermediate electrode or grid, to which is applied a variable negative potential. (See also corresponding *British Patent* 568415.)

2826. **J. Scott-Taggart.** A Quiescent Aerial for Wireless Telephony. (*Electrician*, 87, pp. 234—235, August 19th, 1921.)

A description is given of the application of a double grid thermionic valve * for the modulation of a radiotelephone transmitter. One grid is supplied from the source of continuous oscillations, which may be an ordinary oscillating valve and the second grid is connected to the modulating microphone with the application of a sufficiently large negative potential to reduce the normal anode current practically to zero. Normally therefore no radiation takes place but positive impulses on the second grid from the modulating microphone cause radiation to take place.

2827. **W. A. MacDonald.** Radiotelephone Circuits and Modulation. (*Radio Review*, 2, pp. 409—419, August, 1921.)

2828. **Le Matériel Téléphonique.** Continuous Wave Transmitter. (*French Patent* 513761, April 15th, 1920. Published February 23rd, 1921.)

High-frequency oscillations are modulated in accordance with low-frequency signals by impressing both potential variations on the grid circuit of a thermionic valve, the output circuit of which is coupled to the transmitting aerial or a wire conductor. (See also *British Patent* 141732—RADIO REVIEW Abstract No. 891, October, 1920.)

2829. **R. A. Helsing.** Control Means for Vacuum Tube Generator. (*Wireless Age*, 8, pp. 19—20, April, 1921.)

Describes various arrangements for microphonically modulating the output of an oscillating valve, and deals in particular with arrangements in which the microphone controls the output by changing the working conditions of the valve into the oscillatory or non-oscillatory state. The microphone circuit may be arranged to provide part of the retroactive coupling of the oscillatory valve.

2830. **S. Brydon and A. G. T. Cusins.** Wireless Signalling. (*British Patent* 166594, September 27th, 1919. Patent accepted July 11th, 1921.)

As a means of controlling the amplitude of high-frequency oscillations in a valve generator the anode-cathode resistance of one or more control valves is arranged in series with the source of current supply to the anode circuit of the generator. The magnitude of the anode current in the generator is varied by means of the anode-cathode resistance of the control valve or valves by a variation of grid potential.

2831. **E. H. Colpitts and H. de F. Arnold** [Western Electric Company]. Radiotelephone Transmitter. (*U.S. Patent* 1388450, September 3rd, 1915. Patent granted August 23rd, 1921.)

High-frequency oscillations of feeble amplitude are generated at the transmitter and these feeble oscillations modulated while in their feeble state. These feeble modulated oscillations are then amplified both in voltage and amperage to sufficient power for effective transmission.

(5) MAGNETIC MODULATORS.

2832. **General Electric Company, U.S.A. [British Thomson-Houston Company].** Controlling Apparatus for Radio Transmitters. (*British Patent* 148758, July 9th, 1920. Convention date October 14th, 1913. Patent not yet accepted.)

In a method of controlling the amplitude or frequency, or both, of the emitted waves, the value of an inductance in the aerial or oscillation circuit, or in both, is varied by the speech currents. The inductance has one or more high-frequency windings and the direct-current windings, one of which is supplied with steady current and the other with speech currents. Transformer action between the high and low-frequency windings is prevented by the method of winding.

2833. **Allgemeine Elektrizitäts-Gesellschaft.** Inductances. (*British Patent* 149236, July 12th, 1920. Convention date September 17th, 1914. Patent not yet accepted.)

A short circuited winding is provided for the purpose of protecting the windings or the apparatus connected thereto from undesired voltages of double frequency.

2834. **Gesellschaft für drahtlose Telegraphie.** Wireless Signalling. (*British Patent* 147430, July 7th, 1920. Convention date December 24th, 1915. Patent not yet accepted.)

Magnetic modulation of waves generated by a Poulsen arc, by exciting one winding of a

* See RADIO REVIEW Abstract No. 1987.

cloud iron transformer—with which the arc circuit is coupled to the aerial—by a low-frequency alternator.

2835. **Gesellschaft für drahtlose Telegraphie.** Controlling or Modifying High-frequency Currents. (*British Patent* 157408, January 10th, 1921. Convention date December 27th, 1919. Patent not yet accepted.)

A means of varying the frequency and voltage of the output of a source of alternating current by means of an easily variable inductance controlled by the modulating microphone.

2836. **General Electric Company, U.S.A. [British Thomson-Houston Company].** Wireless Signalling. (*British Patent* 154247, May 27th, 1919. Patent accepted November 29th, 1920.)

In a method of controlling the amplitude of the emitted waves by varying the effective resistance of the aerial circuit without varying its natural frequency, the depression of the signalling key varies the saturation of one or more magnetic amplifiers.*

(6) ELECTROSTATIC MODULATORS.

2837. **J. Massolle, H. Vogt and J. Engl.** Wireless Telephone Apparatus. (*British Patent* 157748, January 10th, 1921. Convention date March 3rd, 1919. Patent not yet accepted.)

An oscillating valve is differentially coupled to the output oscillation circuit, and the transfer of energy to this circuit is controlled by a condenser having a flexible armature between two fixed plates. The sound waves directly influence this diaphragm for telephonic transmission.

2838. **E. Waltz and H. Meusser.** Reproducing Sounds. (*British Patent* 157942, January 10th, 1921. Convention date December 22nd, 1919. Patent not yet accepted.)

Variations of potential applied to a condenser vary its capacity and hence control the thermionic valves.

(7) SPECIAL MICROPHONE APPARATUS.

2839. **O. Angelini.** Microphone. (*French Patent* 506385, November 19th, 1919. Published August 20th, 1920.)

2840. **L. van Rutten [Western Electric Company].** Telephone Transmitters. (*British Patent* 144698, June 10th, 1920. Convention date June 22nd, 1914. Patent accepted January 20th, 1921.)

A microphone transmitter of the granular type.

2841. **H. J. Palmer and Telephone Manufacturing Company.** Microphones. (*British Patent* 159609, December 2nd, 1919. Patent accepted March 2nd, 1921.)

2842. **B. F. Miessner [Miessner Inventions Corporation].** Telephone Transmitters. (*British Patent* 146105, June 17th, 1920. Convention date June 23rd, 1919. Patent accepted May 26th, 1921.)

Relates to microphonic transmitters in which the sound is admitted to both sides of the diaphragm to nullify the effects of disturbing sounds.

2843. **A. Thomas.** Microphones. (*British Patent* 154729, September 11th, 1919. Patent accepted December 9th, 1920.)

2844. **J. S. Timmons.** Microphones. (*British Patent* 152761, July 18th, 1919. Patent accepted October 18th, 1920.)

Microphonic apparatus specially adapted to noisy situations.

2845. **E. F. Huth and S. Loewe.** Microphones. (*British Patent* 148312, July 9th, 1920. Convention date December 31st, 1915. Patent accepted October 10th, 1921.)

Relates to diaphragmless microphones for use in noisy places.

2846. **E. F. Huth and S. Loewe.** Microphones for Wireless Telephony. (*British Patent* 148313, July 9th, 1920. Convention date November 28th, 1916. Patent not yet accepted.)

Deals with the application of diaphragmless microphones as described in the preceding Abstract to wireless telephone transmitters on aircraft.

* See *British Patent* 7151/13.

2847. **C. H. Pritchard** and **J. Mangles**. Microphone Transmitter. (*British Patent* 156354, October 20th, 1919. Patent accepted January 13th, 1921.)
2848. **C. Kearton** and **G. B. Riley**. Microphones. (*British Patent* 156403, December 19th, 1919. Patent accepted January 13th, 1921.)
2849. **R. L. Murray** [Telephone Manufacturing Company]. Microphones. (*British Patent* 151336, June 18th, 1919. Patent accepted September 20th, 1921.)
Microphones for use in noisy places are fastened to the speaker's throat or neck.
2850. **H. Vogt, J. Engl** and **J. Massolle**. Telephony. (*British Patent* 157442, January 10th, 1921. Convention date August 2nd, 1919. Patent accepted September 22nd, 1921.)
An arrangement whereby the distances between an anode and heated cathode are varied by speech vibrations impressed on a diaphragm which may carry the anode plate, or by other suitable means.
2851. **W. K. L. Dickson**. Microphones. (*British Patent* 154335, August 26th, 1919. Patent accepted November 26th, 1920.)
The capsules of a microphone are of special design and geometrically arranged to ensure a constant number of contacts in operation and to prevent jamming.
2852. Anti-noise Telephone for Motor Ships. (*Technical Review*, 9, p. 186, June 21st, 1921.)
Describes an anti-noise transmitter so constructed as to allow extraneous sound-waves equally free access to both sides of the diaphragm. Being thus, as it were, in sound equilibrium, the diaphragm is free to vibrate solely to the directed sound-waves from the lips of the operator impinging against one side only.
2853. **Signal Gesellschaft m.b.H.** Telephony. (*French Patent* 512573, February 26th, 1916. Published January 26th, 1921.)
The transmitter of a telephone is divided into compartments by a grid formed of plush so arranged that the fibres are all inclined in one direction in relation to the electrodes. To prevent fraying of the edges when cutting, the plush is gummed to a paper back. (For further particulars see *British Patent* 100156.)

(8) TIME SIGNALLING APPARATUS.

2854. **A. Gradenwitz**. Nauen Time Signal Radio Service. (*Radio News*, 3, pp. 12 and 78, July, 1921.)
Illustrated description of the apparatus.

(9) AND (10) RELAYING APPARATUS (WIRE TO RADIO AND RADIO TO RADIO).

2855. Radiophone—Telephone Linking. (*Q.S.T.*, 4, pp. 21—22, November, 1920.)
2856. **Western Electric Company**. Telephone Relaying Systems. (*British Patent* 143949, January 29th, 1919. Patent accepted July 31st, 1920, and 144152, September 2nd, 1919. Patent accepted June 10th, 1920.)
Relates to means for controlling valve relaying apparatus over telephone lines.
2857. **A. B. Clark** [Western Electric Company]. Telephone Receiver. (*British Patent* 144293, June 2nd, 1920. Convention date September 20th, 1918. Patent accepted October 28th, 1920.)
2858. **A. B. Clark** [Western Electric Company]. Telephone Repeaters. (*British Patent* 149331, July 19th, 1920. Convention date July 31st, 1919. Patent accepted September 22nd, 1921.)
Relates to an arrangement of valve telephone repeaters to avoid singing of the repeater when the input and output circuits are unbalanced.
2859. **Western Electric Company**. Telephone Repeating Apparatus. (*British Patent* 149139, September 1st, 1919. Patent accepted August 12th, 1920.)
Relates to thermionic valve repeaters.
2860. **E. A. Graham, W. J. Rickets** and **E. A. Sauffleben**. Telephone Repeaters. (*British Patent* 151118, July 4th, 1919. Patent accepted September 23rd, 1920.)

2861. **Western Electric Company.** Telephone Repeaters and Filters. (*British Patent* 151140 August 5th, 1919. Patent accepted September 23rd, 1920.)
2862. **C. Robinson and R. M. Chamney.** Telephone Repeaters. (*British Patent* 145869, April 1st, 1919. Patent accepted July 2nd, 1920.)
Deals with the design of the transformers for valve repeaters.
2863. **R. Fiedler and K. Hopfner.** Relaying Apparatus. (*British Patent* 158536. November 23rd, 1920. Convention date February 5th, 1920. Patent not yet accepted.)
Relaying apparatus for coupling wire and wireless circuits or wire to high-frequency wire telephone circuits.
2864. **M. Latour.** Telephone Repeaters. (*British Patent* 147756, July 8th, 1920. Convention date May 23rd, 1919. Patent not yet accepted.)
2865. **M. Latour.** Thermionic Repeaters. (*British Patent* 147759, July 8th, 1920. Convention date June 25th, 1915. Patent not yet accepted.)
Repeater arrangements to reduce the effects of disturbances.
2866. **Western Electric Co.** Repeaters. (*British Patent* 149858, October 3rd, 1919. Patent accepted August 26th, 1920.)
2867. **Siemens and Halske Akt. Gesellschaft.** Telephone Repeaters. (*British Patent* 153301, November 1st, 1920. Convention date October 31st, 1919. Patent not yet accepted.)
2868. **Automatic Telephone Manufacturing Co., Ltd. and H. H. Harrison.** High-frequency Electric Signalling Systems. (*British Patent* 157556, October 20th, 1919. Patent accepted January 20th, 1921.)
A repeating arrangement for use in telegraph or telephone stations, a number of carrier waves being employed for transmission of messages in both directions simultaneously. Thermionic valve amplifiers are employed.
2869. **G. Crisson** [Western Electric Company]. Thermionic Telephone Repeaters. (*British Patent* 145578, June 29th, 1920. Convention date May 20th, 1919. Patent accepted November 4th, 1920.)
2870. **F. Trives.** Long Distance Telephony. (*Bulletin de la Société Française des Électriciens*, 1 (4th series), pp. 109—124, March, 1921.)
A description of a demonstration of the Western Electric Company's thermionic valve telephone repeaters.
2871. **B. Rosenbaum** [E. F. Huth Gesellschaft]. Wireless Repeating Apparatus. (*British Patent* 149235, July 12th, 1920. Convention date August 18th, 1917. Patent not yet accepted.)
In a relaying system for use in wireless, automatically working intermediate stations are provided which transmit the message from the first transmitting station to the final receiving station or to a second automatic intermediate station.
At the intermediate station the incoming message is stored up on a species of telegraphone, and at the end of each message a special call is sent which operates the necessary relays for changing over the intermediate station from receiving to sending, and the message is then retransmitted automatically from the record on the magnetised steel wire of the telegraphone.

(11) AND (12) COMPARISON OF MODULATION METHODS, SPEECH WAVEFORMS, ETC.

2872. **A. S. Blatterman.** Comparison of Modulation Methods in Radiotelephony. (*Radio News*, 2, pp. 360—362, December, 1920; pp. 438—440, January, 1921. *Radioélectricité*, 1, p. 115D, April, 1921—Abstract.)

The author deduces a formula for the detector response to modulated waves and concludes from it that the received telephone current is proportional to the product of the amplitude of the unmodulated C.W. and the modulating waves. Using this as a basis absorption and constant current methods of modulation are compared with each other and with the method using an amplifier between the modulated oscillation generator and the aerial. He concludes that modulation by absorption or detuning is only half as effective as constant current modulation; that four times as many valves are required for absorption modulation as for power

modulation in order to produce the same effect; and that amplification of the modulated output of an oscillator may result in distortion unless the amplifier is carefully designed.

2873. **V. Cheval.** Why is there a Limit to the Audibility of Sounds? (*Bulletin de la Société Belge des Électriciens*, 35, pp. 55—72, March—April, 1921.)

2874. **E. Lübke.** The Shortest Detectable Duration of a Tone. (*Zeitschrift für technische Physik*, 2, pp. 52—53, February, 1921. *Science Abstracts*, 24A, p. 362, Abstract No. 900, May 31st, 1921—Abstract.)

Experiments in air and water showed that the number of periods necessary for the detection of the tone varied with the pitch as follows:— $f = 500$, 5 periods; $f = 1,000$, 9 periods; $f = 2,000$, 15 periods. In two places in the paper 10^{-2} seconds should obviously be 10^{-3} seconds.

2875. **P. Edwards; E. W. Scripture.** The Nature of Vowel Sounds. (*Nature*, 108, pp. 82—83, September 15th, 1921.)

Further correspondence relative to the article referred to in Abstract No. 1647, April, 1921. (See also Abstract No. 1969, June, 1921.) The letters discuss the meaning of the term "fundamental" and the harmonic analysis of speech wave form.

(H.) Radio Receiving Apparatus.

(1) RECEIVING CIRCUITS; GENERAL DESCRIPTIONS, ETC.

2876. **A Radio Receiver for Everybody.** (*Scientific American*, 124, p. 354, April 30th, 1921.)

A short illustrated description of a time signal receiver with crystal detector.

2877. **Compact Audion Control Unit.** (*Science and Invention*, 9, p. 50 and p. 84, May, 1921.) An illustrated description.

2878. **L. C. F. Horle.** Navy Receiving Equipment. (*Q.S.T.*, 3, pp. 12—14, July, 1920; 4, pp. 8—10, August, 1920.)

Paper presented to the Radio Club of America describing receiving sets used in the U.S. Navy.

2879. **A. H. Lynch.** A New Universal Range Receiver. (*Radio News*, 2, p. 681, April, 1921.)

An illustrated description of a four-valve receiver and amplifier having a range of wavelengths from 150 to 20,000 metres manufactured by **A. H. Grebe Company**.

2880. **A. G. Shalkhauser.** An Ideal Receiving Set for Short and Long Wavelengths. (*Radio News*, 2, pp. 692—732, April, 1921.)

2881. **E. Spon.** A Combined Short and Long Wave Receiver. (*Radio News*, 2, pp. 597 and 656, March, 1921.)

2882. **H. St. J. de A. Donisthorpe** [R. M. Radio, Ltd.]. Wireless Receiving Apparatus. (*British Patent* 160981, January 14th, 1920. Patent accepted April 7th, 1921.)

Describes a portable receiving set constructed in the form of a book, flat spirals being mounted in each cover and tuning effected by varying the angle between them and hence their mutual inductance. The detector is mounted in the hinge of the book.

2883. **J. Robinson and H. L. Crowther.** Wireless Receiving Apparatus. (*British Patent* 159377, December 17th, 1919. Patent accepted March 3rd, 1921. *Engineer*, 131, p. 337, March 25th, 1921—Abstract.)

In wireless receiving apparatus the pitch of the note heard in the telephones is controlled by means of a condenser the capacity of which is varied by electromagnetic means controlled by the intensity of the received signals. The condenser may be in the grid circuit (shunted by a leak) of an oscillating valve, so as to change the period of interruption of the oscillations by the grid leak, or may form part of one of the oscillation circuits so that the heterodyne beat note is changed.

2884. **H. P. Rees.** Wireless Receiving Apparatus. (*British Patent* 158455, January 5th, 1920. Patent not yet accepted.)

Relates to the arrangement of compact inductances in receiving units, the inductances

being wound in many layers of short axial length. The separate wavelength ranges may be made up in different units.

2885. **W. J. Picken** and **J. G. Robb**. Wireless Receiving Systems. (*British Patent* 158707, November 11th, 1919. Patent accepted February 11th, 1921. *Engineer*, 131, p. 337, March 25th, 1921—Abstract. *Jahrbuch Zeitschrift für drahtlose Telegraphie*, 18, pp. 219—220, September, 1921—Abstract.)

When reception takes place on aerials at a distance from the central common receiver, the received oscillations are amplified before transmission over the land lines so as to reduce the influence of the receptive properties of the land lines themselves.

2886. **E. F. Huth** and **S. Loewe**. Wireless Receiving Apparatus. (*British Patent* 148321, July 9th, 1920. Convention date December 20th, 1915. Patent not yet accepted.)

The wireless receiving apparatus is divided up into a number of separate units, some of which can be changed for altering the wavelength range of the set.

2887. **E. E. Frankis**. Wireless Receiving Apparatus. (*British Patent* 152386, June 13th, 1919. Patent accepted October 13th, 1920. *Jahrbuch Zeitschrift für drahtlose Telegraphie*, 18, pp. 215—216, September, 1921—Abstract.)

To reduce interference from undesired signals the receiving aerial circuit is provided with two earth connections, one containing the usual coupling coil to the receiver and in addition a coupling to an auxiliary tunable circuit, and the second including a variable condenser. By appropriate adjustments it is claimed that the interfering wave can be cut out.

2888. **R. A. Weagant** [Radio Corporation, U.S.A.]. Wireless Receiving Apparatus. (*British Patent* 146529, July 5th, 1920. Convention date June 18th, 1914. Patent accepted October 29th, 1921.)

Relates to a receiver with circuits tuned to the acoustic group frequency.

2889. **J. J. Aurynger**. Receiving Apparatus. (*French Patent* 507827, March 25th, 1919. Published September 24th, 1920.)

The invention relates to induction apparatus for setting in motion high-frequency oscillations in local circuits. It includes a condenser which comprises an exhausted glass tube having therein a heated filament. The condenser plates are of aluminium and have a central hole through which the filament passes.

2890. **N. Lea** [Radio Communication Company]. Wireless Receiving Apparatus. (*British Patent* 151848, November 6th, 1919. Patent accepted October 7th, 1920.)

Relates to an indicating mechanism geared to the inductance tapping switch and to the variable condenser, so that the wavelength to which the circuit is tuned is always indicated on the scale. The scale is changed with the inductance switch, and the pointer is moved by the condenser.

2891. **Gesellschaft für drahtlose Telegraphie**. Wireless Receiving Apparatus. (*British Patent* 152036, October 7th, 1920. Convention date October 8th, 1919. Patent not yet accepted.)

In a receiver suitable for use both with a frame antenna and a vertical antenna means are provided for compensating for the capacity of the vertical antenna when the frame is employed.

2892. Wireless Receiving Apparatus—System M.W.B. (*L'Électricité pour Tous*, 3, pp. 165—166, June 30th, 1921.)

A short illustrated description of multi-valve receiving and amplifying apparatus manufactured by **M. de Woutres**.

2893. **M. Moye**. The use of Commercial Supply Systems in Wireless Receiving Stations. (*La Nature*, 49(1), pp. 405—407, June 25th, 1921. *Radio News*, 2, p. 863, June, 1921—Abstract. Also *Wireless World*, 9, p. 103, May 14th, 1921.)

Deals with the use of 110-volt D.C. supply mains for feeding the anode circuits of valve amplifiers.

2894. **A. H. Lynch**. Working Two Radio Watches at the same Time. (*Science and Invention*, 9, pp. 248 and 280, July, 1921.)

Describes an automatic switch arrangement for enabling a single operator to maintain watch of two wavelengths simultaneously.

2895. A Receiving Tuner for C.W. (*Q.S.T.*, 4, pp. 5—7, June, 1921.)
An illustrated description.
2896. **K. Richardson.** A High Efficient Super-portable Receiver. (*Radio News*, 2, p. 767, May, 1921.)
An illustrated description of a pocket receiving apparatus.
2897. **C. T. Atkinson.** The Design and Construction of an Efficient Detector Amplifier. (*Wireless World*, 8, pp. 588—590, November 13th, 1920. *Radio News*, 2, p. 772, May, 1921—Abstract.)
2898. **F. J. Rumford.** Reaction Valve Circuits. (*Wireless World*, 9, pp. 69—70, April 30th, 1921.)
Some useful receiving circuits for amateur use.
2899. **J. Robinson.** Some Acoustical Effects in Wireless. (*Wireless World*, 9, pp. 71—78, April 30th, 1921.)
A paper read before the Wireless Society of London with discussion. (See RADIO REVIEW, 2, p. 248, May, 1921, for abstract.)
2900. **F. J. Rumford.** A Simple and Efficient Short Wave Regenerative Receiver. (*Radio News*, 2, pp. 526—527, February, 1921.)
2901. **H. K. Dunn.** Using an Amplifier as a Detector of Long Waves. (*Radio News*, 2, p. 528, February, 1921.)
Relates to the use of an audio-frequency amplifier for direct reception of long wavelength signals.
2902. **L. H. Nijhof.** The Use of Bell Transformers for Heating Filaments of Valves. (*Radio Nieuws*, 4, pp. 243—245, August, 1921.)
An amateur with a 220-volt A.C. supply has replaced his accumulators by 220/5-volt bell transformers. In parallel with the filament are two small 4-volt lamps in series and the grid and anode tapping is made to their middle point.
2903. **G. A. Beauvais.** A Contribution to the Study of Detectors. (*La T.S.F. Moderne*, 2, pp. 161—166, August, 1921.)
A general discussion of the properties of detectors from the point of view of their characteristics.
2904. **F. Duroquier.** The Construction of Radio Detectors. (*La Nature*, 49(2), Supplement pp. 23—25, July 23rd; pp. 31—32, July 30th; and pp. 37—43, August 6th, 1921.)
Describes a mode of building three-electrode valves and gives many circuit diagrams of their uses.
2905. **J. S. Brown.** Short Wave Tuning Systems. (*Radio News*, 3, p. 18, July, 1921.)
2906. **G. Hild.** Single Circuit Audion Receiver. (*Radio and Model Engineering*, 1, pp. 4—8, May, 1921.)
2907. **W. H. Bullock.** A Real Receiving Equipment. (*Radio and Model Engineering*, 1, pp. 13—17, July, 1921.)
An illustrated description of a three-valve receiver giving constructional details of the parts.
2908. **P. F. Godley.** Simplified *versus* Three Circuit Regenerative Receivers. (*Q.S.T.*, 5, pp. 7—9, September, 1921.)
2909. **F. E. Pernot.** Receiving Circuit for Frequency Selection. (*Wireless Age*, 8, pp. 20—21, April, 1921.)
Deals with the use of special grouped frequency selective circuits for connection in the anode circuit of a detecting valve.
2910. **M. Moyer.** Wireless Receiving Stations using Alternating Currents only. (*Annales des Postes, Télégraphes et Téléphones*, 10, pp. 396—400, September, 1921.)
A detailed description of means for overcoming the difficulties inherent to the use of an A.C. supply for feeding the L.T. and H.T. circuits of receiving valve amplifiers.

2911. **M. Adam.** The Use of Alternating Current in Radiotelegraphic Receivers. (*Radio-électricité*, 2, pp. 137—139, September, 1921.)

Circuit diagram is given of the suggested arrangement with oscillograms of the currents in various circuits.

2912. **H. St. J. de A. Donisthorpe.** Portable Radio Telegraphic and Telephonic Apparatus. (*U.S. Patent* 1388936, April 28th, 1920. Patent granted August 30th, 1921.)

See corresponding *British Patent* 160981—**RADIO REVIEW** Abstract No. 2882.

2913. A Single Control Universal Range Receiver. (*Radio News*, 3, p. 205, September, 1921.)

Gives constructional details.

2914. **F. J. Rumford.** Practical V.T. Detector and Two-stage Amplifiers. (*Radio News*, 3, p. 204, September, 1921.)

Gives constructional details.

2915. **J. Scott-Taggart.** Thermionic Detectors. (*British Patent* 166237, July 28th, 1919. Patent accepted July 11th, 1921.)

A special circuit involving the use of two three-electrode tubes coupled to a common telephone circuit. The device is said to act as a limiter.

2916. **W. J. Henry.** Transatlantic Reception *par Excellence*. (*Radio News*, 3, p. 283, October, 1921.)

A short illustrated description of the U.S. Navy Receiving Station at Otter Cliffs.

(2) CRYSTAL AND MISCELLANEOUS DETECTORS AND RECEIVERS.

2917. **R. Dongier.** Contact Detectors. (*Comptes Rendus*, 171, pp. 238—240, July 26th, 1920. *Science Abstracts*, 23A, p. 659, Abstract No. 1650, December 30th, 1920—Abstract.)

Using a crystal contact detector, the point being attached to a diaphragm, a species of telephone was constructed which could be used as an auto-detector in a wireless telegraph or telephone set. Two effects are apparently present, the ordinary rectifying effect and the effect which gives rise to the production of sound.

2918. **A. N. Goldsmith** and **E. T. Dickey.** Radio Taste Reception. (*Proceedings of the Institute of Radio Engineers*, 9, pp. 206—224, June, 1921. *Electrical Review*, 188, pp. 10—11, January 7th, 1921—Abstract. *Popular Science Monthly*, 99, p. 35, August, 1921—Abstract. *Radio News*, 2, p. 363, December, 1920—Abstract. *Electrical World*, 78, p. 131, July 16th, 1921—Abstract. *Science Abstracts*, 24B, p. 463, Abstract No. 928, September 30th, 1921—Abstract.)

Describes experiments made to determine the feasibility of reception of radiotelegraphic signals by the sense of taste. Silver electrodes were used one of which made contact with the inner part of the upper lip of the operator and the other with the tip of his tongue. With a direct current circuit it was found that the observer could detect a potential difference across the electrodes of 0.4 volt. A potential difference of 2.0 volts was considered sufficient for the transmission of signals. With an alternating current circuit these values were not very much different, but the element of fatigue did not seem to be so noticeable and the taste sensation appeared to be more continuous.

In actual experiments using radio reception and 4-stage amplification, it was found possible to detect signals the audibility of which in the detector circuit was 500 or more. It was also found possible to tune in a station by noting when the intensity of the taste sensation was a maximum. But for messages to be read the speed must not be greater than ten words a minute.

(See also **RADIO REVIEW** Abstract No. 1377, January, 1921.)

2919. The "Excentro" Detector. (*La Nature*, 49(1), Supplement p. 139, April 30th, 1921.)

A short illustrated note describing a completely enclosed type of crystal detector.

2920. **R. Pedegert.** Crystal Detector. (*French Patent* 507108, December 5th, 1919. Published September 6th, 1920.)

The detector is one in which the known properties of galena are employed in a novel manner. The device consists of a container partly filled with mercury and hermetically closed by a plug

of insulating material through which pass two terminals on the inner ends of which are carried galena crystals, which dip into the mercury.

2921. **A. Turpain.** On the Detection of Hertzian Waves. (*Revue Générale de l'Électricité*, 8, p. 513, October 16th, 1920.)

Correspondence with regard to the first invention of a microphonic detector for Hertzian waves. Experiments made by the writer in November, 1894, are quoted.

2922. **R. Audubert.** Rectification at Solid Contacts. (*Journal de Physique*, 7, pp. 209—223, November—December, 1917. *Science Abstracts*, 24A, p. 298, Abstract No. 718, April 30th, 1921—Abstract.)

Describes an investigation of the phenomena of rectification for mixtures of bodies which present in the pure state very different characteristics. Pure materials were mixed together in known proportions and then fused, sulphur being added to prevent oxidation. The resulting solid was then used with a metal point to which various small pressures could be applied.

It was found that the sensibility passes through a minimum value for a mixture corresponding approximately to the eutectic. Curves are also given showing the effect of variation of the pressure on the contact. The results show that pressure, temperature and current across the contact all produce the same effects, a cohering action taking place.

2923. **J. Zenneck.** The Sluggishness of Thermal Detectors. (*Jahrbuch Zeitschrift für drahtlose Telegraphie*, 17, pp. 162—179, March, 1921. *Technical Review*, 9, p. 172, June 14th, 1921—Abstract. *Science Abstracts*, 24B, pp. 364—365, Abstract No. 753, July 30th, 1921—Abstract. *Radioélectricité*, 1, pp. 137D—139D, June, 1921—Abstract.)

A theoretical investigation of the effect of varying degrees of sluggishness on the reception of signals of different kinds both with groups of damped waves and with continuous waves, either direct or with heterodyne.

2924. **A. Bonnefont.** Crystal Detectors for Wireless Signals. (*British Patent* 157778, January 10th, 1921. Convention date November 13th, 1919. Patent not yet accepted.)

Relating to crystal detectors where, in order to facilitate selection of contact point, a searching point can be rotated relatively to the crystal by means of one or more eccentrics.

2925. **S. Oulianine.** Tuned Receiving Apparatus. (*British Patent* 148586, January 29th, 1919. Patent accepted July 29th, 1920.)

Relates to a selective filter based on the audio-frequency tuning of a stretched wire.

2926. **H. M. Dowsett.** Crystal Detector. (*British Patent* 163448, February 14th, 1920. Patent accepted July 17th, 1921. *Engineer*, 132, p. 28, July 1st, 1921—Abstract.)

Relates to the mounting of crystals for detectors.

2927. **E. Wilson.** On Magnetic Detectors. (*Wireless World*, 9, pp. 170—174, June 11th, 1921.)

A paper read before the King's College Wireless Society. The author describes the theory of the magnetic detector, and gives the history of its development. The author suggests the possibility of a further usefulness for the magnetic detector if it is found possible to apply to it a trigger control action to function in a similar manner to the grid of the three-electrode valve.

2928. A New Crystal Detector. (*Radio News*, 3, p. 102, August, 1921.)

2929. **C. Tubandt.** Uni-directional Ionic and Mixed Conductivity in Crystals. (*Electrochemische Zeitschrift*, 26, pp. 358—363, September 1st, 1921. *Science Abstracts*, 24A, pp. 576—577, Abstract No. 1466, August 31st, 1921—Abstract.)

(3) ELECTRON TUBE DETECTORS AND RECEIVERS.

2930. **L. M. Clement.** The Vacuum Tube as a Detector and Amplifier. (*Q.S.T.*, 3, pp. 5—9, April; pp. 11—15, May, 1920.)

2931. **J. Scott-Taggart.** Thermionic Valve Receiving Apparatus. (*British Patent* 153681, August 14th, 1919. Patent accepted November 15th, 1920.)

Arrangements of double grid receiving valves are described in which one of the grids is

coupled to the receiving aerial circuit while the second is retroactively coupled to the plate circuit for regenerative amplification or heterodyne oscillation generation.

2932. **J. Robinson, A. K. Macrorie, C. P. Grenfell and H. Morris-Airey.** Wireless Reception Apparatus. (*British Patent* 153690, August 18th, 1919. Patent accepted November 18th, 1920.)

An arrangement of receiver is described in which the intensity of the received waves is caused to control the pitch of the note heard in the telephone. For this purpose the oscillating thermionic valve is employed, the oscillations generated having a group frequency which is audible in a telephone in the plate circuit, and which is dependent upon the value of the leak resistance in this grid circuit. This leak resistance is formed by a second three-electrode valve which is connected to the receiving circuits. The apparatus is particularly applicable to direction finding systems.*

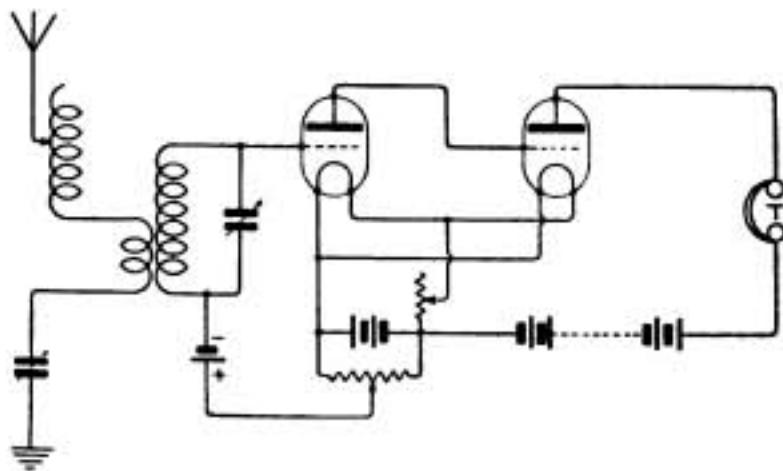


FIG. 2.

2933. **F. W. B. Gill.** Wireless Receiving Apparatus. (*British Patent* 155642, September 22nd, 1919. Patent accepted December 22nd, 1920. *Engineer*, 131, p. 137, February 4th, 1921—Abstract. *Wireless Age*, 8, p. 23, July, 1921—Abstract.)

One of the suggested arrangements is indicated in Fig. 2.

2934. **General Electric Company, U.S.A. [British Thomson-Houston Company].** Wireless Receiving Apparatus. (*British Patent* 160941, December 31st, 1919. Patent accepted March 31st, 1921.)

A thermionic valve with a tuned grid circuit and a retroactively coupled plate circuit is started into self-oscillation when waves of the proper frequency are received in the aerial circuit. The change in the steady component of the plate current thus produced destroys the balance in a Wheatstone bridge circuit by altering the potential of the grid of a valve forming one arm of the bridge. The bridge is supplied from a source of audible frequency currents, so that when a signal is received they produce a sound in the receiving telephones connected to the bridge.

2935. **E. O. Hulbert and G. Breit.** The Detecting Efficiency of the Single Electron Tube. (*Jahrbuch Zeitschrift für drahtlose Telegraphie*, 17, pp. 119—132, February, 1921. *Radioélectricité*, 2, pp. 30—50, July, 1921—Abstract. *Science Abstracts*, 24B, pp. 269, 270, Abstract No. 540, May 31st, 1921—Abstract. *Revue Générale de l'Électricité*, 9, pp. 183D—184D, June 4th, 1921—Abstract.)

See RADIO REVIEW Abstract No. 1902, June, 1921, for original paper.

2936. **E. F. Huth.** Wireless Receiving Apparatus. (*British Patent* 149240, July 12th, 1920. Convention date October 13th, 1917. Patent not yet accepted.)

In a thermionic receiver for wireless the incoming energy is applied to the anode of

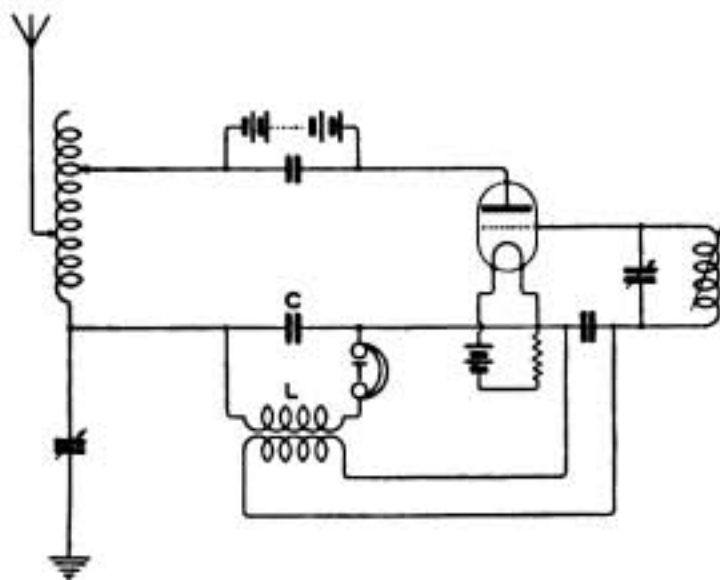


FIG. 3.

* See RADIO REVIEW, 2, p. 248, May, 1921, for further references to this arrangement.

the valve. Low-frequency amplification of the rectified impulses may also be obtained in the manner indicated in Fig. 3. The circuit CLT is tuned to the group frequency of the signals.

2937. **S. Loewe.** Wireless Receiving Apparatus. (*British Patent 149237*, July 12th, 1920. Convention date April 18th, 1918. Patent not yet accepted.)

A modification of the arrangement described in RADIO REVIEW Abstract No. 2938, and using an indirect coupling between the output of the first reversed valve and the input of the amplifier (Fig. 4).

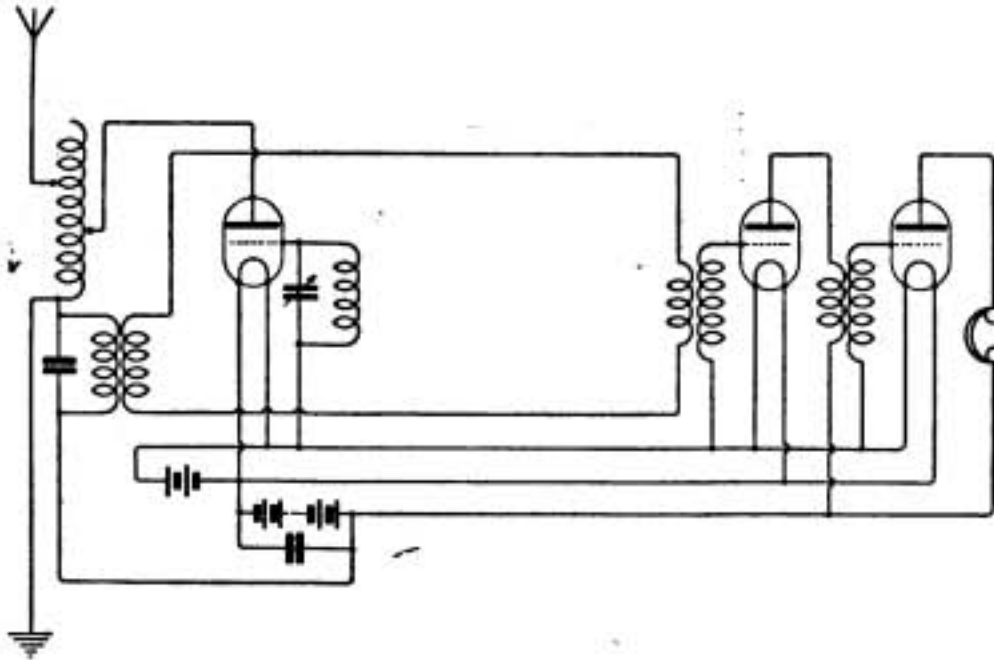


FIG. 4.

2938. **S. Loewe.** Wireless Receiving Apparatus. (*British Patent 149218*, July 12th, 1920. Convention date April 18th, 1918. Patent not yet accepted.)

In thermionic valve apparatus for receiving wireless signals the received oscillations are led to the anode of the receiver, and the output energy is taken from the grid circuit of the receiver. This minimises retroactive self-oscillation. The suggested arrangement is shown in Fig. 5, in which v_1 is the first valve having its anode connected to the aerial circuit and its grid joined to the input circuit of the next valve.

2939. **A. Williams and H. St. J. de A. Donisthorpe** [R. M. Radio, Ltd.]. Thermionic Valve Receivers. (*British Patent 159679*, December 16th, 1919. Patent accepted March 10th, 1921.)

Relates to a receiver comprising a number of valve units which may be joined in cascade by appropriate plug connections.

2940. **J. Robinson and H. L. Crowther.** Wireless Receiving Apparatus. (*British Patent 159683*, December 17th, 1919. Patent accepted March 10th, 1921.)

An addition to *British Patent 153690* * in which the intensity of the incoming signals is arranged to vary the resistance connected to an oscillation circuit. Two oscillating valves are

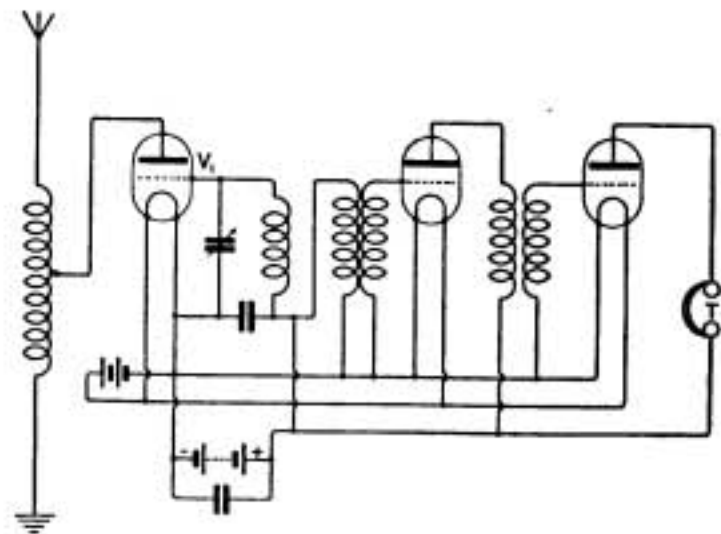


FIG. 5.

* RADIO REVIEW Abstract No. 2932.

used so that the resistance change produced by the incoming signal alters the pitch of the beat note.

2941. **J. Robinson** and **H. L. Crowther**. Wireless Receiving Apparatus. (*British Patent* 159959, December 5th, 1919. Patent accepted March 7th, 1921.)

In a C.W. receiving system a valve oscillating at an audible frequency is arranged to affect the grid potential of the receiving valve so that the positive peaks of the L.F. oscillations just bring the receiving valve to the detecting point.

2942. **R. A. Weagant** [Radio Corporation of America]. Valve Oscillation Generator. (*U.S. Patent* 1384108, April 8th, 1914. Patent granted July 12th, 1921.)

Means for generating electrical oscillations for receiving purposes, comprising a vacuum tube oscillator circuit in which an adjustable non-inductive resistance is connected between two of the electrodes of the vacuum tube.

2. Books.

THERMIONIC TUBES IN RADIOTELEGRAPHY AND TELEPHONY. By John Scott-Taggart. (London: *The Wireless Press, Ltd.* 1921. Pp. xxiii + 424. $8\frac{1}{2}'' \times 5\frac{1}{2}''$. Price 25s. net.)

Although the title of this book gives the impression that the tubes dealt with are for radiotelegraphic and telephonic purposes only, the information contained therein is found to cover the use of thermionic tubes for practically all the known purposes to date.

For the beginner in thermionic tube or thermionic valve work (as it is usually termed in this country) the elementary theory of thermionic currents given in Chapter I. will be found of great value.

In this chapter the two-electrode valve principles are extensively and carefully treated in such a way as to prepare the student for the more complicated forms and characteristics of the three-electrode and other valves.

Chapter II. is devoted to three-electrode valve theory and contains a large number of useful characteristic curves together with diagrams of the circuits used in obtaining these characteristics.

The valve as a detector and as an amplifier is dealt with in Chapters III. and IV. respectively.

The curves given in Chapter III. of the detector valve have been prepared in a most comprehensive manner.

Retroactive amplification theory and practice is skilfully explained in Chapter V. and the complete set of diagrams of reactively coupled circuits cover most of those in use.

Chapters VI., VII. and VIII. deal with high and low-frequency amplifiers in an able manner, giving no superfluous mathematical equations. This will be appreciated more by the beginner and practical student than by the academically inclined.

The reception of continuous waves with circuit diagrams is described in Chapter X.

Separate heterodyne and auto-heterodyne reception is fully dealt with, but no mention is made of the earlier methods of C.W. reception which include tikker or chopper circuits. As valve heterodyne or beat reception is approximately twenty-five times as sensitive as the older systems the omission of any of these cannot be considered serious.

Valve transmitting systems for C.W. and telephony are diagrammatically illustrated and described in Chapters XI. and XIII. These chapters include useful historical references to the many patented systems.

The distance ranges, comparative and actual, of the various transmitting systems have not been attempted in this volume. This is perhaps a drawback as it is as necessary to have an approximate idea of the transmitting and receiving range of the apparatus as to know how it functions, even though it must be admitted that local conditions play as important a part as actual transmitting and receiving efficiency.

The dynatron and miscellaneous valve devices including Turner's relay are briefly treated in Chapters XIV. and XV.

It is a book that can be recommended to all classes of physical and wireless students.

W. A. APPLETON.

LES TUBES À VIDE. By Paul Dapsence. (Paris: *G. Péricaud*. Second Edition. 1921. Pp. 50. 8 $\frac{1}{2}$ " \times 5 $\frac{1}{2}$ ". Price fr. 2.50.)

A general instructional book primarily written for the amateur, it has chapters devoted to Ionic Electricity, the General Properties of Vacuum Tubes, General Theory, and Practical Sets.

The explanations are helped by reference to the characteristic curves of the valves, and all mathematics is excluded. Numerous circuit diagrams are given for different arrangements of high and low-frequency amplifiers, and a few illustrations of commercial instruments are included.

P. R. C.

NOTIONS ÉLÉMENTAIRES DE TÉLÉGRAPHIE SANS FIL, ET CONSTRUCTION PRATIQUE DE POSTES RÉCEPTEURS. By Jean Rémaur. (Paris: *Librairie Générale Scientifique et Industrielle Desforges*. 1921. Pp. 116. 8 $\frac{1}{2}$ " \times 5 $\frac{1}{2}$ ". Price not stated.)

As may be gathered from the title of this book, it is written at least in part for the wireless amateur or experimenter. In bulk, however, it is designed as an elementary text-book on wireless in general. It commences with a consideration of the oscillatory discharge of a condenser, illustrated by hydraulic analogy. Chapter II. discusses coupled circuits and resonance curves, and Chapter III. the principles of wave transmission, aerials, earth connections, etc.

Chapter IV. is devoted to C.W. transmission, and includes brief descriptions of the mode of establishing continuous oscillations by arcs, alternators and thermionic valves; and Chapter VI. describes various forms of detectors, and the three-electrode valve detector in particular.

The second part of the book contains five chapters giving constructional details for various parts of an amateur receiving equipment; while in the third part general information is included with regard to the Morse code, time signals, etc., and the codes used for the transmission of meteorological messages.

P. R. C.

A CATALOGUE OF BRITISH SCIENTIFIC AND TECHNICAL BOOKS. Prepared by a Committee of the British Science Guild. (London: *The British Science Guild*. 1921. Pp. xviii + 376. 8 $\frac{1}{2}$ " \times 5 $\frac{1}{2}$ ". Price 10s. net.)

A committee of ten members of the British Science Guild (whose headquarters are at 6, John Street, Adelphi, London, W.C. 2) has prepared a most useful catalogue of scientific books which are at present in print in this country. It is divided into fifty main sections covering all the chief branches of science and engineering, and each of these is in most cases further subdivided. In each section or sub-section the books are indexed under the authors' names, arranged in alphabetical order, and extensive name and subject indexes are also added.

The information given appears to be very complete and includes the date of the most recent edition or impression. A useful addition is the list of publishers' names and addresses which is given at the end of the catalogue.

P. R. C.

Books Received.

PREPARED RADIO MEASUREMENTS WITH SELF-COMPUTING CHARTS. By Ralph R. Batcher, E.E. (New York: *Wireless Press, Inc.*; London: *The Wireless Press, Ltd.* 1921. Pp. 132. 8 $\frac{1}{2}$ " \times 6". Price 10s. 6d. net.)

LA THÉORIE ET LA PRATIQUE DES RADIOCOMMUNICATIONS—II. LA PROPAGATION DES ONDES ÉLECTROMAGNÉTIQUES À LA SURFACE DE LA TERRE. By Léon Bouthillon. (Paris: *Librairie Delagrave*. 1921. Pp. xv + 340. 10" \times 6 $\frac{1}{2}$ ". With 133 figures. Price 20 gns.)

FIFTY YEARS OF ELECTRICITY: THE MEMORIES OF AN ELECTRICAL ENGINEER. By J. A. Fleming, M.A., D.Sc., F.R.S. (London: *The Wireless Press, Ltd.* 1921. Pp. xi + 371. 9 $\frac{1}{2}$ " \times 7 $\frac{1}{4}$ ". Price 30s. net.)

DIRECTIVE WIRELESS TELEGRAPHY, DIRECTION AND POSITION FINDING, ETC. By L. H. Walter, M.A., A.M.I.E.E. (London: *Sir Isaac Pitman & Sons, Ltd.* 1921. Pp. xii + 124. 6½" × 4". With 57 diagrams and illustrations. Price 2s. 6d. net.)

RAYS OF POSITIVE ELECTRICITY AND THEIR APPLICATION TO CHEMICAL ANALYSIS. By Sir J. J. Thomson, O.M., F.R.S. (London: *Longmans, Green & Co.* 1921. Pp. x + 237. 8¾" × 5¾". With 9 plates and 42 figures. Price 16s. net.)

THE FRAMEWORK OF WIRELESS TELEGRAPHY. A New Theory of Electric Wave Sources and Propagations, with Rational Applications. By R. C. Galletti di Cadilhac. (London: *Crosby Lockwood & Son.* 1921. Pp. 48. With 6 diagrams. 8½" × 5½". Price 3s. 6d. net.)

THE SIGNAL SERVICE IN THE EUROPEAN WAR OF 1914—1918 (FRANCE). By R. E. Priestley, M.C., B.A. (Late Major, R.E.). Published by the Secretary, the Institution of Royal Engineers, and by the Signals Association. (Chatham: *W. & J. Mackay & Co., Ltd.* 1921. Pp. xvi + 359. 9½" × 6". With 20 plates. Price not stated.)

Correspondence.

TRIODE CHARACTERISTICS WITH HIGH GRID POTENTIAL.

TO THE EDITOR OF THE "RADIO REVIEW."

SIR,—In the November issue of the RADIO REVIEW Mr. Bartlett suggests that we should interpret the form of triode characteristics as indicating a pronounced lateral collection of electrons by the grid whenever the grid potential v_g is greater than 0.8 times the anode potential v_a . He considers this "snatching" action of the grid as the cause of the peculiar potential-current characteristics in the region where v_g is about equal to v_a whereas I think that secondary electrons are the main influencing factor. Probably the best way of differentiating between the two theories is by saying that Mr. Bartlett assumes that the electrons tend markedly to follow the lines of force whereas I think that they do so only to a very limited extent.

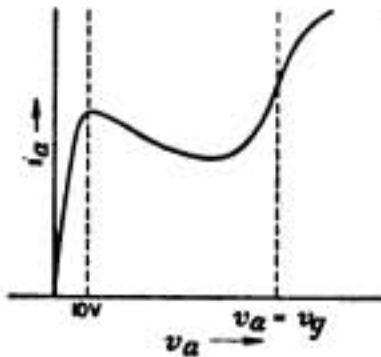


FIG. 1.

Mr. Bartlett states that the bend of the $i_a - v_g$ characteristic always occurs when $v_g = 0.8 v_a$ but I do not find this to be the case. For example at low potentials (e.g., v_a below about 10 volts) no bend at all occurs, and it is just at these low potentials that one might expect the pronounced "snatching" contemplated by Mr. Bartlett. I interpret the absence of the bend in these low voltage characteristics as indicating that no secondary electrons are produced at the anode when v_a is less than 10 volts or so.

As experimental results which appear to me to decide quite definitely between the two theories I submit the following:—

(a) Fig. 1 shows the $i_a - v_a$ characteristic of a B triode for a fixed grid potential of 43 volts. As the anode potential increases the number of electrons reaching it increases until v_a is approximately 10 volts, above which the current falls. I cannot see how increasing the positive potential of any electrode can decrease the current to it unless secondary electrons are produced.

(b) The values of the ratio $\frac{\text{number of secondary electrons}}{\text{number of primary electrons}}$ obtained from my interpretation

are almost identical with those obtained by Professor Millikan and G. Barber throughout the whole range of impact potentials with which they worked.

(c) The question as to whether the electrons follow the lines of force to any marked extent or not seems to be definitely settled by the determination of the i_g/i_a ratio for values of v_a equal to v_g . In such a case it may be shown that the ratio of the number of lines of force ending on the grid to the number ending on the anode is equal to the amplification factor and

thus if pronounced "snatching" were present we should expect the i_g/i_a ratio to be 8 to 10 in most receiving triodes whereas it is usually about 0.25 to 0.30 or about equal to metal-space ratio of the grid. The remarkable constancy of the ratio for all values of $v_a = v_g$ when saturation has been attained was first discovered by Dr. van der Pol.

The truth is, of course, that Mr. Bartlett's reasoning contains a very fundamental error in electrostatics. It is a commonplace electrical theory that it is dangerous to deal with *resultant* charges on electrodes instead of potentials and potential gradients. Thus Mr. Bartlett states that until the value of v_g is equal to $0.8 v_a$ the resultant charge on the grid is negative and the grid is actually repelling electrons. We are told that it is only an accident that the electrons reach the grid at all and we naturally wonder why the accident should take place quite suddenly when the grid potential is brought from negative to positive values. We have always previously thought that this particular critical point was accounted for by the change in sign of the potential gradient between that part of the filament opposite the grid and the grid itself but Mr. Bartlett discountenances this view since for him the grid is always repelling electrons when the *resultant* charge on the grid is negative, even though v_g may be positive. And thus our difficulties would go on were we not to remember the simple fact that the grid can have a positive charge on the side facing the filament and a negative charge on the anode side and although its *resultant* charge may be negative it will attract electrons on the filament side and repel them on the anode side.

I mentioned above that it was dangerous to deal with *resultant* charges on the electrodes and for an illustration of this I cannot do better than to indicate the trouble into which we are led by Mr. Bartlett's own result. For example he has found that $v_g = 0.8 v_a$ is a critical point and that so long as $(v_g - 0.8 v_a)$ is negative the resultant grid charge is negative but when $(v_g - 0.8 v_a)$ assumes positive values electrons are attracted and true grid current begins. Let us take an example. Let us assume that v_g is fixed at -20 volts and that v_a is taken through continuous values from -24 volts to -26 volts. It requires simple algebra to prove that the resultant charge on the grid reverses in sign from negative to positive values when $v_a = -25$ volts. We thus are led to expect a sudden increase in grid current at this point but it is a commonplace that no such increase occurs. Indeed no grid current at all occurs in a hard tube until v_g itself assumes positive values.

I should be the last to say that all difficulties are cleared away by the secondary electron theory. For example the question of emission velocities is still unsettled but I hope that some experiments now in hand will help. My view is that the pure "snatching" theory contemplated by Mr. Bartlett raises more difficulties than it solves whereas a secondary electron theory explains at least the main effects.

E. V. APPLETON.

Cambridge,
November 13th, 1921.

A HIGH-FREQUENCY MACHINE OF GREATER SPECIFIC POWER AND HIGHER EFFICIENCY.

TO THE EDITOR OF THE "RADIO REVIEW."

SIR,—The high-frequency alternator marketed by the Société Française Radio-Électrique possesses a further marked advantage which I omitted to mention in my article which appeared in the RADIO REVIEW for August, 1921. This advantage lies in the particular aptitude of this alternator for parallel working.

In alternators coupled in parallel, the stator reactance can always be balanced to any required extent by capacities and the synchronising torque then becomes greater the lower the apparent stator resistance at the frequency considered.

Now, as shown by the writer, the losses due to the output are much smaller in the alternator having a reduced number of stator slots than in the ordinary machine. Hence the apparent resistance is much lower in the first type of machine and consequently the parallel coupling of such machines becomes relatively easy, as has been proved in practice.

MARIUS LATOUR.

Paris,
November 23rd, 1921.