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Phenomena in Oxide-coated Filament Electron Tubes.*

By H. D. ARNOLD.

The most generally interesting phenomena in electron tubes are those relating to the flow of electrons through the space, the control of the flow by plate and grid voltages, and the operation of the tubes in the various circuits in which they are used. These phenomena are essentially the same whether the filament is pure metal or is oxide-coated and a considerable literature has already grown up in this field. The phenomena distinctive of oxide-coated filament tubes are those relating to the economic and scientific factors involved in the process of electron emission and the influence of these factors on the design of the tube. Wehnelt oxide filaments offer the most economical source of electrons at present available in three-electrode vacuum tubes, and thus from a commercial point of view they are at present of the greatest interest and importance.

The early work of Richardson, H. A. Wilson and others established beyond reasonable doubt that for pure metals the emission of electrons is due to thermal action and not to chemical action in the ordinary sense of the word. In view of this physicists have believed for the past ten years or more that there was no place for a chemical theory of emission as far as pure metals are concerned.

With respect to Wehnelt oxides, however, there was somewhat less certainty as to whether chemical action might not be necessary for electron emission. The fact that coating metals with chemical compounds increased their electron emission many times seemed to invite the hypothesis that this increase resulted from chemical action.

Data similar to those which established the purely thermal nature of electronic emission from metals were accumulated more slowly in the case of Wehnelt oxides, largely because of the experimental difficulties which were encountered. As regards the velocity distribution among the emitted electrons, this has still to be satisfactorily determined for the oxides, but nevertheless the evidence as it has been verified step by step has in every case supported the opinion of the physicists who believed that emission from oxides as well as metals was in all probability a purely thermal affair.

* Abstracted from the *Physical Review*—see Abstract No. 1226 in this issue.

With the introduction of oxide filaments for commercial vacuum tubes it became necessary to produce filaments in quantities and with a very high degree of uniformity. Considerations of mechanical strength, electrical resistance, non-oxidizability, availability and reproducibility of commercial supply, etc., led to the choice of a wire of platinum-iridium alloy containing about six per cent. iridium for the core of the filament. This wire was rolled to a ribbon to increase the surface and the ribbon was twisted to secure a better mechanical structure. This core could be produced in quantity with electrical and mechanical properties sufficiently uniform for the required purposes.

In the choice of coating materials the oxides of barium, strontium and calcium were available, their thermionic activities being in the order given. Coatings of barium oxide however showed a mechanical disintegration which outweighed their superior activity. Efforts to secure a longer life resulted in the use of a mixture of barium and strontium oxides applied in a number of consecutive coatings.

In the process which was most commonly used, barium in the form of carbonate, and strontium in the form of hydroxide or carbonate, were mixed with some carrier such as resin or paraffin, which would burn away when heated in the air. In the coating process four applications of the strontium mixture were followed by four of the barium mixture, and this process was then repeated making a total of sixteen separate applications. After each application the wire was raised momentarily to a temperature of about 1000°, which burned away most of the organic carrier. When the coating was complete the wire was heated to about 1200° for two hours. At the end of this time there remained a fairly heavy coat of barium and strontium (from 2 to 3 milligrams per square centimetre of surface) while next to the core was a firmly adhering layer built up by chemical reactions between the coating and the core. Analysis showed this coating to consist of barium and strontium combined with platinum, rhodium and iridium, the compound present in largest amount being barium-platinate ($BaPtO_3$). The compound with rhodium seems to be more readily formed, but due to the small percentage of rhodium present this compound makes up only a small fraction of the total. The filament thus formed can be handled without undue precaution so long as it is not exposed to moisture or carbon dioxide. When stored in vacuum containers it shows no signs of deterioration even after a period of several years.

The time required for the proper evacuation of an oxide filament tube is determined almost entirely by the requirement that a large part of the occluded gases must be removed from the metal and glass parts inside the bulb. In any event it is desirable to carry the evacuating process considerably further in the case of oxide filament tubes than with tungsten filament tubes, since the "clean-up" effect of the filament itself is not nearly so marked as is the case with tungsten. During the pumping process the filaments are glowed for several minutes to liberate any occluded gases.

With the exercise of proper care as to the purity of the materials used and with adherence to a definite schedule of coating and heat treatment filaments can be produced with every expectation of uniformity and long life. During the war some half million vacuum tubes were made employing this filament, and the filament was prepared as a part of the regular manufacturing process by practically unskilled labour.

What terminates the useful life of an oxide filament is usually the development of local faults or " bright spots " due to the evaporation of the coating. They are practically free from the most common ageing effect of pure metal filaments, namely the gradual increase of electrical resistance caused by the evaporation of the filament. In the case of tungsten filaments used on constant voltage supply, evaporation with the resulting increase in resistance causes a lowering in the filament temperature and therefore a decrease of the electron emission, while with a constant current supply the increase in resistance results in an increase of temperature and a progressive increase in rate of disintegration of the filament. With oxide-coated filaments it is the coating alone that evaporates at least until a bright spot is formed and the temperature and operating characteristics remain unchanged throughout life on either constant current or constant voltage supply.

The cost of electrons in a vacuum tube device is determined by the characteristics of the filament, by the cost of the power used in heating the filament, and by the life and the replacement cost of the tube. The physical factors necessary for computing the cost are the constants in Richardson's equation, the constants of the evaporation equation, and the radiation constant peculiar to the filament. In order to relate the life of the tube to the vaporization constants it is necessary in addition to know to what extent vaporization may proceed on the average, before the useful life is terminated, and this can, of course, only be arrived at by exhaustive life tests.

The preliminary values of the evaporation constants obtained by evaporating barium oxide from a tungsten boat, catching it on a platinum shield, and weighing the deposit show that with a fair approximation

$$m = 4{\cdot}6 \times 10^8 \,.\, T^{-\frac{1}{2}} \epsilon^{-[(4\cdot6 \times 10^4)/T]}$$

where m is the rate of evaporation in grams per square centimetre per second.

In the determination of the constants in Richardson's equation for oxide filaments over 4,000 filaments have been examined in the Western Electric Company's laboratories. In order to simplify the investigation it has been found desirable to employ a specially ruled paper on which the results may be plotted. The co-ordinate lines are so disposed and numbered that if the emission from a filament satisfies Richardson's relation and the thermal radiation satisfies the Stefan-Boltzmann law, then the points on the chart co-ordinating power and emission for such a filament will fall in a straight line. The diagram (Fig. 1) gives some idea of the characteristics of the standard filaments which have been evolved, and their range of variability. Ten per cent. of the filaments had a greater activity than that given by the upper line, while 90 per cent. were above the lower line in the diagram. It may be noted that in the great majority of vacuum tube applications we are concerned only in maintaining the electron emission at a value greater than a certain fixed limit. In a limited number of cases, however, it is desirable to use tubes with as nearly as possible the same voltage saturation value of the emission. For these special problems pure metal filaments offer at present the best solution.

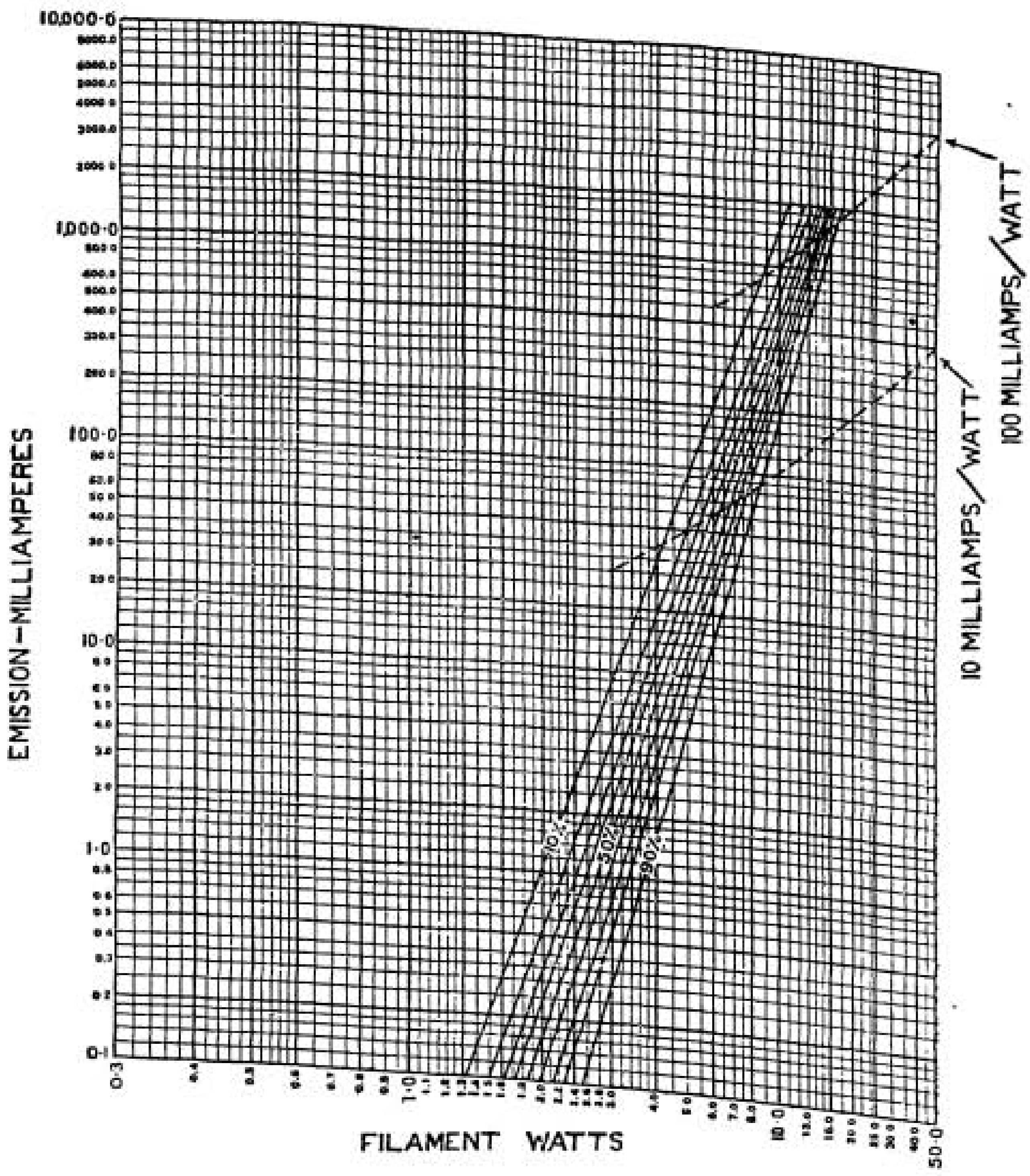

Fig. 1.—Chart showing average characteristics of standard Western Electric Oxide-coated Filament, based on tests of 4,301 samples, April to October, 1918.

The customary operating power of these filaments is from 8 to 9 watts per square centimetre. From the test results the following values are obtained for the thermionic characteristics of the filament:

Richardson's constant b, $19{\cdot}4 \times 10^3$ to $23{\cdot}8 \times 10^3$.
Richardson's constant a, $0{\cdot}5 \times 10^{24}$ to $1{\cdot}5 \times 10^{24}$ for electrons per second per square centimetre;
or 8×10^4 to 24×10^4 for amps. per square centimetre.

Dr. W. Wilson has found that when proper consideration was taken of the geometrical form and of the voltage drop along the filament, the space charge equation took the form

$$i = \frac{2}{5} k \frac{(V - V_0')^{5/2}}{V_0 - V_0'} \left[1 - \left(1 - \frac{V_0 - V_0'}{V - V_0'} \right)^{5/2} \right]$$

where V_0' is the potential of the negative end of the filament and V_0 the potential of the positive end. The value of e/m obtained from the experimental data by the use of this equation was found under the best conditions to be about 5 per cent. lower than the value obtained for electrons by other methods. This deviation is explicable either by the presence of a very small number of negative carriers of molecular size or by the emission of secondary electrons from the anode under the bombardment of the primary electrons. The deviation is however, no greater than that obtained with tungsten filaments, and the concordance of the results indicates clearly that Wehnelt oxides may be considered to give a pure electron discharge.

With the introduction of various gases at pressures of the order of 0·001 mm, or so, the electron emission currents suffer rather large changes, although not of the degree found with the emission from tungsten filaments under similar conditions. The presence of oxygen and carbon dioxide inhibits the electron emission while a small amount of hydrogen in contact with a filament of abnormally low emission may result in restoring it to a normal condition.

In recent experiments it has been found of great convenience to use filaments which have been coated by active material evaporated from a standard filament. The standard filament and the wire to be coated are mounted close together in the same tube and the primary is run at a fairly high temperature for various lengths of time according to the purpose of the experiment. Observations are then made on the emission from the secondary filament. One advantage of this method of experimentation is that the core of the secondary filament may be any suitable material, for example tungsten or iron, without meeting the difficulties of oxidation, which are often troublesome when these materials are coated in the open air.

These secondary filaments have many interesting properties which no doubt will prove of importance in establishing the process of electron emission from Wehnelt oxides. One of the most striking facts is that the secondary filament may show a high electron emission when only a very minute amount of active material has been transferred to it. In certain experiments where the secondary filament was tungsten, the standard filament was glowed for so short a time that only approximately one-tenth of the surface of the tungsten filament was covered with active material.

It is most interesting to note that the electron current obtainable at a given temperature from filaments coated in this very tenuous fashion may be only a little smaller than that obtained when the entire filament is covered with a heavy deposit.

It is natural to ask whether this result is due to a difference in the *a* or in the *b* of Richardson's equation as applied to these partly coated filaments.

Measurements of b taken at intervals while the deposit was forming have never shown an increase with thickness of deposit, and therefore it seems that the result must be due to a difference in a. If we assume that a completely coated filament emits uniformly over its entire surface while a partly coated filament emits only in the vicinity of the molecule of active material, we compute an a for the partly coated filaments which is much greater than the values ($0{\cdot}5 \times 10^{24}$ to $1{\cdot}5 \times 10^{24}$) given above for the standard filament. The fact that the b obtained for filaments coated merely with a few widely separated molecules is the same as that obtained with a complete coating shows that the reduction of the work function at the metal surface can be brought about by a very small group of molecules. Under these conditions it seems reasonable to suppose that the only important effect of the molecule of active material is to lower the restraining voltage in its own vicinity and thus facilitate the passage of electrons from the metal core. The number of electrons that can avail themselves of such a molecular opening is limited to those presenting themselves with a sufficient outward velocity, and this in turn is determined by the properties of the core material. Since the core materials used have values of a greater than those which we find for the standard filaments it does not seem so strange that the values of a for the partly coated filaments should be found to run higher than those for completely covered filament.

We hope that our present experiments will throw more light on the factors involved in the escape of electrons through these minute activated areas. Our information is at present too meagre to warrant an opinion as to whether an electron on its way out remains for some time as a part of the molecule of active material or merely slips past it. The number of electrons passing but through one molecular opening in a second may be of the order of ten thousand and that this rate may persist for some time is indicated by the rather slow rate of decay of activity. This proves at least that no irreversible chemical change in the active coating is involved in the emission of an electron. Perhaps a more striking proof of this is found in certain of these filaments which through a life of twenty thousand hours have emitted fifteen times more mass of electrons than the mass of their coating.

Another factor of importance in connection with the use of Wehnelt oxides is the velocity with which they emit electrons when bombarded. Such secondary emission may be comparatively large when they are bombarded by electrons, but there is no evidence of more than a few electrons being emitted for each impact of a positive ion. This negatives the idea that positive ion bombardment is a controlling factor in the emission from oxide coated filaments.

The limit to which the improvement in the emission qualities of electron tube filaments may be expected to extend can only be determined when the factors governing electron emission from oxides are as well understood as are at present those governing electron emission from pure metals. It is more than probable that in the process of obtaining this knowledge new light will be thrown upon the process of emission from pure metals as well.

An American Duplex Radiotelephone Set.*

By M. B. SLEEPER.

The question of two-way radiotelephony in which two speakers may carry on a conversation without the necessity of changing the circuit connections from receiving to sending, or *vice versa*, and which is commonly referred to as " duplex radiotelephony," is one which has interested radio engineers for some time past.† While many attempts have been made to obtain successful duplex working it has not yet by any means come into general use. This is no doubt due largely to the enormous ratio between the power in the transmitter and the energy received from the distant station. Hence it has been necessary in most commercial radiotelephone apparatus to use some form of switch or key for throwing over from speaking to listening, the set normally being in the condition for reception and being thrown over to transmission only during the actual speaking period, during which time the local receiving circuit is entirely disconnected.

The Western Electric Company (U.S.A.) have recently designed and built duplex radiotelephone sets for the United States Navy which permit two people to converse together by radio without the necessity of throwing switches and with no more thought to the question of whether the other is transmitting or receiving than in the case of an ordinary wire telephone conversation.

A number of different arrangements are possible for duplex radio signalling. One method is obviously to employ two separate antennæ, one for transmitting and one for receiving, the two being tuned to different wavelengths and so disposed relative to each other that the receiving antenna is not appreciably affected by its own transmitting station. This is particularly convenient if the receiving and transmitting stations can be separated by a distance of a few miles and connected together by land wires. Another method is to employ a single aerial only for both transmitting and receiving with the addition of some balancing arrangement to reduce the amount of power from the transmitter which enters the receiving circuits.

Where space is restricted such as on ships the first method cannot be used and the second offers the only satisfactory solution to the problem provided that the balancing of the circuits can be effected with sufficient accuracy. Some years ago experiments were conducted by the U.S. Navy using the first of these two methods at land stations, and successful communication was established between Washington and installations on battleships at sea. The arrangement of the latest sets built by the Western Electric Company

* Abstracted from *Everyday Engineering Magazine*—see Abstract No. **1216** in this issue.

† The application of duplex radiotelephony to aircraft was recently discussed by Captain P. P. Eckersley in a paper read before the Wireless Section of the Institution of Electrical Engineers. An abstract of this paper will be found on pp. 338—340 and pp. 383—385 in our issues of April and May, 1920.

for duplex working may be seen from the circuit diagrams of Figs. 1 and 2. Fig. 1 is a simplified diagram of connections of the transmitting unit which unit may also be seen on the left-hand side of Fig. 3. Two three-electrode tubes are employed, one of which acts as an oscillation generator and the other

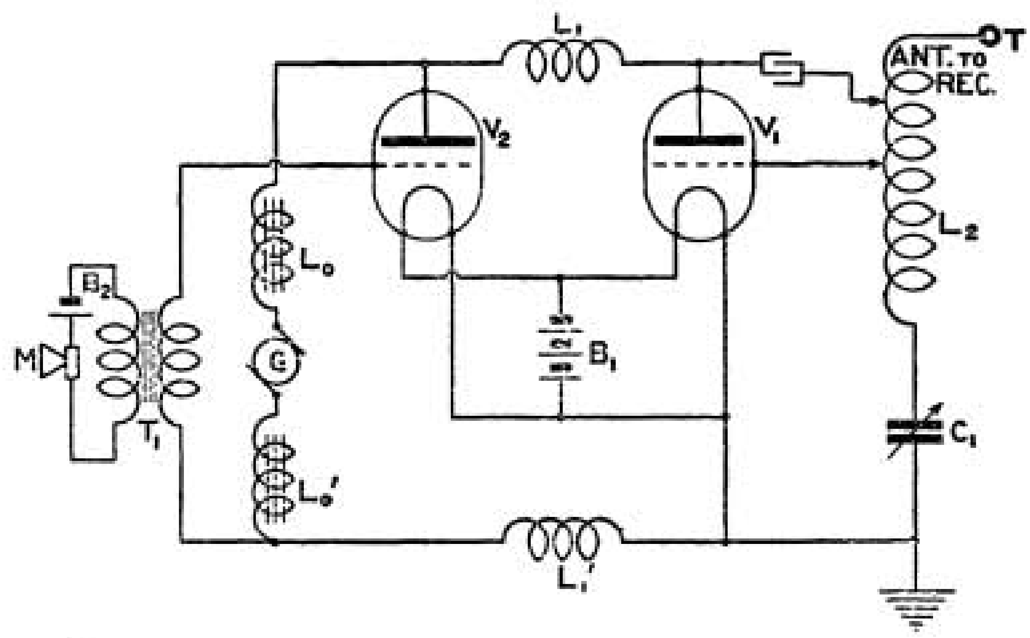

Fig. 1.—Simplified Connections of Transmitter.

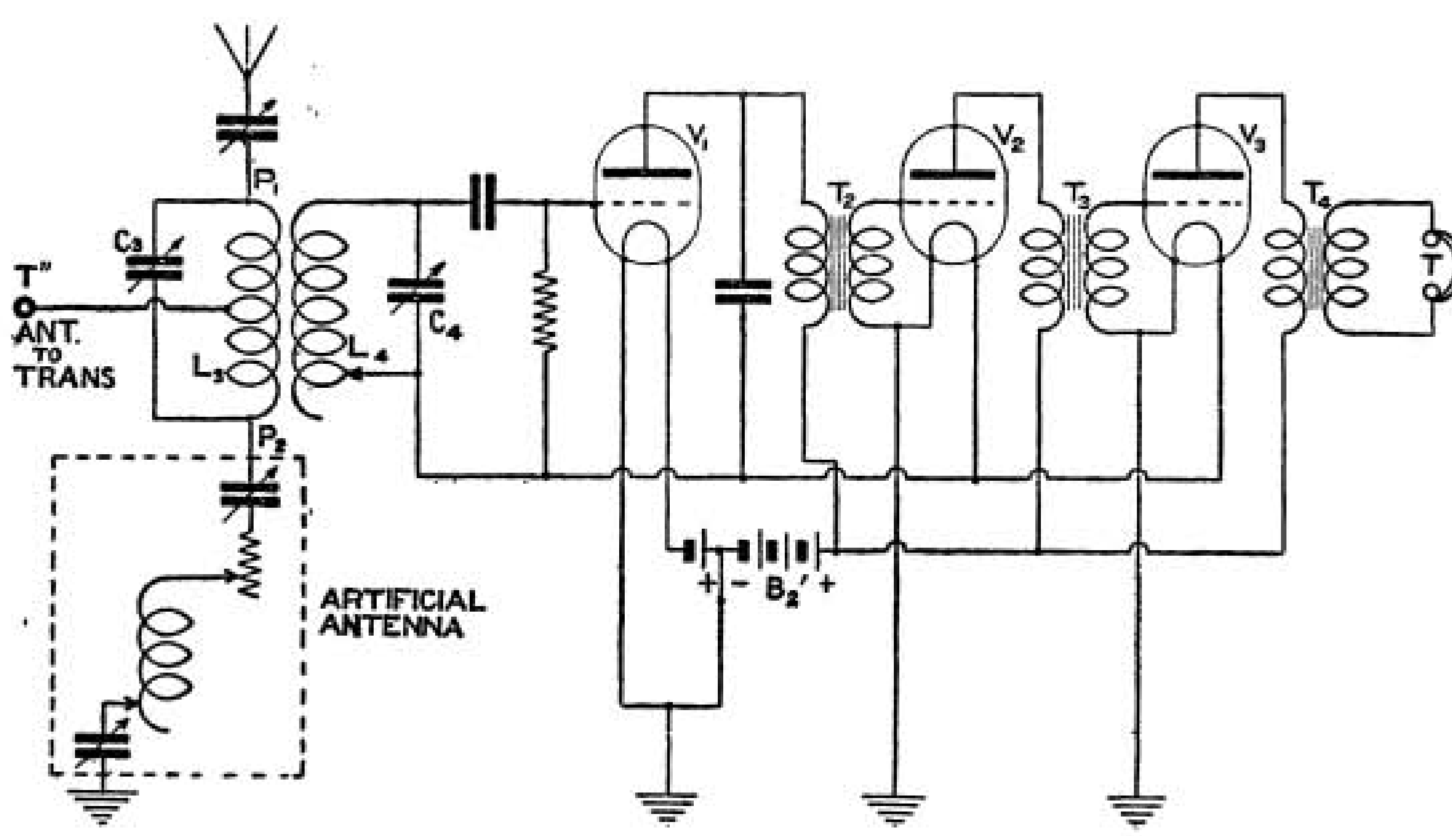

Fig. 2.—General Arrangement of Receiver and Artificial Antenna.

as a modulator. The particular circuit used in this set is that commonly referred to in America as the "Colpitts Circuit." It consists briefly of a tuned circuit having two capacities in series, one being in shunt to the plate circuit and the other to the grid circuit of the tube. In this instance the coil L_2 forms the inductance of the tuned circuit, C_1 is the condenser in the

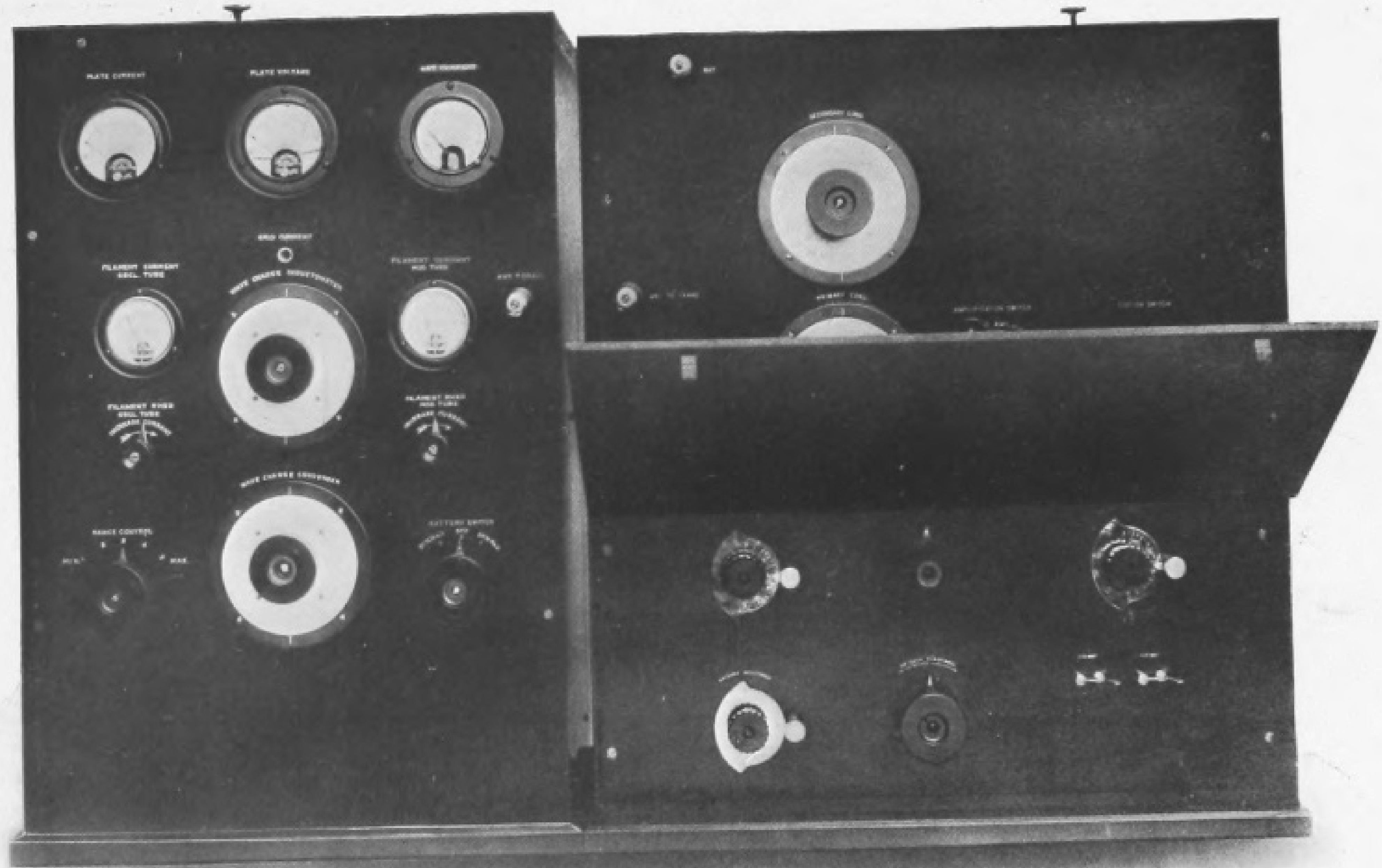

FIG. 3.—GENERAL VIEW OF DUPLEX RADIOTELEPHONE (WESTERN ELECTRIC CO., U.S.A.).
Transmitter Unit on left; Receiver and Artificial Antenna on right.

(To face p. 752.)

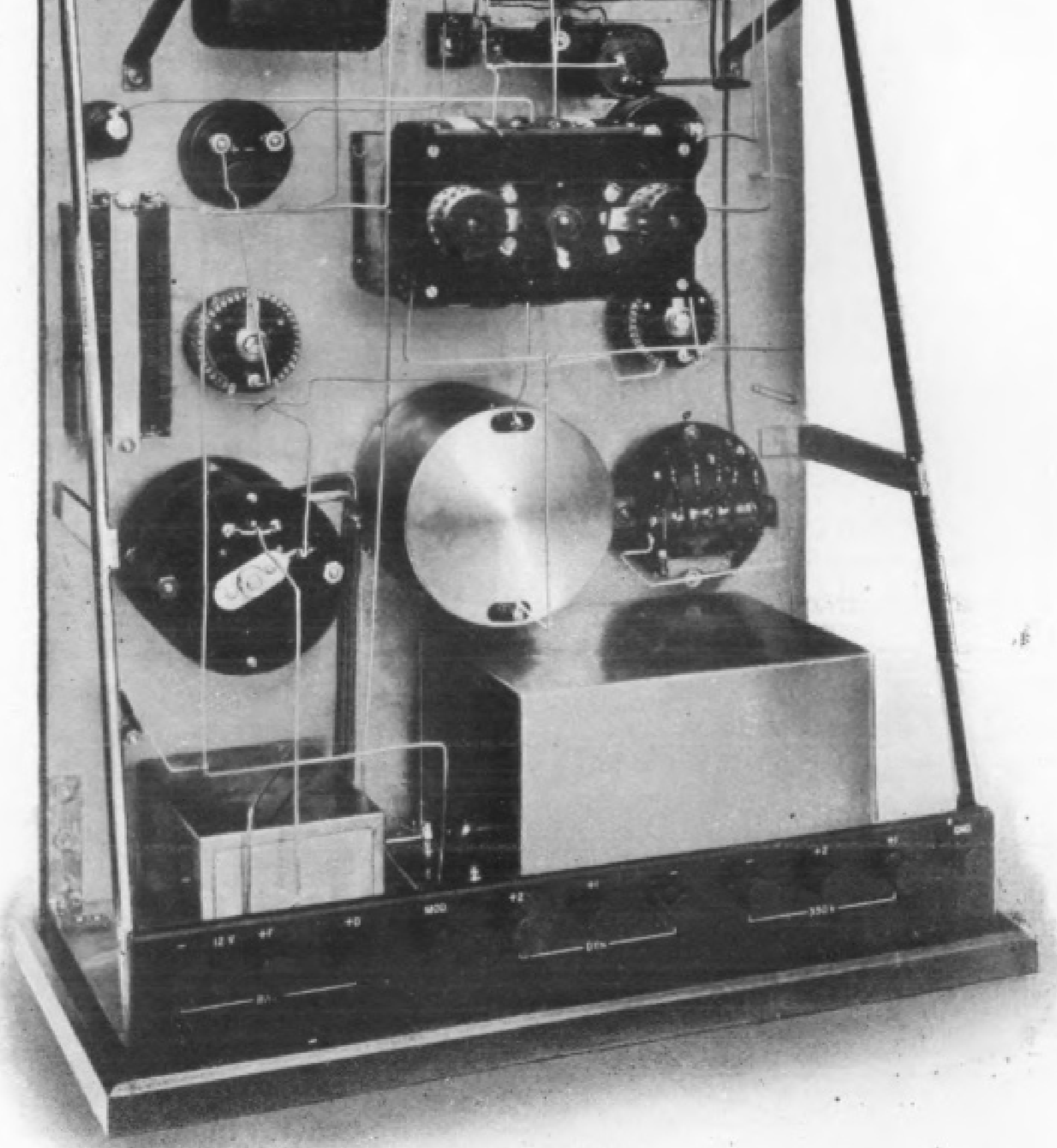

FIG. 4.—REAR VIEW OF TRANSMITTER UNIT.

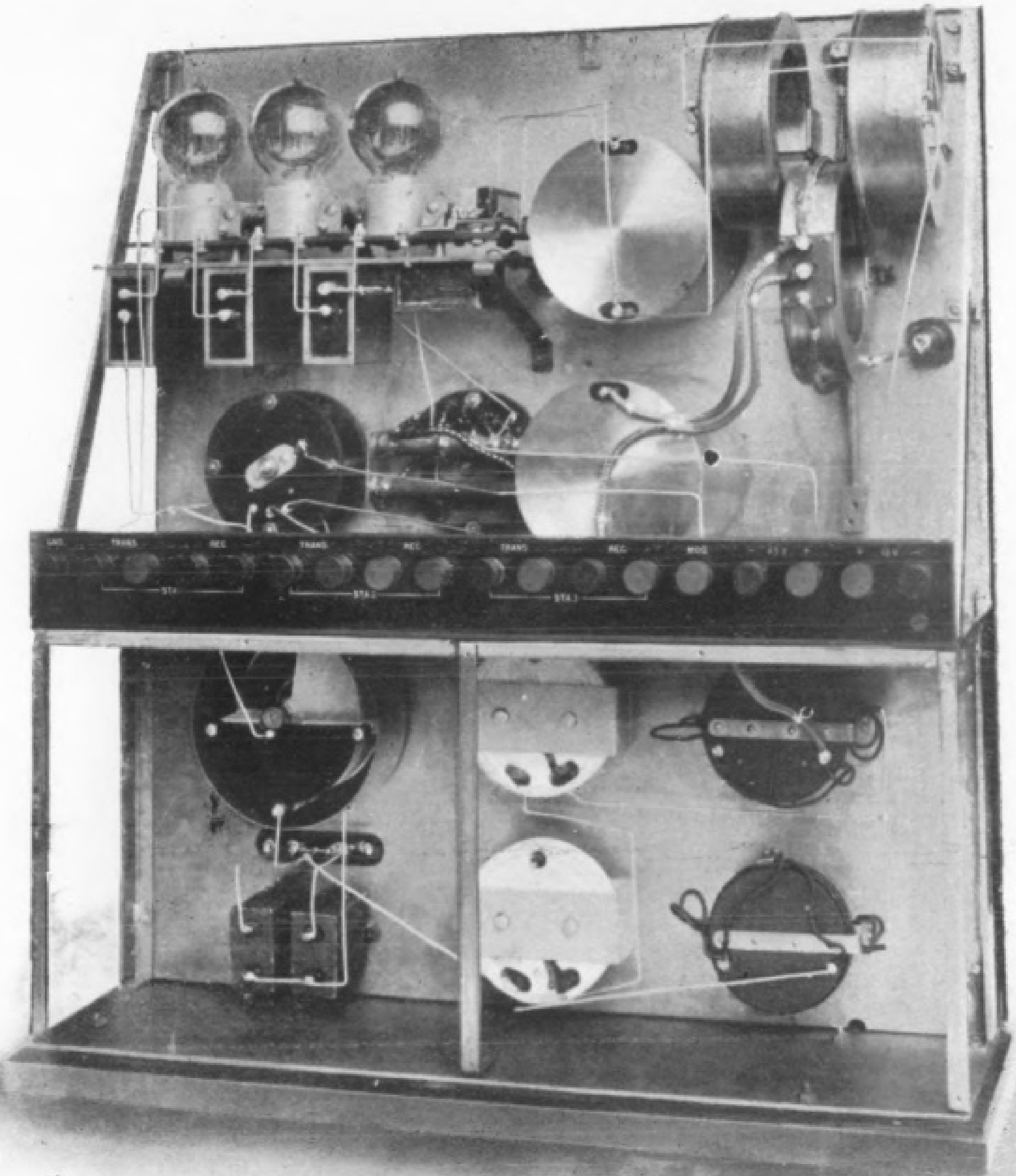

Fig. 5.—Rear View of Unit containing Receiver, Amplifier and Artificial Antenna.

grid circuit and the capacity of the aerial system to earth is in shunt to the plate circuit. The filament is connected to the common point between the two capacities, in this case the earth connection. Power is supplied to the plate circuits of the tube by the generator G. The oscillations set up by the oscillating valve V_1 are modulated by the tube V_2 by the method often referred to as "choke control," suitable choking inductances L_0L_0' and L_1L_1' being inserted in the position shown. The modulator tube V_2 is controlled by the transmitting microphone M through the coupling transformer T_1. The modulator tube therefore acts as a variable shunt to the oscillating tube, and this controls the amplitude of the oscillations that are radiated. The terminal T′ shown in Fig. 1 corresponds to that marked **ANT. to REC.** in Fig. 3. When the instruments are in use this terminal is joined to the adjacent one on the right-hand unit in Fig. 3 which is marked **ANT. to TRANS.**

A simplified circuit diagram of the receiver unit which is on the right-hand side of Fig. 3, is given in Fig. 2. In this circuit the inductance L_3 and condenser C_3 constitute the tuned circuit which by varying the condenser C_3 can be tuned to the signalling frequency. Associated inductively with this coil is a second tuned circuit L_4C_4 which is connected directly to the grid circuit of the detecting valve V_1. The plate circuit of this tube is coupled through transformer T_2 to the two-stage amplifier indicated at $V_2T_3V_3T_4$, the secondary circuit of the last transformer T_4 containing the telephone receivers T. The plate circuits of all the receiving tubes are supplied from the common battery B_2'. The connection to the transmitting apparatus is made from the mid-point of the coil L_3 *via* the terminal T″ which corresponds to the terminal marked **ANT. to TRANS.** of the right-hand unit shown in Fig. 3. The right-hand unit in Fig. 3 contains the receiving apparatus in its upper part and the artificial balancing antenna in its lower part. This artificial antenna is joined between the point P_2 and earth (Fig. 2). The oscillatory current from the transmitter therefore divides equally through the coil L_3, one half flowing into the antenna and the other half through the artificial antenna. The points P_1 and P_2 are thus always at equal potentials as regards the transmitter. Oscillations received on the aerial, however, are not so balanced and will therefore produce an effect in the telephones. The artificial antenna must be made to imitate as closely as possible the actual antenna both in oscillation and in damping characteristics.

A rear view of the two units is shown in Figs. 4 and 5 from which the general arrangements of the parts of the apparatus may be seen.

When required for aircraft use it has been found more convenient to divide the receiving unit (Fig. 5) into two parts containing respectively the actual receiver and the artificial antenna. The latter may then be mounted in a less accessible position so as not to interfere with other instruments on the machine.

A Theory of the Amplitude of Free and Forced Triode Vibrations.

By BALTH. van der POL, Jun., D.Sc.

(Continued from page 710, November, 1920.)

We shall now consider a little more in detail the amplitude of the generated oscillations.

Let AB (Fig. 8) be an $i-v$ diagram constructed for a certain positive value of $k=g\,\dfrac{M}{L}-1$ as explained in section **2** and Fig. 3.

In order to simplify the discussion we take a symmetrical characteristic, *i.e.*, one for which the unimportant factor $\beta = 0$. Let further the equation of AB be

$$i = -\alpha v + \gamma v^3$$

where both $\alpha > 0$ and $\gamma > 0$.

Draw COD such that $\tan \xi = -\dfrac{1}{R}$.

The tangent FG at AB in O gives $\tan \zeta = -\alpha$.

From (20) it is seen that as long as $\tan \zeta > \tan \xi$ or $\zeta > \xi$, *i.e.*, as long as CD cuts the characteristic AB, oscillations will be possible. Now from the

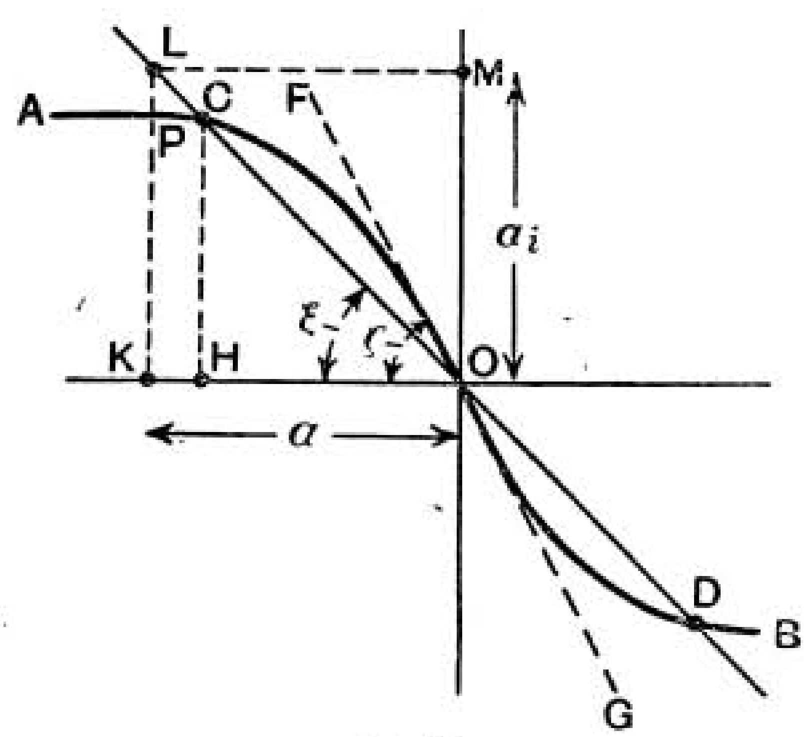

FIG. 8.

equations for AB and CD namely

$$i = -\alpha v + \gamma v^3$$

and

$$i = -\frac{1}{R}\, v$$

we find the abscissa OH of C to be

$$\mathrm{OH} = \sqrt{\frac{\alpha - \frac{1}{R}}{\gamma}}$$

Hence the amplitude OK of the maintained oscillations

$$\left(a = \sqrt{\frac{4}{3}\frac{\alpha - \frac{1}{R}}{\gamma}} \right)$$

is obtained by multiplying the length of OH by $\frac{2}{\sqrt{3}} = 1{\cdot}155$.

The oscillations therefore extend beyond the point C where the resistance curve CD cuts the characteristic, while the fundamental anode-current amplitude OM equals $\frac{1}{R}$ times the fundamental P.D. amplitude OK, and can be constructed simply as indicated in the figure by extending KP till it cuts OL at L.

A further physical investigation of the amplitude of the vibrations necessary for them to reach the steady state may be obtained from the following considerations.

From (I.[a, b]) it follows, with $\frac{di}{dt} = \frac{d\psi}{dv}\frac{di}{dt}$ that the oscillations must satisfy the equation

$$\frac{d^2v}{dt^2} + \frac{1}{C}\left(\frac{1}{R} + \frac{d\psi}{dv}\right)\frac{dv}{dt} + \frac{1}{CL}v = 0.$$

where $\frac{1}{C}\left(\frac{1}{R} + \frac{d\psi}{dv}\right)$ is the damping coefficient which, in our case, is a function of the amplitude. Referring to Fig. 8 let the curve AB represent $i = \psi(v)$ and as before let $\tan \xi = -\frac{1}{R}$, then the function $\frac{1}{C}\left\{\frac{1}{R}v + \psi(v)\right\}$ may be

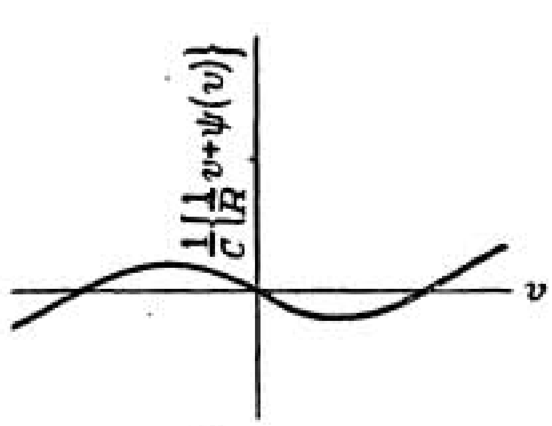

FIG. 9.

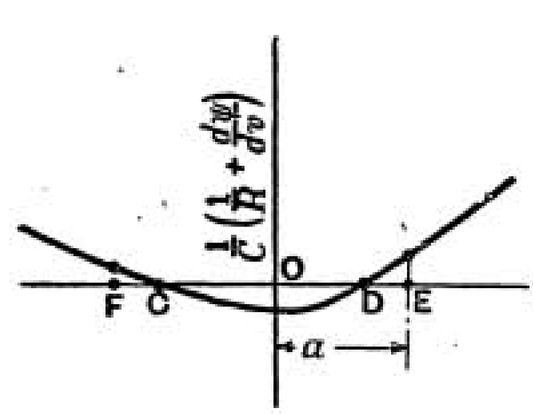

FIG. 10.

constructed from Fig. 8 as indicated in Fig. 9; the next step is to differentiate this last function (of Fig. 9) and thus obtain Fig. 10.

Now the ordinates of Fig. 10 give the damping coefficient (the coefficient of the $\frac{dv}{dt}$ term in the differential equation) as a function of the amplitude of the oscillations. As long as the amplitude is smaller than OD the damping coefficient is negative over the whole period, and hence the oscillations will tend to increase. Even when the amplitude has reached OD the damping coefficient over the whole period is still negative and the oscillations will go on still further to increase. But when a certain point beyond OD is reached, such as E, the amplitude will be stationary, as during a part of one complete oscillation the damping factor is negative while over the other part it is positive. That finally the case referred to above, where

$$\alpha - \frac{1}{R} < 0$$

$$\gamma < 0$$

does not allow a stable oscillation to be set up is obvious from the fact that the damping factor, being again a function of the amplitude, is here of the form of Fig. 11.

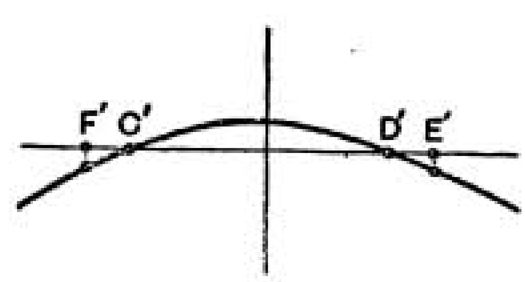

FIG. 11.

For, when the amplitude OE is reached, a slight increase of the latter would make the damping factor negative over a greater part of the period with the result that the amplitude would increase indefinitely.

7. In order to find an approximate value for the stationary amplitude of the fundamental of an oscillating triode, it is not necessary for the derived characteristic to be developable as

$$i = -\alpha v + \beta v^2 + \gamma v^3.$$

For, if we take the general case, where the steady anode-current—anode voltage characteristic is given as $i_{a_0} = \phi(E_{a_0})$ the function $i = i_a - i_{a_0} = \psi(kv)$ becomes

$$i = \phi(E_a - kv) - \phi(E_a) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (23)$$

Now applying again the method of section **5**, we have

$$\frac{1}{T}\int_0^T ivdt + \frac{1}{R}\frac{1}{T}\int_0^T v^2 dt = 0$$

which, with the assumption $v = a \sin \omega t$, becomes

$$\frac{a^2}{2R} + \frac{1}{2\pi}\int_0^{2\pi} a \sin t \, \{\phi \, (E_a - ka \sin t) - \phi \, (E_a)\} \, dt = 0$$

or

$$\frac{a}{2R} + \frac{1}{\pi}\int_{-1}^{+1} \frac{\phi \, (E - kay) \, . \, y \, . \, dy}{\sqrt{1-y^2}} = 0 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (24)$$

from which an approximate value of the amplitude a might be obtained, when the function ϕ is known.

8. The question may be raised: What is the maximum amplitude to be obtained for a given triode and given circuits by varying M, the back coupling? From the derived characteristic

$$i = -\alpha v + \beta v^2 + \gamma v^3$$

we found for the square of the amplitude

$$a^2 = \frac{4}{3}\frac{\alpha - \frac{1}{R}}{\gamma} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (20)$$

where

$$\alpha = k \left(\frac{\partial i_a}{\partial v_a}\right)_{v_a = E_a}$$

and

$$\gamma = -\frac{k^3}{6}\left(\frac{d^3 i_a}{d v_a{}^3}\right)_{v_a = E_a}$$

After differentiating (20) with respect to $k = \left(g\frac{M}{L} - 1\right)$ and putting $\frac{da^2}{dk} = 0$ we find

$$\gamma \frac{d\alpha}{dk} - \left(\alpha - \frac{1}{R}\right)\frac{d\gamma}{dk} = 0$$

which leads to the condition for the back coupling M:

$$\frac{2}{3}\alpha = \frac{1}{R} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (25)$$

or

$$\left(g\frac{M}{L} - 1\right) h_a = \frac{3}{2}\frac{1}{R} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (26)$$

while a^2_{max} becomes

$$a^2_{max} = \frac{4}{9}\frac{\alpha}{\gamma} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (27)$$

It was seen above that with a gradual increase of M from $M = 0$, the system started oscillating, though originally with very small amplitude, as soon as M had reached the value M_0 given by

$$\left(g\frac{M_0}{L}-1\right)h_a=\frac{1}{R}$$

If therefore *e.g.* M is left at this value M_0, and we decrease the damping to $\frac{2}{3}$ of its original value, we may (from (26)) expect the system to vibrate with the maximum amplitude possible. However, there is some uncertainty whether the power series for the characteristic is still valid for such big amplitudes. As far as our theory goes it would follow that the maximum amplitude possible by varying the back coupling would be independent of the damping of the circuit as long, at least, as (25) can be satisfied.

9. Moreover, the question as to the maximum amplitude obtainable, may be solved by starting from the general derived characteristic of (23).

For, after differentiating (24) with respect to k and putting $\frac{da}{dk}=0$, we find for the condition of maximum oscillations:

$$\int_{-1}^{+1}\frac{d\phi\,(E-kay)}{d\,(E-kay)}\cdot\frac{y^2\,dy}{\sqrt{1-y^2}}=0 \quad . \quad . \quad . \quad . \quad . \quad . \quad (28)$$

Hence, generally from (28) together with (24) the maximum value of a may be obtained, as well as the necessary value of M.

10. It remains to be considered how the triode vibrations gradually reach the finite stationary amplitude discussed above. To this end we multiply (I.^{a}) with $\int_0^t vdt$, and again consider the derived characteristic to have the form:

$$i=-\alpha v+\beta v^2+\gamma v^3$$

we thus obtain

$$C\frac{d^2v}{dt^2}\cdot\int_0^t vdt+\left(\frac{1}{R}-\alpha\right)\cdot\frac{dv}{dt}\cdot\int_0^t vdt+\frac{1}{L}\,v\cdot\int_0^t vdt+$$
$$+\beta\frac{d(v^2)}{dt}\cdot\int_0^t vdt+\gamma\frac{d(v^3)}{dt}\cdot\int_0^t vdt=0 \quad . \quad . \quad (29)$$

Again, assuming v to be of the approximate form

$$v=a\cos\omega t$$

where now a is a gradually varying function of t (as a first approximation ω is kept independent of t) we substitute this expression for v in (29). The equation thus obtained consists of two kinds of terms, one varying slowly and the other rapidly with t. Retaining only the terms which vary slowly, or what amounts to the same thing, taking the mean over one period of the terms of equation (29), we obtain the approximate equation

$$\frac{1}{4}C\frac{d(a^2)}{dt}+\left(\frac{1}{R}-\alpha\right)\frac{a^2}{2}+\frac{1}{4L\omega^2}\frac{d(a^2)}{dt}+\frac{3}{8}\gamma a^4=0 \quad . \quad . \quad (30)$$

Now (30) may be written approximately

$$\left(\frac{1}{R}-\alpha\right)a^2+\frac{3}{4}\gamma a^4+C\frac{d(a^2)}{dt}=0$$

the solution of which is

$$a^2=\frac{\alpha-\frac{1}{R}}{\frac{3}{4}\gamma}\cdot\frac{1}{1-\text{const.}\ \epsilon^{-\left(\frac{\alpha-1/R}{C}\right)t}} \quad . \quad . \quad . \quad . \quad . \quad (31)$$

The final value $\frac{4}{3}\frac{\alpha-\frac{1}{R}}{\gamma}$ is therefore reached asymptotically, though not according to a simple exponential law.

II.—THE BEHAVIOUR OF A TRIODE SYSTEM UNDER AN IMPRESSED SINUSOIDAL E.M.F.

11. Let (Fig. 12) an E.M.F. $B \sin pt$ be impressed upon the L branch of an oscillatory circuit connected to a thermionic tube in the usual way. It is

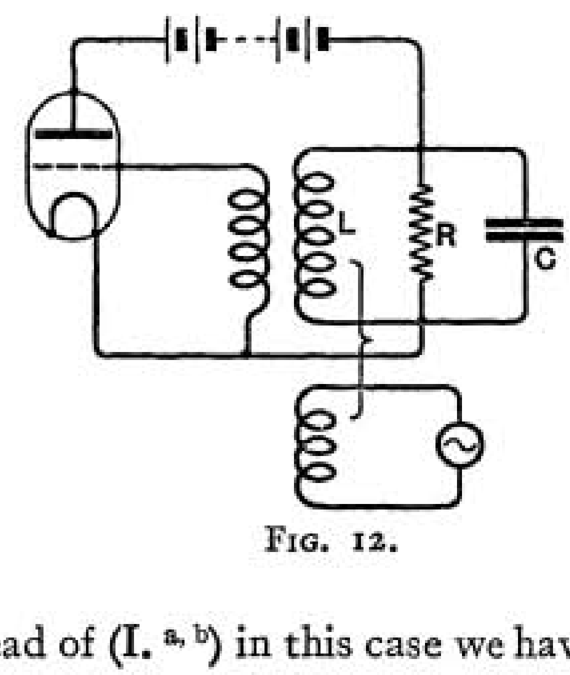

FIG. 12.

easy to show that instead of (I. [a, b]) in this case we have to solve the equations

$$\left.\begin{aligned}\frac{di}{dt}+C\frac{d^2v}{dt^2}+\frac{1}{R}\frac{dv}{dt}+\frac{1}{L}v&=\frac{B}{L}\sin pt.\\ i&=\psi(kv)\end{aligned}\right\} \quad . \quad . \quad . \quad . \quad (\text{III.})$$

If here again the derived characteristic is taken to be

$$i=-\alpha v+\beta v^2+\gamma v^3$$

(III.) is reduced to

$$C\frac{d^2v}{dt^2}+\left(\frac{1}{R}-\alpha\right)\frac{dv}{dt}+\frac{1}{L}v+\beta\frac{d(v^2)}{dt}+\gamma\frac{d(v^3)}{dt}=B'\sin pt. \quad . \quad \text{(IV.)}$$

where $B'=\frac{B}{L}$.

A simple way of obtaining an approximate solution of (IV.), sufficiently accurate to explain some properties of the system not explained by the linear theory, is to assume v to be of the form $v=b\sin(pt+\phi)$.

We therefore only consider the case where the reaction is not sufficient to make the triode system oscillate spontaneously.

First multiply (IV.) by $\sin pt$ and integrate over the fundamental period, secondly multiply (IV.) by $\cos pt$ and integrate over the same period. We thus arrive at the two equations

$$\left(\frac{1}{Lp}-Cp\right)\cos\phi-\left\{\left(\frac{1}{R}-\alpha\right)+\frac{3}{4}\gamma b^2\right\}\sin\phi=\frac{B'}{bp}$$

$$\left(\frac{1}{Lp}-Cp\right)\sin\phi+\left\{\left(\frac{1}{R}-\alpha\right)+\frac{3}{4}\gamma b^2\right\}\cos\phi=0.$$

Eliminating ϕ results in

$$\frac{B'^2}{b^2p^2}=\left(\frac{1}{Lp}-Cp\right)^2+\left(\frac{1}{R}-\alpha+\frac{3}{4}\gamma b^2\right)^2 \quad . \quad . \quad . \quad . \quad (32)$$

which gives the amplitude b of the forced vibration in terms of the constants of the circuit and the triode and of the impressed E.M.F.

Some special cases present themselves.

1. If the impressed angular frequency p is appreciably different from the natural frequency $\omega=\frac{1}{\sqrt{LC}}$, and if the impressed amplitude is small, so that the second term in the right-hand member of (32) may be neglected in comparison with the first, the simple well-known result emerges

$$b=\frac{B'}{\left(\frac{1}{L}-Cp^2\right)}$$

where the induced amplitude is simply proportional to the impressed E.M.F.

2. If the impressed E.M.F. B' is small the back coupling being adjusted such that the system is not yet oscillating $\left(\alpha<<\frac{1}{R}\right)$, $\frac{3}{4}\gamma b^2$ may be neglected in comparison with $\frac{1}{R}-\alpha$.

Then the result is

$$b^2=\frac{B'^2}{p^2}\cdot\frac{1}{\left(\frac{1}{Lp}-Cp\right)^2+\left(\frac{1}{R}-\alpha\right)^2}$$

and the circuit behaves as if the conductance $\frac{1}{R}$ parallel to the capacity were reduced to $\frac{1}{R} - \alpha$. If, over and above this condition, the impressed E.M.F. is in resonance with the triode circuit, we have

$$b = \frac{B'}{p} \cdot \frac{1}{\frac{1}{R} - \alpha}$$

showing that, with a retro-action such that

$$\alpha = \left(g\frac{M}{L} - 1\right) \cdot \frac{di_a}{dv_a} < 0$$

the system presents a damping greater than would occur without the triode, while for

$$\alpha > 0$$

the damping is reduced, resulting in a greater amplitude than would be obtained without the triode. Hence the resistance term $\frac{1}{R}$ is simply reduced or increased to $\frac{1}{R} - \alpha$.

With the retro-action adjusted such that exactly $g\frac{M}{L} - 1 = 0$ the system has, with the triode, the same damping as without. This affords an easy means of obtaining the voltage magnification factor g under actual (high frequency) working conditions. The experiment therefore consists in letting (*e.g.* by means of a second oscillating triode system) an E.M.F. be induced in the inductance of the triode system under consideration. Next measure (*e.g.* with crystal and galvanometer) the current induced when the heating current is cut off. Now heat the filament and adjust the back coupling until the same galvanometer deflection is obtained, then

$$g = \frac{M}{L}.$$

Obviously this method is independent of any calibration of the galvanometer-crystal combination.

3. If, finally, under resonance condition, the retro-action is adjusted near the point where the system would just commence to oscillate freely, and therefore

$$\alpha \doteq \frac{1}{R}$$

we have

$$\frac{B'}{p} = \frac{3}{4}\gamma b^3$$

or

$$b = \sqrt[3]{\frac{B'}{\frac{3}{4}\gamma p}} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (33)$$

30

The same formula (33) may also be applied if, in general, the induced E.M.F. is big enough to make the resulting induced b such that

$$\frac{3}{4}\gamma b^2 >> \frac{1}{R} - \alpha$$

and

$$\frac{3}{4}\gamma b^2 >> \frac{1}{pL} - Cp$$

thus showing clearly the well-known limiting action of a triode. For, under these conditions, the resulting amplitude, instead of being proportional to the *first power* of the induced E.M.F., is proportional to the *third power root* of the same quantity. Small oscillations are therefore magnified to a greater extent than bigger ones.

4. In conclusion the main results of Parts I. and II. of this paper may be summarised as follows:

An oscillatory circuit consisting of three parallel branches L, C and R, and connected in the usual way to a triode generator behaves as if the conductance $\frac{1}{R}$ were reduced to

$$\frac{1}{R} - \alpha + \frac{3}{4}\gamma a^2$$

where a is the alternating voltage across the plate-filament.

For self-oscillation this conductance must be zero, thus yielding at once the amplitude of the vibrations in terms of the circuit and triode constants.

If an impressed E.M.F. is applied to the system, the conductance is reduced to the same value, while a again represents the alternating P.D. set up between plate and filament.

As long, therefore, as only *one single* vibration is present in any system of triodes and circuits, however complicated it may be, the simple well-known alternating current theory may be used to find the resulting amplitudes in the different circuits, in terms of the triode constants α and γ if only the conductance $\frac{1}{R}$ be replaced by $\frac{1}{R} - \alpha + \frac{3}{4}\gamma a^2$.

Finally, the parallel conductance $\frac{1}{R}$, which materially simplifies the formulæ, can easily be replaced by a series resistance, either in the L or C branch, as indicated in the paper.

Physical Laboratory,
Teyler's Institute, Haarlem (Holland).

July 17th, 1920.

The Calculation of the Self and Mutual Inductance of Coils.

At intervals during the past year A. Esau has published papers dealing with the calculation of the inductance of coils of various types, and although abstracts have been given these have been too brief to enable one to use Esau's results without reference to the original publications. We have been asked therefore to give further information as to the values of the various coefficients appearing in the final formulæ, so that these may be used without reference to the original papers.

I. Single layer coil on square frame.*

L = inductance in cm; a = side of square; n = number of turns;

g = pitch of turns; ρ = radius of wire.

$$\text{then } L = 8\,an(S_1 + S_2)$$

where $S_1 = f\left(\frac{a}{\rho}\right)$ and $S_2 = f\left(\frac{g}{a}, n\right)$.

Table I. gives the values of $S_1 = f\left(\frac{a}{\rho}\right)$ and Table II. the values of $S_2 = f\left(\frac{g}{a}, n\right)$.

TABLE I.

a/ρ	S_1	a/ρ	S_1
20	2·472	300	5·180
30	2·877	400	5·467
40	3·165	500	5·691
50	3·388	600	5·873
60	3·570	700	6·027
70	3·724	800	6·161
80	3·858	900	6·278
90	3·976	1000	6·383
100	4·081	2000	7·077
120	4·264	3000	7·483
140	4·418	4000	7·770
160	4·551	5000	7·993
180	4·669	10000	8·690
200	4·774		

* RADIO REVIEW Abstract No. 73, December, 1919.

TABLE II.

n	Values of g/a.							
	0·002	0·004	0·006	0·008	0·01	0·02	0·03	0·04
2	5·44	4·75	4·36	4·06	3·84	3·16	2·76	2·49
3	10·43	9·04	8·26	7·67	7·23	5·87	5·08	4·55
4	15·09	13·02	11·84	10·96	10·30	8·27	7·10	6·31
5	19·52	16·75	15·19	14·02	13·14	10·45	8·90	7·86
6	23·75	20·32	18·34	16·88	15·79	12·44	10·52	9·24
7	27·81	23·69	21·33	19·59	18·27	14·28	11·99	10·47
8	31·74	26·94	24·19	22·16	20·63	16·00	13·35	11·60
9	35·55	30·67	26·92	24·60	22·87	17·59	14·60	12·63
10	39·24	33·09	29·56	26·96	25·01	19·11	15·77	13·58
11	42·84	36·01	32·09	29·21	27·05	20·53	16·85	14·45
12	46·36	38·86	34·56	31·39	29·02	21·89	17·88	15·26
13	49·77	41·60	36·92	33·43	30·90	23·18	18·82	16·00
14	53·12	44·28	39·21	35·44	32·71	24·39	19·71	16·69
15	56·40	46·89	41·44	37·39	34·46	25·54	20·55	17·33
16	59·62	49·44	43·61	39·28	36·15	26·65	21·33	17·89
17	62·78	51·93	45·73	41·12	37·79	27·71	22·08	18·45
18	65·88	54·36	47·78	42·89	39·37	28·71	22·78	18·97
19	68·92	56·74	49·78	44·62	40·90	29·68	23·46	19·44
20	71·92	59·07	51·74	46·30	42·39	30·61	24·10	19·89
21	74·86	61·36	53·65	47·94	43·84	31·50	24·71	20·32
22	77·76	63·59	55·52	49·54	45·24	32·36	25·23	20·70
23	80·63	65·80	57·33	51·11	46·62	33·20	25·91	21·07
24	83·38	67·92	59·15	52·58	47·91	33·95	26·37	21·37
25	86·21	70·03	60·85	54·06	49·20	34·72	26·80	21·66

II. Square plane or pancake coils.*

$$L = 8\,an(S_1 + S_3)$$

where $S_1 = f\left(\frac{a}{\rho}\right)$ is the same as in the previous case (Table I.) and $S_3 = f\left(\frac{g}{a}, n\right)$. Table III. gives the values of S_3.

a is here the side of the mean turn.

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* RADIO REVIEW Abstract No. 272, April, 1920.

TABLE III.

n	Values of g/a.				
	0·002	0·004	0·01	0·02	0·04
2	5·44	4·76	3·90	3·18	2·49
3	10·43	9·05	7·21	5·85	4·49
4	15·09	13·02	10·23	8·24	6·23
5	19·50	16·76	13·10	10·38	7·71
6	23·74	20·29	15·73	12·35	9·06
7	27·79	25·63	18·20	14·15	10·26
8	31·71	26·91	20·54	16·83	11·34
9	35·51	30·02	22·75	17·39	12·31
10	39·20	33·04	24·88	18·90	13·19
11	42·79	35·94	26·89	20·26	13·99
12	46·30	38·78	28·83	21·58	14·76
13	49·72	41·51	30·68	22·79	15·46
14	53·06	44·17	32·45	23·95	16·10
15	56·32	46·76	34·17	25·08	16·78
16	59·54	49·30	35·85	26·15	17·42
17	62·69	51·67	37·43	27·11	17·89
18	65·76	54·18	39·02	28·10	18·33
19	68·80	56·54	40·49	29·02	19·03
20	71·78	58·87	41·93	29·89	19·39
21	74·72	61·12	43·32	30·70	19·95
22	77·60	63·34	44·65	31·50	20·44
23	80·46	65·53	46·06	32·32	20·97
24	83·22	67·62	47·26	33·03	21·44
25	85·96	69·71	48·51	33·73	21·91

III. Multi-layer coils.*

$$L = 4\pi rmn(S_4 + S_5)$$

where r = mean radius of coil.
m = number of layers.
n = number of turns per layer.
ρ = radius of wire.

$S_4 = f\left(\frac{r}{\rho}\right)$ (see Table IV.),

* See RADIO REVIEW Abstract No. 329, May, 1920.

and $S_5 = f\left(\frac{g}{2r}, n, m\right)$ (see Tables VA. and VB.).

g = pitch of turns in a layer, which is assumed to be equal to the radial pitch of successive layers.

Table VA. gives the values of S_5 for $m = 2$ and Table VB. the values for $m = 3$.

TABLE IV.

r/ρ	S_4	r/ρ	S_4	r/ρ	S_4
20	3·329	120	5·121	700	6·884
30	3·734	140	5·275	800	7·018
40	4·022	160	5·408	900	7·135
50	4·245	180	5·526	1000	7·240
60	4·427	200	5·631	2000	7·934
70	4·581	300	6·037	5000	8·850
80	4·715	400	6·324	10000	9·543
90	4·833	500	6·548		
100	4·938	600	6·730		

TABLE VA. $m = 2$.

n	Values of $g/2r$.			
	0·002	0·004	0·01	0·02
2	16·45	14·37	11·62	9·55
3	26·54	23·08	18·49	15·04
4	36·07	31·22	24·80	20·00
5	45·13	38·89	30·64	24·48
6	53·84	46·22	36·15	28·61
7	62·24	53·26	41·33	32·36
8	70·34	60·00	46·25	36·04
9	78·26	66·47	50·90	39·34
10	85·88	72·74	55·36	42·49
11	93·35	78·84	59·64	45·44
12	99·80	83·94	63·93	47·42
13	107·8	90·54	67·72	50·93
14	114·7	96·15	71·52	53·45
15	121·6	101·6	75·21	55·88

TABLE VB. $m = 3$.

n	Values of $g/2r$.			
	0·002	0·004	0·01	0·02
2	26·54	23·09	18·49	15·05
3	41·36	35·84	28·48	22·98
4	55·44	47·85	37·75	30·17
5	68·89	59·23	46·40	36·74
6	81·80	70·07	54·48	42·85
7	94·30	80·50	62·17	48·50
8	106·4	90·56	69·49	53·84
9	118·2	100·2	76·42	58·78
10	129·6	109·6	83·05	63·43
11	140·8	118·7	89·46	67·89
12	150·6	126·4	94·46	70·96
13	162·3	136·1	101·4	74·96
14	172·7	144·5	107·1	79·60
15	182·9	152·6	112·5	83·20

TABLE VI.

n	Values of $g/2r$.			
	0·002	0·004	0·01	0·02
2	16·45	14·38	11·62	9·56
3	41·36	35·84	28·48	22·98
4	73·90	63·55	49·75	39·48
5	113·52	96·90	74·90	58·48
6	159·7	135·6	103·5	79·58
7	212·2	179·1	135·0	102·5
8	270·5	227·0	169·2	126·7
9	334·6	279·4	206·3	152·4
10	405·9	337·6	247·3	181·0
11	478·4	395·7	286·3	206·3
12	558·2	459·5	329·4	234·5
13	643·0	527·0	374·0	264·0
14	734·0	600·0	423·0	295·0
15	825·0	671·0	468·0	322·0

If the winding space is square $m = n$ and

$$L = 4\pi r n^2 (S_4 + S_6)$$

where n = turns per layer = number of layers

n^2 = total number of turns

and $S_6 = f\left(\frac{g}{2r}, n^2\right)$—see Table VI.

IV. Attention should also be drawn to Abstract No. **1192** on p. 773 of this issue, where formulæ and tables are given for the self and mutual inductances of single square turns.

G. W. O. H.

Mica Condensers for Radio Work.

By PHILIP R. COURSEY, B.Sc.

The use of mica as a dielectric for condensers for high voltage work has increased greatly in the past few years. In particular the commercial development of these types of condensers has been carried on by the Dubilier Condenser Company, Inc., of New York, by the Wireless Speciality Apparatus Company also of New York, and by the Dubilier Condenser Company of London. Condensers manufactured by these firms have been used extensively during the war for radio work by many of the Allied Governments as well as by commercial wireless companies.

In a recent infringement suit brought by the Dubilier Condenser Company, Inc., against the Wireless Speciality Apparatus Company (who manufacture condensers under the trade name of "Faradon") a final decree has been handed down by His Honour Augustus N. Hand, U.S. District Judge for the Southern District of New York, on October 4th, 1920, holding :—

"That said Letters Patent Nos. 1,229,914 and 1,229,915 are good and valid in law as to the second, third, fourth, fifth, seventh, eighth, ninth, twelfth, fourteenth, and fifteenth claims of Letters Patent No. 1,229,914 and as to the first, eighth, twelfth, sixteenth and seventeenth claims of Letters Patent No. 1,229,915.

That the defendant Wireless Speciality Apparatus Company has infringed upon each and all of said claims, of said Letters Patent Nos. 1,229,914, and 1,229,915 by manufacturing, selling and using, or causing to be manufactured, sold or used, condensers embodying or employing the inventions of said claims of said Letters Patent.

That the fourth claim of Letters Patent No. 1,229,915 is invalid in law, being anticipated by the prior use of the subject-matter thereof by the United States Navy, and National Electrical Supply Company of Washington, D.C., and that the bill be dismissed as to said claim of said patent."

The patents in question deal respectively with means for boxing up the complete condenser in a metallic case, and for the method of constructing high voltage condensers. The claims referred to in the judgment cover in effect the following leading features :—A condenser so constructed that one

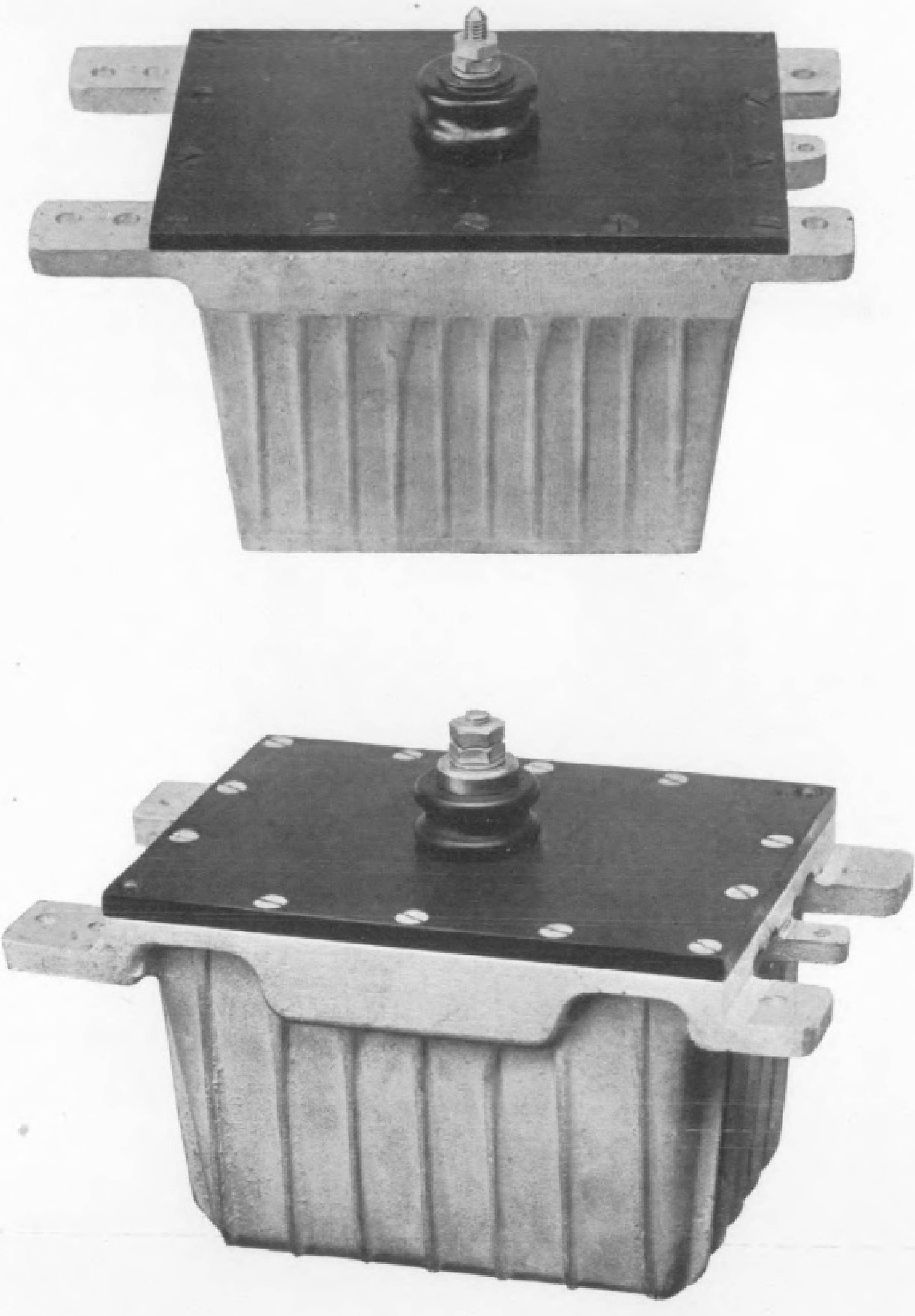

Fig. 1.—Outside View of Two Patterns of Dubilier Mica Condenser, showing Metallic Case with inclined Sides and Insulated Terminal in Lid.

(*To face p.* 768.)

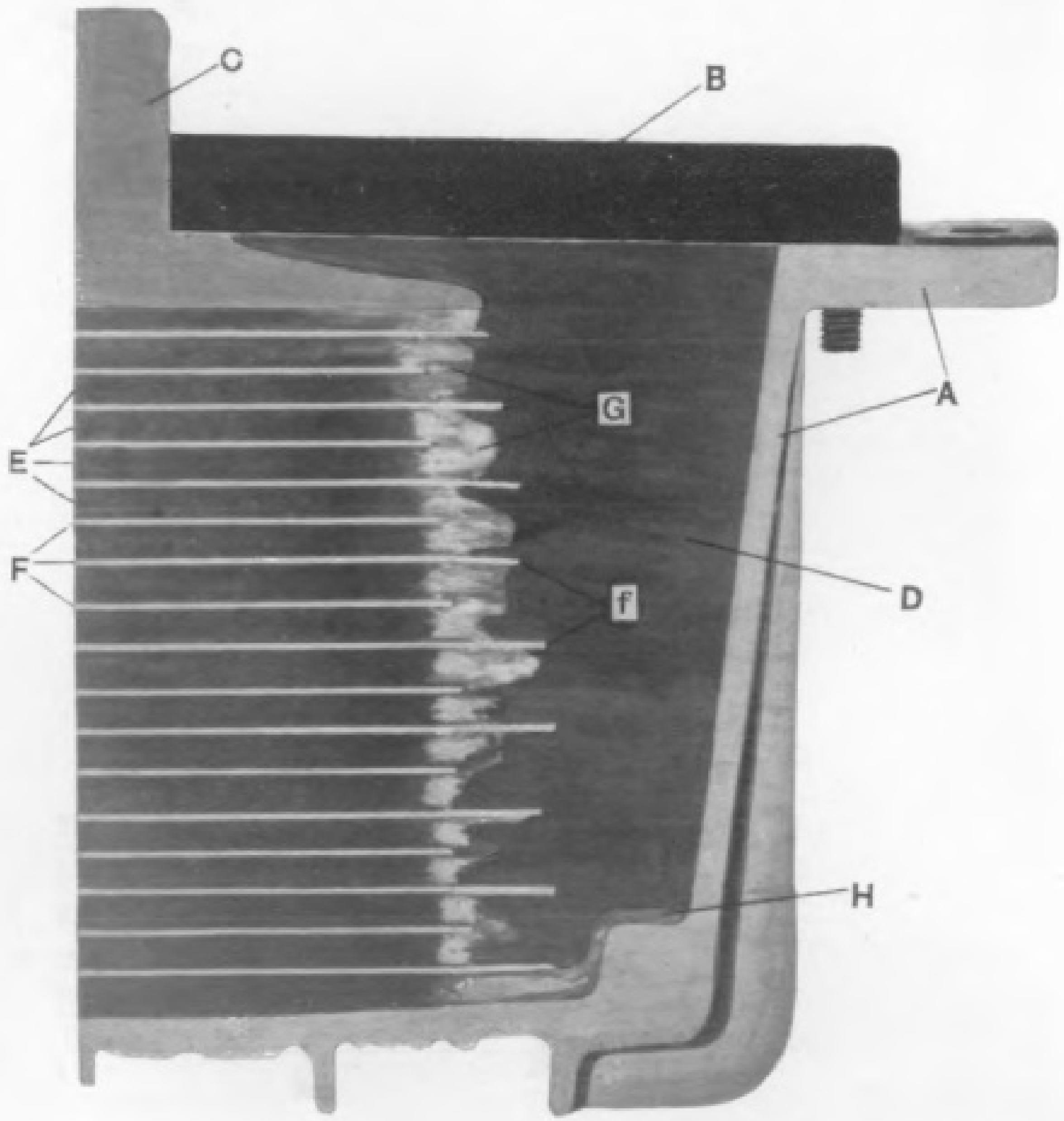

FIG. 2.—CROSS SECTIONAL VIEW OF MICA CONDENSER IN CONTAINING CASE SAWN THROUGH CENTRALLY.

A = Metal case with inclined sides. B = Insulating lid. C = Terminal in lid provided with enlarged lower surface for compressing the condenser. D = Insulating filling compound. E = Condenser sections which are connected in series to form the complete unit. F = Mica insulating barriers. G = Soldered connections between condenser sections. H = Connection between lowest section and case.

(*To face p.* 769.)

of its terminals is formed by the metallic containing case while the other is arranged so as to compress the condenser into the case. These terminals should preferably be of relatively small mass and relatively large surface to enable them to conduct away any heat from the interior of the condenser case. The second terminal may be mounted in or through an insulating lid or closure for the containing case, and it is then enabled to serve not only as an electrical connection to the condenser but also for compressing the condenser and preventing its expansion or vibration when in use, as well as for conducting away the heat.

In order to provide greater insulation from the case at the high potential end of the condenser—*i.e.*, the end connected to the insulated terminal in the lid—the use of a case having inclined sides is covered by the claims that have been upheld. The condenser unit is disposed centrally within the casing with its elements parallel to the bottom, the sides of the case sloping outwards so as to obtain a greater spacing between the condenser sections and the case at the upper end of the unit.

As regards the construction of mica condensers for high voltage circuits, the claims of U.S. Patent 1,229,915 which have been upheld cover a high tension condenser unit consisting of sections connected in series for dividing the potential among them, each section comprising conducting plates and intervening sheets of insulation constituting the dielectric, the said sheets having a layer of insulating adhesive between them and the conductor plates and being arranged to overlap the edges of the conductor plates. Between adjacent sections extra insulating plates are customarily inserted so as to have their ends projecting alternately in opposite directions beyond the condenser sections so that the terminals of the sections can be joined together in pairs between the projecting ends of the insulating plates. This last feature of construction is one, however, that has not been upheld in the infringement suit on account of prior use. The fourth claim of Patent 1,229,915 which has been held to be invalid for this reason reads as follows :—

"A condenser unit comprising sections, and insulating plates between the sections, said plates being arranged to have their end projecting alternately in opposite directions, whereby the terminals of the sections can be joined together in pairs at both ends of said plates, the projecting ends of the plates intervening between the sections having their terminals so connected and adjacent sections."

In order to render clearer the features of this type of condenser construction the general appearance of two condensers built in accordance with these specifications is shown in Fig. 1, while in Fig. 2 is an interesting illustration of a condenser which has been sawn through centrally, perpendicularly to the condenser plates, in order to show the internal arrangements. The reference letters placed on this illustration indicate the parts mentioned above. The insulating barriers between the condenser sections, each of which consists of a complete small condenser comprising interleaved sheets of mica and metal foil, may be seen at F, the alternately projecting ends, which separate the soldered connections G between condenser sections, being indicated at f.

Features for the New Volume.

By THE EDITOR.

With this issue we complete the first volume of the Radio Review. In order to avoid the disadvantage which one always experiences when looking up references to a journal in which the change of volume does not coincide with the change of year, it was decided not to close the first volume with the twelfth monthly issue in September, but to run on to the end of the year.

The experience gained during the last fifteen months has suggested a number of improvements which it is intended to introduce in the new volume. Some of these improvements are due to suggestions made by readers, and we take this opportunity of thanking them for writing to point out ways in which they considered that the usefulness and interest of the Radio Review might be increased. By using a thinner paper it will be possible to increase the number of pages in each issue without increasing the bulk of the annual volume. By increasing the number of pages it will be possible to publish more papers of general interest as distinct from those which, by reason of their mathematical character or of their detailed investigation of specific points, appeal to a smaller circle of readers. It is also intended to publish translations either in full or abbreviated of those articles in foreign periodicals which appear to be of such importance as to merit fuller treatment than is possible in a brief abstract. An abstract can only indicate the general nature of an article, but cannot in many cases give sufficient detail for a person specially interested in that branch of the subject. If the original article is in a language with which the reader is familiar, he can then refer to it for further detail, and the abstract has fulfilled its purpose. In many cases, however, this will not be so, and we have therefore decided to devote considerable space to translations of foreign papers which are likely to interest the majority of our readers.

A new feature will be the inclusion of personal, scientific, and commercial notes relating to radiotelegraphy. A section will be devoted to the wireless telegraphy laws of various countries so that all changes in the legislation affecting radio work will be noted in our columns.

In order to increase their utility the abstracts of articles, patents, etc., will be classified so that it will be possible to refer without any trouble to the information recently published about any particular branch of the subject. As part of this classification references will be included to those articles which are dealt with more fully in other parts of the Review, so that the references under any given subject heading will be quite complete.

By thus broadening the scope of the Radio Review it is hoped to make it of greater value to all wireless engineers and students of radiotelegraphy and telephony as well as to the scientist and research worker.

Review of Radio Literature.

1. Articles and Patents.

1182. ELECTROSTATICALLY COUPLED CIRCUITS. L. Cohen. (*Proceedings of the Institute of Radio Engineers*, 8, pp. 434—437, October, 1920.)

The theory of electrostatic coupling is discussed from the point of view of energy transfer and sharpness of tuning. The circuit considered is shown in Fig. 1, where C_1 L_1 and C_2 L_2 are the two oscillatory circuits and C_0 the coupling condenser. In the case of syntony (when $C_1 L_1 = C_2 L_2$) there are two natural frequencies of oscillation f_1 and f_2 where

$$f_1 = \frac{1}{2\pi\sqrt{LC}}$$

$$f_2 = \frac{1}{2\pi\sqrt{LC\left(1 + \frac{C_0}{C_1} + \frac{C^0}{C_2}\right)}}$$

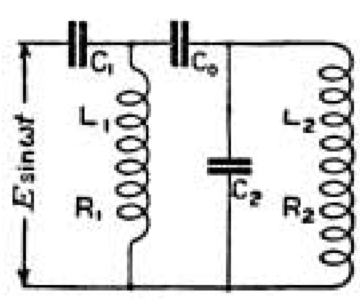

FIG. 1.

It is shown that even for tight coupling to get the maximum energy transfer to the secondary circuits C_0 is small in comparison with C_1 and C_2 so that for practical purposes the assembly has one frequency. The current in the secondary circuit L_2C_2 is shown to be

$$\frac{E}{\sqrt{\left(R_1R_2\,\frac{C_1C_2\omega}{C_0}\right)^2 + \left(R_2\frac{C_2}{C_1}\right)^2}}$$

In a comparison with electromagnetic coupling it is shown that the secondary resonance currents in the two cases are of the same order of magnitude but that the electrostatic coupling yields superior sharpness of resonance.

1183. THE ADJUSTMENT OF COUPLING IN QUENCHED SPARK SYSTEMS. (*Elektrotechnische Zeitschrift*, 41, p. 556, July 15th, 1920.)

The German courts have decided in favour of the Telefunken Company's Patent No. 198562 for the use of the critical value of the coupling to give the optimum effect, and have forbidden E. Huth & Co. to use a system in which the coupling is so adjustable.

1184. THE ENERGY RELATIONS IN A CIRCUIT WITH SELF-INDUCTION. P. Terpstra. (*Physikalische Zeitschrift*, 21, pp. 467—469, September 1st, 1920.)

Shows how the energy stored in the field and that lost as heat when a steady P.D. is suddenly applied to an inductive circuit can be represented graphically by the volumes enclosed by certain curved surfaces.

1185. A MECHANICAL APPARATUS FOR DEMONSTRATING PROPERTIES OF OSCILLATORY CIRCUITS. O. Oldenberg. (*Physikalische Zeitschrift*, 21, pp. 463—465, September 1st, 1920.)

A system of coupled pendulums with electromagnetic damping, fitted with projecting and recording devices. The system is analogous to electric circuits with capacity coupling. All the various quantities can be readily varied. It was designed by Simon and is now being made by Leybolds of Cologne.

1186. ELECTRICAL OSCILLATIONS IN ANTENNAS AND INDUCTION COILS. A. Hund. (*Proceedings of the Institute of Radio Engineers*, 8, pp. 424—430, October, 1920.)

Further discussion of the paper by J. M. Miller with the above title.* The calculation of the correct effective antenna constants is dealt with for any case of coil loading for a long horizontal antenna excited by a sinusoidal radio frequency electromotive force. If C and L are the correct antenna capacity and inductance we have

$$C = \frac{8\lambda'}{\pi\lambda} \frac{\sin^2 90 \frac{\lambda}{\lambda'}}{\pi \frac{\lambda}{\lambda'} + \sin 180 \left(1 - \frac{\lambda}{\lambda'}\right)} C_A$$

$$L = \frac{\lambda'}{2\pi\lambda} \frac{\pi \frac{\lambda}{\lambda'} - \sin 180 \left(1 - \frac{\lambda}{\lambda'}\right)}{\sin^2 90 \frac{\lambda}{\lambda'}} . L_A$$

where λ and λ' denote the natural fundamental wavelengths for the unloaded and the coil-loaded antenna system respectively. The quantities C_A and L_A represent the static antenna constants for which the potential as well as the current are for all points of the horizontal length of antenna of unchanged amplitude and same phase. C_A and L_A may be determined by any of the ordinary low frequency methods.

1187. THE USE OF GROUND WIRES AT REMOTE CONTROL STATIONS. E. W. Stone. (*Proceedings of the Institute of Radio Engineers*, 8, pp. 431—433, October, 1920.)

Further discussion of the paper with the above title by A. H. Taylor and A. Crossley, previously published.†

Experiments with ground and water wires (similar to those of Taylor's) were carried out at North Island with very successful results. Taylor accounts for the operation of the buried antennæ by the induction of potentials within the wire by the horizontal component of the tilted electromagnetic wave front. This explanation however does not account for the action of submarine antennæ in which case the most satisfactory operation is always obtained with a medium of good conductivity. To explain this the theory is suggested that the potentials are induced in the antenna wire by the magnetic field surrounding the currents produced in the earth or water. Since these earth currents are greatest in media of high conductivity there will be maximum induction of potentials with consequent greatest signal strength.

1188. THE WAVELENGTH RELATION FOR A GENERALISED BESSEL'S ANTENNA. A. Press. (*Proceedings of the Institute of Radio Engineers*, 8, pp. 441—447, October, 1920.)

A continuation of the author's discussion ‡ of a vertical antenna taking into account the variable distribution of both inductance and capacity per unit length of the aerial. An antenna of negligible resistance and height l is assumed together with an impressed frequency f such that $\frac{\pi l}{\lambda} = 1$ where λ is the wavelength corresponding to f. The solution for the voltage and current distribution along the antenna is given in terms of Bessel's Functions. Curves for ready application to numerical cases are given.

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* See RADIO REVIEW Abstract No. 2, October, 1919, for abstract of the original paper; also No. 269, April, 1920, for further reference to additional discussion.

† See RADIO REVIEW Abstract No. 832, September, 1920, for abstract of the original paper.

‡ See *Proceedings of the Institute of Radio Engineers*, December, 1918.

1189. **THE EFFICIENCY OF AERIALS, AND THE POWER REQUIRED FOR LONG DISTANCE TRANSMISSION.** G. W. O. Howe. (*Electrician*, 85, pp. 298—300, September 10th, 1920. *Technical Review*, 7, pp. 144—145, November 2nd, 1920 —Abstract.)

Paper read before Section G of the British Association at Cardiff. The subject-matter is covered by the editorial articles in our August and September issues,* where the full paper was given with all the diagrams.

1190. **OSCILLATING CIRCUITS WITH TRIODE GENERATORS AS ACOUSTIC FREQUENCY STANDARDS.** (*Zeitschrift für Instrumentenkunde*, 40, pp. 119—120, June, 1920.)

The Reichsanstalt has made experiments to see whether the constancy of the frequency is such that such valve circuits could be used instead of standard tuning forks. The possibility of a continuous variation of the frequency would be a great advantage. Experiments showed that with proper precautions the frequency was constant to 1 part in 10,000 even when the triode was changed.

1191. **A SIMPLE METHOD OF CALCULATING THE INDUCTANCE OF A SINGLE LAYER WINDING.** (*La T.S.F. Moderne*, 1, pp. 151—154, August, 1920.)

The method first described is essentially that first developed by H. Nagaoka. (Inaccuracies in the formulæ and numerical examples were corrected in the September issue.)

1192. **THE MUTUAL INDUCTANCE OF SINGLE TURN RECTANGLES AND SQUARES.** A. Esau. (*Annalen der Physik*, 61, pp. 410—420, February 22nd, 1920. *Science Abstracts*, 23A, pp. 289—290, Abstract No. 743, May 31st, 1920—Abstract.)†

The author develops a formula for the mutual inductance of two parallel rectangles of different sizes but symmetrically placed and then considers several special cases, obtaining results in accordance with the known formulæ for these cases. Simplified approximate formulæ are obtained for the case of squares of nearly the same size, when separated by a short distance. The accurate formula for the mutual inductance of two squares placed parallel and symmetrical is simplified and written thus

$$M = aS$$

where a = side of smaller square
$a + 2c$ = side of large square
d = distance between the planes of the squares
$S = f(c/a, d/a)$, the values of which are given in the following table.

c/a	Values of d/a						
	0·0	0·1	0·2	0·5	1·0	2·0	4·0
0·0	—	13·02	8·264	3·224	1·016	0·202	0·028
0·1	14·74	12·12	8·832	3·688	1·312	0·264	0·036
0·2	10·70	9·904	8·232	4·232	1·576	0·360	0·056
0·5	6·40	6·256	5·872	4·264	2·136	0·600	0·112
1·0	3·968	3·936	3·856	3·384	2·328	0·952	0·208
2·0	2·320	2·296	2·256	2·176	1·888	1·184	0·416
4·0	1·232	1·248	1·256	1·232	1·200	1·200	0·568

* RADIO REVIEW, 1, pp. 540—543, August, and pp. 598—608, September, 1920.
† See also pp. 763—768, in this issue.

This formula in conjunction with the following formula for the self-inductance of a single square turn enables one to calculate the coupling coefficient of two single square turns.

$$L = aS', \text{ where } S' = f\left(\frac{a}{\rho}\right) \text{ and } \rho = \text{ radius of wire.}$$

a/ρ	S'	a/ρ	S'	a/ρ	S'
20	20·18	200	38·23	2000	56·62
40	25·52	400	43·76	4000	62·16
60	27·90	600	47·00	6000	65·41
80	30·97	800	49·30	8000	67·70
100	32·73	1000	51·08	10000	69·49

1193. A METHOD FOR MEASURING FREQUENCIES. A. Zacek. (*Physikalische Zeitschrift*, 20, pp. 348—350, August 1st, 1919. *Electrical World*, 75, p. 1150, May 15th, 1920—Abstract.)

An apparatus is referred to comprising a double branch test circuit each one branch containing an ohmic resistance and the other an inductance. The heater wire of a thermo-element is included in each branch, and the thermocouples themselves connected to the two windings of a differential galvanometer. The frequency of the test current may be determined by varying the resistance branch until the galvanometer shows zero deflection.

1194. THE USE OF THE TELEPHONE RECEIVER IN BRIDGE METHODS. (*Zeitschrift für Instrumentenkunde*, 40, pp. 123—124, June, 1920.)

Low-frequency A.C. can be used if a buzzer be inserted to interrupt the current. The arrangement is inferior to the vibration galvanometer.

1195. THE INTENSITY OF WIRELESS SIGNALS. (*Scientific American*, 123, p. 149, August 14th, 1920.)

Reference is made to a method of comparing the strengths of received radio signals which has been worked out in France. It is applicable only to C.W. reception and the comparison is made by adjusting a local source of oscillations to give the same heterodyne note and signal strength as that of the incoming signals. Fine adjustment can be obtained by shunting the telephones. An accuracy of between 5 and 10 per cent. is claimed.

1196. MEASUREMENT OF SMALL MUTUAL INDUCTANCE. (*Zeitschrift für Instrumentenkunde*, 40, pp. 122—123, June, 1920.)

The coil L_1, Fig. 2, constitutes the primary of the mutual inductance M. r is a fixed and R an adjustable resistance. If R is kept negligibly small compared with $1/\omega C$, zero reading is obtained on the galvanometer G when $M = CrR$. It is important to make an earth connection at the indicated point. The method is only suitable when M is small.

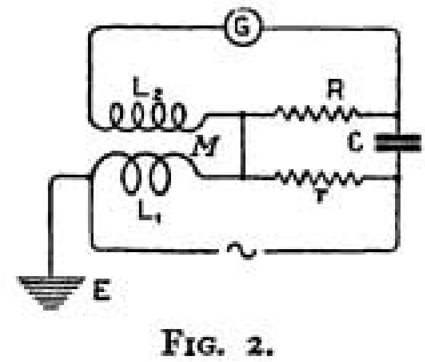

FIG. 2.

1197. THE PRODUCTION OF VERY SHORT WAVES BY MEANS OF TRIODES. R. Ettenreich. (*Verhandlungen der Deutschen Physikalischen Gesellschaft*, 1, pp. 49—50, June 10th, 1920.)

A brief summary of an experimental lecture given at Vienna illustrating the phenomenon discovered by Barkhausen (see RADIO REVIEW, 1, p. 434, June, 1920).

1198. THE CATHODE RAY OSCILLOGRAPH. (*Scientific American*, 123, p. 121, August 7th, 1920.)

A short note referring to the utility of the cathode ray oscillograph for radio frequency work.

1199. THE CORONA VOLTMETER AND THE ELECTRIC STRENGTH OF AIR. J. B. Whitehead and T. Isshiki. (*Journal of the American Institute of Electrical Engineers*, 39, pp. 441—444, and pp. 511—526, May, 1920. *Science Abstracts*, 23B, pp. 339—340, Abstract No. 661, July 31st, 1920—Abstract. *Technical Review*, 7, pp. 64—65, October 19th, 1920—Abstract.)

Discusses the possibilities of utilising the phenomena of the corona discharge for the measurement of high voltages.

1200. CALIBRATION OF WAVEMETERS. (*Zeitschrift für Instrumentenkunde*, 40, pp. 120—121, June, 1920.)

An account of the determination of the frequencies of standard wavemeters at the Reichsanstalt. Harmonics are used for the higher frequencies and the frequency of the fundamental was determined (1) by measuring the inductance and capacity, (2) by acoustic methods and (3) by measuring the speed of a high-frequency alternator. In the case of a circuit of 0·02 μF and 0·01 H the three methods gave 10,567, 10,570 and 10,573 cycles per second.

1201. TRANSMITTER FOR USE ON DIRECT CURRENT. (*Wireless Age*, 7, p. 22, September, 1920.)

A description is given of a motor-driven commutator arrangement—here termed a resonant converter—for transforming direct current into low-frequency alternating current for wireless transmission. A rotary spark gap is mounted on the same shaft as the commutator and the arrangement of connections of the direct current supply follows the usual one for such apparatus. The low-frequency circuit through the commutator is tuned to the frequency of interruption.

1202. APPARATUS FOR GENERATING OSCILLATIONS. E. F. Huth and S. Loewe. (*German Patent* 307712, March 14th, 1917. Patent granted October 7th, 1919. *Jahrbuch Zeitschrift für drahtlose Telegraphie*, 15, p. 488, June, 1920.)

An arrangement in which quenched spark gaps QQ are connected in series with rectifying devices RR. Both half cycles of the A.C. source are thus used. See Fig. 3.

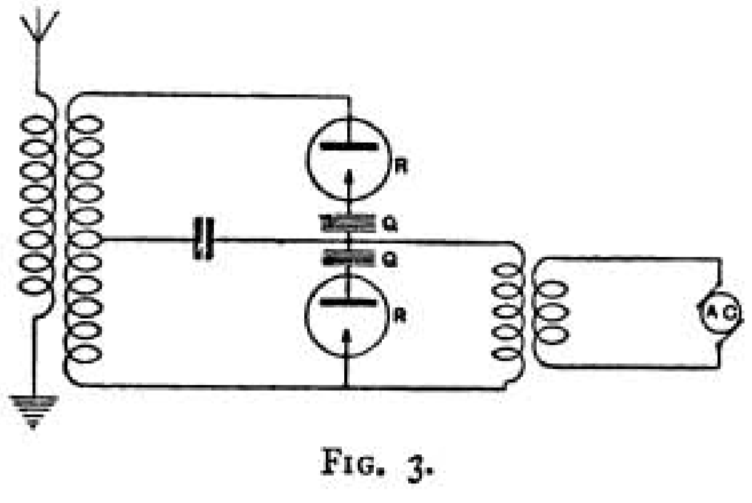

FIG. 3.

1203. METHOD OF SIGNALLING WITH AN ARC. (*Wireless Age*, 7, p. 23, January, 1920.)

Abstract of a patent by R. G. Marks and L. F. Fuller describing a means whereby the oscillations set up by an arc oscillation generator may be started and stopped by means of the ordinary telegraphic key. When the key is depressed the arc is shunted by an electrolytic lightning arrester of three or four units, the discharge through which suppresses the arc. On releasing the key the circuit through this arrester is broken and a high-voltage high-frequency source is momentarily switched on to create a potential difference across the arc terminals sufficient to reignite the arc. The arc may thus be extinguished and relighted at ordinary telegraphic speed.

1204. THE 10 kW VACUUM TUBE TRANSMITTER OF THE TELEFUNKEN COMPANY. W. Schäffer. (*Telefunken Zeitung*, 4, No. 21, pp. 20—26, July, 1920.)

A description with photographs and diagrams of connections of a transmitter containing thirty tubes in parallel supplied at 3,000 volts and supplying 10 kW to the direct coupled aerial.

1205. VOLTAGE SOURCE FOR VALVE TRANSMITTERS. C. Lorenz. (*German Patent* 310121, July 24th, 1918. Patent granted October 4th, 1919. *Jahrbuch Zeitschrift für drahtlose Telegraphie*, p. 165, February, 1920—Abstract.)

A series arrangement of an alternating current source and a direct current source by means of which either type of voltage may be used as required.

1206. CONTRIBUTION TO THE THEORY OF AUDION GENERATORS: THE CONDITION FOR EXCITATION AND THE DEGREE OF DAMPING OF FEEBLE OSCILLATIONS OBTAINED FROM THIS APPARATUS. A. Blondel and C. Lavonchy. (*Science Abstracts*, 23B, p. 112, Abstract No. 215, February, 1920—Abstract.)

See RADIO REVIEW Abstract No. 419, June, 1920.

1207. A GRAPHICAL STUDY OF THE OPERATION OF AUDIONS AS SENSITIVE RECEIVERS OR AS DECREMENT PRODUCERS (" DESAMORTISSEURS ") IN A RESONANT CIRCUIT. A. Blondel. (*Science Abstracts*, 23A, p. 240, Abstract No. 611, April, 1920—Abstract.)

See RADIO REVIEW Abstract No. 422, June, 1920.

1208. HIGH-FREQUENCY ALTERNATOR. Société Française Radio-Électrique. (*French Patent* 487996, March 13th, 1915. Published August 9th, 1918.)

To obtain a constant load on the shaft of a high-frequency alternator used in wireless telegraphy, so as to maintain a constant frequency, an auxiliary generator is mechanically coupled to the alternator. The auxiliary generator is excited and acts as a load when the alternator is not excited. In the apparatus described the auxiliary generator is a three-phase alternator and it has a de-magnetising winding connected to the exciter for the high-frequency alternator, in such a manner that the said winding and the exciting winding of the high-frequency alternator are controlled by the signalling switch. For further particulars see British Patent 100184.

1209. TRANSOCEANIC RADIO COMMUNICATION. E. F. W. Alexanderson. (*Proceedings of the Institute of Radio Engineers*, 8, pp. 263—285, August, 1920.)

This paper was presented at a joint meeting of the American Institute of Electrical Engineers and the Institute of Radio Engineers and the report of it in the *Proceedings of the American Institute of Electrical Engineers* has already been abstracted.* In this account photographs

* RADIO REVIEW Abstract No. 216, March, 1920.

of the installation at New Brunswick, N.J., are given together with a detailed description from which the following details are taken.

The generator in use at present is a 200 kW radio frequency alternator which when operated at a wavelength of 13,000 metres runs at a speed of 2,170 r.p.m. As the wavelength depends on the speed an important accessory is the speed regulator, the speed determining element of which is a resonant radio frequency circuit fed by one of the sixty-four alternator windings and which is set aside for that purpose.

The method of modulating or controlling the radio frequency energy for telegraphy involves the use of the magnetic amplifier, while when the station is used for telephony the controlling current is an amplified telephone current. The antenna is of the multiple type with a total resistance of 0·5 ohm.

1210. WIRELESS TELEPHONY AT THE TELEFUNKEN EXHIBITION. (*Telefunken Zeitung*, 4, No. 21, pp. 60—62, July, 1920.)

A description of a set permanently installed for demonstration; it works with another station across a canal.

1211. CONDENSER TYPE TRANSMITTER. I. B. Crandall. (*Electrical World*, 75, p. 1151, May 15th, 1920.)

Some measurements are referred to on the sensitiveness and other constants of a telephone transmitter of the condenser type.

1212. A NEW MICROPHONE. A. Soret and R. Couespel. (*Annales des Postes, Télégraphes et Téléphones*, 8, p. 666, December, 1919. *Telegraphen- und Fernsprech-Technik*, p. 33, May, 1920—Abstract.)

In this microphone the granules are not in contact with one another but only with the carbon block and the diaphragm; the former is 27 mm. diameter and contains 220 cavities each with a single granule; the diaphragm is only 0·2 mm. thick and is highly polished, the best adjustment is obtained by means of a micrometer screw. The authors claim that this is very superior to other microphones both in sensibility, purity of tone and constancy.

1213. TELEPHONE RELAYS. M. Latour. (*British Patent* 142937, February 14th, 1919. Convention date, February 14th, 1918. Patent accepted May 14th, 1920.)

An addition to British Patent 140506 * providing for slight modifications in the connection arrangement of the coupling transformers.

1214. TELEPHONE TRANSMITTER. S. C. Porter. (*French Patent* 489694, June 10th, 1916. Published March 1st, 1919.)

The telephone transmitter is mounted with its diaphragm adjacent to one wall of a resonant chamber whose opposite side is open. This chamber is placed within a second resonant chamber with its open side opposite to the end of the second chamber. The front of the second chamber is open and may be covered by a screen which will allow the passage of sound waves. See also British Patent 100689.

1215. TELEPHONE TRANSMITTER. A. Vaugean, A. de Lavendeyra, and W. Garthwaite. (*French Patent* 502437, September 4th, 1915. Published May 14th, 1920.)

This specification describes a telephone transmitter in which the microphone is constituted by one or more very light cases, for example, of glass, containing spheres of carbon.

1216. A DUPLEX RADIOTELEPHONE SET. M. B. Sleeper. (*Everyday Engineering Magazine*, 9, pp. 256—258, June, 1920.)

See pp. 751—753 in this issue for abstract.

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* See RADIO REVIEW Abstract No. 897, October, 1920.

1217. WIRELESS TELEPHONY. (*La Nature*, 48 (1), Supplement, p. 161, May 29th, 1920.)
A short note referring to the inception in France of wireless telephony tests carried out between London and Rome.

1218. HIGH-POWER WIRELESS IN ARGENTINA. (*Times Trade Supplement*, 6, No. 1010, p. 577, August 14th, 1920. *Electrical Review*, 87, p. 245, August 20th, 1920—Abstract.)
Refers to the formation of a wireless company in Argentina under German financial control for the establishment of direct radio communication with Nauen.

1219. WIRELESS TELEPHONY ON SEABOARD. (*Science and Invention*, 8, p. 404, August, 1920.)
A short illustrated description of some seaboard installations.

1220. EXPERIMENTS WITH WIRELESS HIGH SPEED TELEGRAPHY. F. Kiebitz. (*Telegraphen- und Fernsprech-Technik*, 9, p. 90, August, 1920.)
A description of a receiving system very similar to that described by Banneitz,* the principal difference being in the use of an ironless tuned intermediate circuit of the telephone frequency, with the object of reducing interference.

1221. THE THERMIONIC VALVE IN WIRELESS TELEGRAPHY AND TELEPHONY. J. A. Fleming. (*Nature*, 105, pp. 706—720, August 5th, 1920.)
Abstract of lecture delivered at the Royal Institution on May 21st, 1920, summarising the stages in the discovery and development of the triode valve and including a description of the author's five-electrode valve relay.†

1222. KEYING DEVICE FOR WIRELESS TELEGRAPHY. C. Lorenz. (*German Patent* 298872, April 1st, 1916. Patent granted, October 4th, 1919. Addition to German Patent 195029. *Jahrbuch Zeitschrift für drahtlose Telegraphie*, 15, pp. 505—506, June, 1920.)
An ordinary Morse contact key which is inserted in parallel with a glow lamp resistance directly in the antenna circuit. When the key is pressed the lamp is short circuited. The device ensures a constant load on the generator.

1223. THE MANUFACTURE OF HIGH-VACUUM TUBES. (*Telefunken Zeitung*, 4, No. 19, pp. 14—26, and No. 21, pp. 5—20, July, 1920.)
A popular well illustrated description of the various processes in the construction of high-vacuum tubes, including illustrations of a number of types of tube.

1224. VACUUM TUBE AMPLIFIERS. M. Latour. (*Electrical World*, 76, p. 241, July 31st, 1920.)
Correspondence relative to an article by M. C. Batsel in the *Electrical World* for March 29th, 1919, describing radio frequency valve amplifying apparatus manufactured by the Signal Corps, U.S.A. The writer states that the amplifiers described are only reproductions of apparatus designed by him for the French Military Telegraphs in 1916.

1225. THE VACUUM TUBE IN RADIOTELEPHONY. J. Scott-Taggart. (*Electrician*, 85, pp. 301—303, September 10th, 1920.)
The author points out that the essence of radiotelephony lies in the provision of an adequate modulation system for controlling the high-frequency energy. This article briefly summarises the various modulation methods that have been proposed, and is divided into the following heads: Amplification of the Modulated Energy, Grid Potential Modulation, Anode Potential Modulation, Absorption Method, the Triode as a Variable Conductor of Continuous Oscillations, Choke Control Methods. No new methods are dealt with, and in the description of the last one the designation of the valves appears to be in error.

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* See RADIO REVIEW Abstract No. 1065, November, 1920.
† RADIO REVIEW Abstracts No. 805, September, and No. 976, October, 1920.

1226. PHENOMENA IN OXIDE-COATED FILAMENT ELECTRON TUBES. H. D. Arnold. (*Physical Review*, 16, pp. 70—82, July, 1920.)

See pp. 745—750 in this issue for abstract.

The original contains an extensive bibliography of the subject.

1227. VACUUM VALVES AND VALVE CIRCUITS. A. V. Ballhatchett. (*Model Engineer*, 43, pp. 232—236, September 16th, 1920.)

A short account of various types of valves with circuit diagrams explaining their use. A Round valve, a Q valve, an audion and a French valve are illustrated.

1228. A NEW METHOD OF MEASURING VERY HIGH VACUA. H. Riegger. (*Zeitschrift für technische Physik*, 1, pp. 16—19, January, 1920.)

A description of a new instrument on the Knudsen principle. Current is passed through a circular heater below which is placed an aluminium disc carrying inclined vanes around its periphery; this wind-mill, which is suspended by a fine tungsten wire, is rotated by bombardment of the gas molecules rebounding from the heater. The disc carries a scale and is damped by means of an external electromagnet. An instrument with a period of three minutes could measure vacua of 10^{-6} to 10^{-7} mm., but the reliability of its readings has yet to be investigated.

1229. HIGH-VACUUM PUMPS. A. Gehrts. (*Zeitschrift für technische Physik*, 1, pp. 61—71, March, 1920.)

An illustrated description with extensive bibliography of the recent advances in high vacuum pumps, especially those of the condensation type. A description is given of a pump made by Siemens and Halske of the type first described by Gones and Russell in which the mercury is vaporised by means of an arc.

1230. ELECTROTHERAPEUTIC APPARATUS. W. L. Carlson and E. C. Hanson. (*U.S. Patent* 1338812, July 12th, 1919. Patent granted May 4th, 1920.)

Describes the use of a three-electrode valve for generating sustained oscillations for electro-medical application.

1231. THE PRODUCTION OF HIGH D.C. VOLTAGES WITHOUT TRANSFORMERS. H. Greinacher. (*Bulletin der Schweizerische Electrotechnische Verein*, 11, pp. 59—66, March, 1920. *Elektrotechnische Zeitschrift*, 41, p. 759, September 23rd, 1920—Abstract. *Science Abstracts*, 23B, pp. 244—245, Abstract No. 486, May 31st, 1920—Abstract. *Technical Review*, 6, p. 545, June 22nd, 1920—Abstract.)

Schenkel has invented the device shown in Fig. 4 for multiplying up and rectifying a given A.C. supply without the use of step-up transformers.* The thermionic

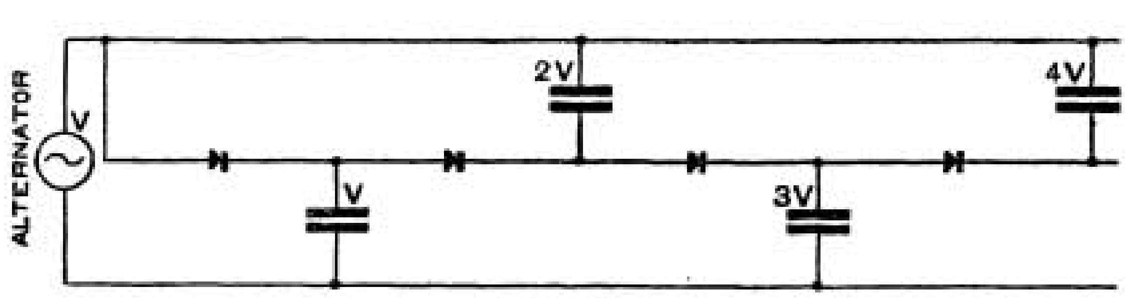

FIG. 4.

rectifiers are shown diagrammatically. This article describes several extensions of this arrangement. The general scheme of one of the improved arrangements is indicated in

* RADIO REVIEW Abstract No. 117, January, 1920. (See also correction, p. 264, February, 1920.)

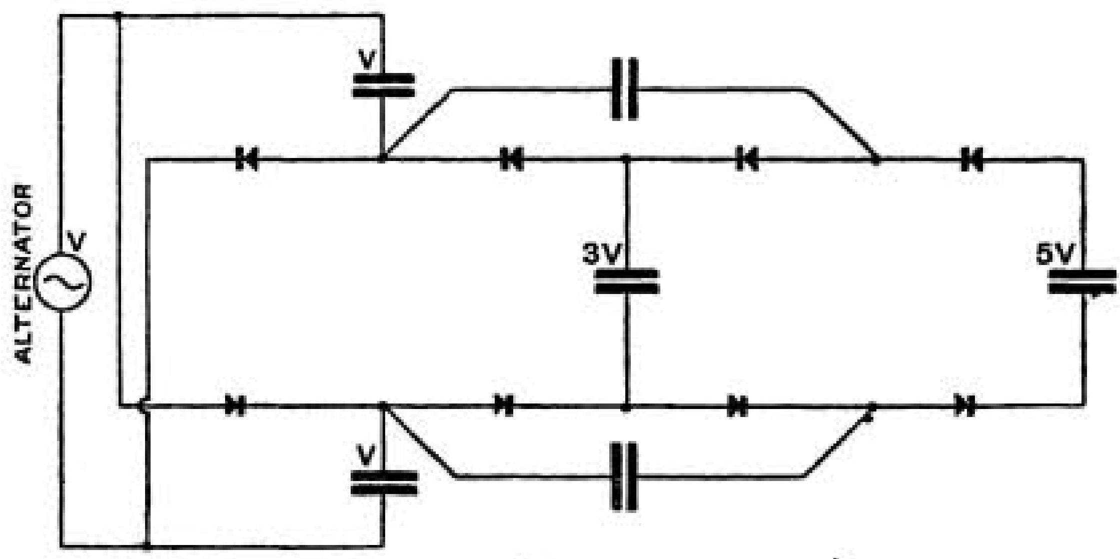

FIG. 5.

Fig. 5. Other arrangements are described for giving even multiples of the supply voltage and experimental results which confirm the theory.

1232. DIRECTIVE WIRELESS TELEGRAPHY. F. Kiebitz. (*Telegraphen- und Fernsprech-Technik*, 9, pp. 46—50, June, 1920.)

A paper read before the telegraph section of the Elektrotechnische Verein, Berlin, giving a historical survey of the subject and a brief discussion of the applications of directive telegraphy to aeroplanes and to the guidance of ships. Scheller's method * and a modification of it are discussed at some length. The methods were illustrated by a number of experiments with waves of 1 or 2 metres length. In the discussion that followed, the principal subject was the Marconi bent antenna, which Seibt maintained had a directive action *per se*, whereas Kiebitz and K. W. Wagner insisted that any such action was due to resistance in the earth beneath the antenna.

1233. AN IMPROVEMENT IN FRAME AERIAL DIRECTION FINDERS. J. de Mare. (*La T.S.F. Moderne*, 1, pp. 148—150, August, 1920.)

The author describes a modification of the ordinary polar reception curve of a frame aerial which results from earthing one terminal of the frame. The application of this modification to direction finding is then described and a circuit diagram of the arrangement given. (Compare also RADIO REVIEW Abstract No. 946, October, 1920.)

1234. DIRECTION FINDING BY RADIO. (*Scientific American*, 122, p. 669, June 19th, 1920.)

A short note relative to the errors found in D.F. work on long wavelengths and the influences of transmission overland.

1235. THE APPLICATION OF THE AUSTIN-COHEN FORMULA TO THE SOLUTION OF SOME IMPORTANT PROBLEMS OF RADIOTELEGRAPHIC TRANSMISSION. (*Jahrbuch Zeitschrift für drahtlose Telegraphie*, 16, pp. 114—125, August, 1920.)

This is a free translation by Franz Tank of a paper by Bouthillon in *Revue Générale de l'Électricité*, 3, pp. 419—425, 1918. On certain simplifying assumptions as to the radiation resistance of the sending antenna and the detector resistance, an expression is obtained for the efficiency of transmission. Various problems are then considered, *e.g.*, given the wavelength and the distance to determine the characteristic magnitudes at the sending and receiving stations; the determination of the range of transmission; the determination of the most efficient wavelength. A graphical method is given which the author claims to be simpler than those already published.

* See RADIO REVIEW Abstract No. 674, August, 1920, for description.

1236. REPORT OF THE WORK OF THE GERMAN TELEGRAPH EXPERIMENTAL DEPARTMENT BETWEEN 1913 AND 1918. (*Telegraphen- und Fernsprech-Technik*, pp. 69—85, August, 1920.)

A section of this deals with radiotelegraphy, but the reports are very brief and merely summarise the results obtained; the subjects dealt with include the velocity of propagation over dry and damp earth; the directive effect of horizontal aerials with a view to duplex working; the effect of aperiodic and tuned intermediate circuits in eliminating atmospherics; a new method of measuring coupling (in reality a very old method), and the accuracy obtainable by the parallel ohm method of measuring signal strength.

1237. ELECTRIC PHENOMENA OCCURRING IN HIGH LEVELS IN THE ATMOSPHERE. S. Chapman. (*Journal of the Institution of Electrical Engineers*, 57, Supplement, pp. 209—222, October, 1920.)

Paper read before the Institution of Electrical Engineers May 22nd, 1919, and dealing with various phenomena such as ionisation, etc., some of which are of interest in radio theory. As a result of the large number of measurements on auroræ it was shown that the average height at which ionisation appears to begin is about 100 km.

1238. THE UNILATERAL CONDUCTIVITY OF CRYSTALS. F. Streintz and A. Wesely. (*Physikalische Zeitschrift*, 21, pp. 316—321, June 15th, and pp. 367—374, July 15th, 1920.)

A continuation of a previous paper on this subject.* These parts deal very fully with thermoelectric measurements on crystals of silver sulphide.

1239. ON THE CAUSE OF THE EFFECTIVENESS OF RADIATION DETECTORS AND ELECTRON RELAYS. E. F. W. Rasch. (*Physikalische Zeitschrift*, 21, pp. 381—382, July 15th, 1920.)

A reproduction of a letter sent to Ferd. Braun in 1903 on the coherer action due to the heating of conductors of the second class, such as films of oxide and sulphide and suggesting the practical importance of research on the subject in connection with radio-telegraphy.

1240. ELECTRIC CONTACT AND COHERER ACTION. H. Rohmann. (*Physikalische Zeitschrift*, 21, pp. 417—423, August 15th, 1920.)

A device is described whereby the distance between two electrodes can be varied and determined to 1 $\mu\mu$ ($=10^{-10}$ cm). The movable electrode is carried on a short arm near the fixed end of a steel rod the other end of which can be twisted by a long arm against the end of which a fine micrometer screw presses. Tables and curves are given for various electrodes, showing the current for a constant E.M.F. as the distance is varied from 1 to 50 $\mu\mu$, and for a constant distance as the E.M.F. is varied. The latter shows the current to be proportional to the E.M.F. up to a certain point where it increases much more rapidly, probably owing to electrostatic forces closing the contact. The author concludes that current passes before the actual metals make contact, probably through a film of water, but there is no certainty as to the nature of the film. The author thinks that his results disprove the passage of free electrons, but admits that further research on this point is desirable. The author's device allows such fine adjustment that reliable microphone action can be obtained between metals, tungsten and chromium needing no adjustment for hours. If the distance between the electrodes is too small or too great the refinements in the sound are not reproduced. The device lends itself to the study of coherer action.

1241. PHOTOGRAPHIC RECEPTION OF SPARK SIGNALS. J. A. Hoxie. (*Elektrotechnische Zeitschrift*, 41, pp. 733—734, September 16th, 1920.)

A brief reference to reception by means of a reflecting galvanometer and photographic apparatus.

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* RADIO REVIEW Abstract No. 752, September, 1920.

1242. WIRELESS CALL FOR SHIPS. H. Thurn. (*Telegraphen- und Fernsprech-Technik*, 9, pp. 64—65, July, 1920.)

Describes the automatic call device developed by Marconi's Wireless Telegraph Company, Limited.*

1243. STATIC ELIMINATION BY DIRECTIONAL RECEPTION. G. W. Pickard. (*Proceedings of the Institute of Radio Engineers*, 8, pp. 358—415, October, 1920.)

Paper read before the Institute of Radio Engineers, November, 1919, of which an abstract has already been given.† In the discussion, C. L. Farrand criticised Pickard's use of the phrase "elimination by directional reception" with regard to the circuits proposed by the latter; and also attempted to meet the objections usually raised against the "vertical propagation of static" theory. The argument that the theory fails because a vertical antenna is strongly affected by static is met by the assumption of the generation of "static" currents in the conducting earth.

Details of some experiments carried out with the "Barrage" receiver of Alexanderson ‡ were given by H. H. Beverage who found that the signal-stray ratio was most favourable with the particular adjustment which balanced south-west signals. Tests at Long Island confirmed Pickard's observations that the strays are directional on the North Atlantic coast with a maximum on the south-west horizon.

G. W. Pickard in reply discussed the simple theory that atmospherics are mainly of tropical origin and indicated marked correspondence between the seasonal variation diagrams of thunderstorms and atmospherics in the United States. Directional bearings from two stations on the Atlantic and Pacific coasts apparently locate the source of static somewhere in the vicinity of the Gulf of Mexico. But it is impossible to attribute every stray to a lightning flash as in the United States half a million flashes each day would be required to fit the facts. Although only an inconsiderable portion of static can be attributed to lightning flashes, thunderstorms are probably the sources of many atmospherics because of the high level discharges associated with them. The potential of a thundercloud is of the order of two hundred million volts and from a detailed consideration of these clouds the theory is advanced that the portion of the total static which may be attributed to thunderstorms is due to equalising lateral discharges at an altitude of 50 or 100 kilometres. In this connection L. W. Austin stated that it is difficult to understand how electrical disturbances without visible manifestation can be produced which are more powerful than any known high power station while a lightning flash hardly produces a disturbance twenty miles away.

It has been found by H. H. Beverage that an antenna directive towards the north-east receives only very little grinder static while an antenna directive to the south-west receives very strong grinder static often ten to forty times as strongly. Clicks can usually be attributed to lightning discharges in the neighbourhood.

C. A. Hoxie dealt with some photographic galvanometer records obtained in some experiments carried out with the aim of localising the direction of atmospherics. Considerably more static was obtained on a NE-SW loop than from one placed E-W or one placed NW-SE. A. S. Blatterman from some observations made in New Jersey confirmed Hoxie's statement that the maximum effect is obtained in the SW-NE direction.

F. K. Vreeland pointed out that the balancing system previously suggested by Austin requires that the shock oscillation in the two collectors must agree in magnitude, phase, frequency and decrement. It was difficult to arrange that this should be so in practice. The problem of eliminating the effects of sharp impulsive strays can be met in a simple manner. which is not described. Dr. Austin in reply mentioned that disturbances had been met with which indicated that static had sometimes definite wavelengths of its own.

1244. RECEIVER CIRCUIT. U. B. Ross. (*Wireless Age*, 7, p. 27, January, 1920.)

In the circuit described the plate and grid of the detecting valve are connected across the

* See RADIO REVIEW Abstract No. 551, July, 1920.

† RADIO REVIEW Abstract No. 525, July, 1920.

‡ See RADIO REVIEW Abstract No. 75, December, 1919, for description.

aerial tuning inductance while the aerial shortening condenser completes the grid filament circuit, a separate grid condenser being interposed in the grid lead. The H.T. batteries in series with the telephones are connected between plate and filament in shunt to the antenna circuit. A low-frequency magnifier may be joined across the telephones in the plate circuit of the first valve.

1245. LONG WAVE TUNER AND C.W. RECEIVER AND AMPLIFIER. (*Model Engineer*, 43, pp. 270—272, September 30th, 1920.)

Constructional details are given for a tuner to operate between 150 and 4,500 metres and a single valve detector which may be operated as an autodyne.

1246. QUANTITATIVE EXPERIMENTS WITH COIL ANTENNÆ IN RADIO TELEGRAPHY. L. W. Austin. (*Proceedings of the Institute of Radio Engineers*, 8, pp. 421—423, October, 1920.)

The original paper was first published in the *Journal of the Washington Academy of Sciences*—see RADIO REVIEW Abstract No. 3, October, 1919. In the discussion of the paper as presented to the Institute of Radio Engineers, Dr. J. H. Dellinger refers to the differences in the values of the constants of the transmission formulæ given by Austin and himself (see RADIO REVIEW Abstract No. 4, October, 1919). The Austin antenna to antenna formula is based on the assumption that the ground is a perfect conductor in which case the hypothetical Hertzian oscillator is equal in length to twice the height of the antenna to its centre of capacity. The other formula suggested assumed a Hertzian oscillator having its length equal to the actual height of the antenna above the ground. The truth lies somewhere in between the two. For an antenna on good conducting ground or over salt water there is probably a considerable image effect but in most cases the equivalent oscillator is somewhat less than twice the antenna height.

G. S. Davis expresses the opinion that the development of the use of coil aerials was not due solely to the assistance of valve amplifiers but because of the necessity of developing direction finders for war purposes.

1247. HIGH-FREQUENCY AMPLIFIERS AND FRAME ANTENNÆ. R. Ettenreich. (*Verhandlungen der Deutschen Physikalischen Gesellschaft*, 1, pp. 66—67, June 14th, 1920.)

A brief account of an experimental lecture given at Vienna, illustrating the properties of the triode and the action of a five-stage amplifier in connection with a frame aerial and a separate heterodyne generator. Reference is made to a patent application by E. Schrack for graphite resistances fused into the bulb of the triode for both anode circuit and grid leak.

1248. LOOP ANTENNA FOR SUBMARINES. R. R. Batcher. (*Wireless Age*, 7, pp. 28—31, January, 1920.)

A brief *résumé* of the experiments carried out by J. A. Willoughby and P. D. Lowell. (See RADIO REVIEW Abstract No. 85, December, 1920.)

1249. CHRISTIANIA WIRELESS STATION. (*Telefunken Zeitung*, 4, No. 21, pp. 27—37, July, 1920.)

A description of the recently erected Telefunken Station. The transmitting plant is similar to that at Nauen, with high-frequency generator and frequency transformers; the power delivered to the antenna is 15 kW, and the wavelengths 4,000, 5,400 and 8,000 metres. The article is well illustrated and photographs are given of the accumulation of snow and ice on the aerial towers, etc. This has necessitated a modification in the original scheme, an extra tower having been erected to halve the span.

1250. WIRELESS HALF WAY ROUND THE WORLD. J. W. Kean. (*Scientific American*, 122, pp. 698 and 712, June 26th, 1920.)

A description of the work of building and equipping the Bordeaux (Lafayette) Radio Station with some particulars of the plant, towers, power supply, etc.

1251. THE WIRELESS STATION AT NAUEN. G. Arco. (*Revue Générale de l'Électricité*, 7, p. 198D, June 19th, 1920—Abstract.)

See RADIO REVIEW Abstract No. 531, June, 1920.

1252. The High Frequency Machine and Transformers at Nauen. W. Dornig. (*Telefunken Zeitung*, 3, No. 17, pp. 65—74, August, 1919.)

An illustrated descriptive article—for abstract of which see Radio Review Abstract No. 532, July, 1920.

1253. The Large Wireless Stations. A. Bocquet. (*Bulletin de la Société Belge des Electriciens*, 34, pp. 176—180, August, 1920.)

A summary is given of the recent rapid development of large wireless stations in France and on the increase of sensitiveness of receiving apparatus arising through the use of the three-electrode valve. It is stated that using a valve an audible signal can now be obtained over a received energy of only 0·000,000,001 microwatt. Developments in the large French wireless stations are briefly summarised.

1254. Large German Wireless Station. (*Elektrotechnische Zeitschrift*, 41, p. 677, August 26th, 1920.)

Germany possesses three large stations suitable for transocean service, Nauen, Eilvese and Königswusterhausen, of which the former is the largest in the world and can communicate with the antipodes, a distance of 20,000 kms. The technical equipment of these stations cannot be fully utilised because suitable stations abroad are neither numerous nor powerful enough.

1255. Development of the German Network of Wireless Stations. (*Elektrotechnische Zeitschrift*, 41, p. 534, July 8th, 1920.)

Gives a list of the towns in which the stations are now installed with the object of relieving the telegraph lines throughout the country.

1256. Wireless Telegraphy in the German Colonies. (*Telefunken Zeitung*, 4, No. 21, pp. 48—57, July, 1920.)

A lecture given to the officers of the Telegraph Corps by Dr. Roscher, describing the pre-war scheme for an imperial network, the development up to the outbreak of war, the service rendered by the stations during the war and the ultimate loss of all the stations.

1257. The Windhuk Radio Station during the War. W. Thiess. (*Telefunken Zeitung*, 4, No. 21, pp. 43—47, July, 1920.)

A non-technical description of the arrival of the news of the outbreak of war while the station was still undergoing its test after completion, of the reception of messages from Nauen (8,500 km) after Kamina (Togoland) had fallen, of the capture of Windhuk by the Union troops on May 1st, 1915, after the receiving apparatus and several essential parts of the sending apparatus had been removed to Tsumeb, and of the capture of this latter place a few months later.

1258. The Electrical Equipment of the "Vaterland." (*Electrician*, 85, p. 160, August 6th, 1920. Abstracted from *Elektrotechnische Zeitschrift*.)

Reference is made to the wireless telegraph installations, of which the vessel carries three, including a high frequency alternator.

1259. Wireless Stations in China. (*Elektrotechnische Zeitschrift*, 41, p. 557, July 15th, 1920.)

The Ministry of Communications has given permission to a number of companies in China to erect wireless stations to be used solely for commercial purposes. Stations are being erected under the direction of a British engineer for communication between Pekin and Chinese Turkestan.

1260. Wireless Telegraphy in Ecuador. (*Elektrotechnische Zeitschrift*, 41, p. 557, July 15th, 1920.)

The Société Française Radio-Électrique have erected a 10 kW station at Quito for the Government; similar stations are being erected at Guayaquil and Esmeralda. The private importation and erection of wireless apparatus is forbidden.

1261. A PORTABLE WIRELESS SET. (*Scientific American*, 122, p. 697, June 26th, 1920.)

Reference is made to a portable transmitting receiver using a loop aerial and crystal detector with a sending range from 10 to 12 miles.

1262. LIFEBOAT WIRELESS SET. C. Gruner. (*Telefunken Zeitung*, 4, No. 21, pp. 57—59, July, 1920.)

A description of a Telefunken set suitable for a 10 metre boat with a 6 metre mast. The double-hand-driven generator gives 500 cycles per second at 72 revs. per minute. It is a quenched gap system tuned to 300 and 600 metres wavelength.

1263. THE WIRELESS TELEPHONE RECEIVING STATIONS AT STOCKEL. (*Bulletin de la Société Belge des Electriciens*, 34, pp. 120—121, April—June, 1920.)

Some notes are given as to the installation at the Belgian station at Stockel. A frame aerial is used together with valve amplifiers and separate heterodyning when required.

1264. THE ROME WIRELESS STATION. (*Scientific American*, 123, p. 207, August 28th, 1920.)

A short note referring to the installation at Rome using arc transmitters.

1265. HIGH-POWER WIRELESS IN CANADA. (*Electrical Industries*, 20, p. 1276, October 6th, 1920.)

A short note referring to the preparations for building a huge experimental radio station near Toronto for communication between Canada and England.

1266. WIRELESS PLANT TO BE ERECTED IN MEXICO. (*Telegraph and Telephone Age*, 38, p. 425, August 1st, 1920.)

Refers to a scheme for the erection of four new wireless stations in Mexico.

1267. LIGHTSHIPS TO HAVE WIRELESS. (*Wireless Age*, 7, p. 8, January, 1920.)

Refers to the need for installing wireless apparatus on all of the sixty-seven lightships stationed round the U.S. coast.

1268. AN EFFICIENT PLAIN AERIAL RECEIVER. A. Cooper. (*Wireless World*, 8, p. 224, June 26th, 1920.)

1269. WIRELESS IN THE A.E.F. L. R. Krumm and W. H. Taylor. (*Wireless Age*, 7, pp. 12—19, January, 1920; pp. 10—14, April, 1920.)

In Part III.* some of the D.F. and intercepting stations installed in France are described and illustrated. Circuit diagrams of the French amplifier type R. 2 bis, type 3 ter, type No. 3, type L. 3 and of wavemeters types 2 and 3 are given.

In Part IV. buzzer signalling stations and trench listening stations are described. A circuit diagram is given of the French type 3 ter amplifier.

1270. WINDING AND TAPPING RADIO COILS. L. M. Lafave. (*Wireless Age*, 7, p. 28, January, 1920.)

Simple constructional details are given.

1271. WINDING INDUCTANCES OF HONEYCOMB CROSS SECTION. E. L. Sweet. (*Wireless Age*, 7, p. 27, January, 1920.)

Details are given for building a former upon which honeycomb pattern of inductances may be wound by hand.

1272. CONDENSER. W. Dubilier. (*French Patent* 502095, July 29th, 1919. Published May 4th, 1920.)

The condenser is enclosed in a metal casing and a compressor member is provided for adjusting the pressure on the condenser elements. The casing is provided with an insulating cover, the under surface of the cover and the upper surface of the compressor member having corrugations to prevent creepage from the terminal passing through the centre of the cover to the walls of the casing. The terminal is surrounded by an insulating bush and the casing is filled with a molten wax or similar insulating compound. There is a corresponding British application No. 130595, the patent on which has not yet been granted.

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* See RADIO REVIEW Abstract No. 194, February, 1920, for abstract of first parts.

1273. LINEAR VARIABLE CONDENSERS FOR WIRELESS WORK. (*Electrical World*, 75, p. 1225, May 22nd, 1920.)

A variable condenser manufactured by the International Radio Telegraph Company is briefly described and illustrated.

1274. RADIO FREQUENCY INDUCTANCE COILS. M. Z. Zinn. (*Wireless Age*, 7, pp. 21—23, May, 1920. *Science Abstracts*, 23B, p. 326, Abstract No. 644, June 30th, 1920. *Electrical World*, 76, p. 33, May 3rd, 1920—Abstract.)

This paper discusses some of the practical considerations which enter into the design of coils for high-frequency circuits. The influence of distributed capacity and of skin effect are considered in increasing the effective resistance of the coil. Impedance measurements are given of a coil at various frequencies using a radio frequency bridge which is described. It is concluded that for wavelengths above 5,000 metres a multilayer coil is many times more efficient than a single layer one, but that for short wavelengths a single layer coil is the best.

1275. INDUCTANCE. Société Française Radio-Électrique. (*French Patent* 488195, November 11th, 1915. Published September 10th, 1918.)

The invention consists essentially in a switch for controlling the relative arrangement of two inductances used in wireless signalling. The switch has two concentric rows of contacts and rotating arms which are so connected that the two inductances may be connected in parallel with opposed fluxes, in series with opposed fluxes, or in series with adding fluxes.

See also British Patent 102148.

1276. HIGH INDUCTANCE VARIOMETERS. (*Everyday Engineering Magazine*, 9, p. 159, May, 1920.)

Constructional details of a variometer of the sliding coil type.

1277. TELEPHONE. Naamlooze Vennootschap de Nederlandsche Thermo-Telephoon, Maatschappij. (*French Patent* 488967, February 19th, 1918. Published December 3rd, 1918.)

This specification describes a thermal-telephone and thermal-microphone. The novel feature consists in covering the conductors of the hot wire transmitter and receiver with a skin of insulating or poorly conducting material. See also British Patent 114418.

1278. ADJUSTABLE TUNED TELEPHONE RECEIVER. G. Seibt. (*Elektrotechnische Zeitschrift*, 41, pp. 625—627, August 12th, 1920. *Technical Review*, 7, p. 144, November 2nd, 1920—Abstract.)

A description of a receiver designed for earth signalling during the war. The number of such sets was so great that to prevent interference it was desirable to work at different frequencies and use highly resonant receivers tuned to the appropriate frequency. The resonance curve of the ordinary receiver is very flat. A receiver with two tuned diaphragms, the outer one operated by the ordinary one through the layer of air between them was tried but given up in favour of the type described which also has two steel diaphragms which, however, are rigidly connected at their centres by a screwed pin, the rotation of which forces them apart and thus alters their tension and natural frequency. The edges between which they are clamped are so rounded that, as the diagrams are forced apart, their effective diameter is decreased, thus giving a wider range of natural frequencies which can be adjusted between 450 and 1,400 per second. To increase the resonance, the diaphragms are weighted at their centres. Photographs of the complete receiver are given but no definite figures to enable one to compare the sensitiveness of the receiver with that of the ordinary type.

1279. TELEPHONE RECEIVER. A. Vaugean, A. de Lavendeyra and W. Garthwaite. (*French Patent* 502436, September 4th, 1915. Published May 14th, 1920.)

1280. HOW TO MAKE A TELEPHONE TRANSFORMER. A. D. Kent. (*Wireless World*, 7, pp. 699—700, March, 1920. *Technical Review*, 6, p. 342, April 13th, 1920—Abstract.)

Constructional details with particulars of the core and windings are given for a telephone transformer having a primary resistance of 4,500 ohms and a secondary of 60 ohms.

1281. THE DESIGN AND CONSTRUCTION OF AN AMATEUR RECEIVING SET. A. D. Kent. (*Wireless World*, 7, pp. 536—540, December, 1919.)

1282. A CRYSTAL RECEIVER WITH VALVE MAGNIFIER. (*Wireless World*, 8, pp. 64—66, April 17th, 1920; pp. 99—101, May 1st, 1920; pp. 139—140, May 15th, 1920.)

Constructional details are given with particulars of the windings, condensers, etc.

1283. AUDION VACUUM TUBE DETECTOR. (*Electrical World*, 75, p. 1290, May 29th, 1920.)

A short illustrated note describing a single valve detector unit manufactured by the International Radio Telegraph Company, New York.

1284. AMPLIFYING RADIO TRANSFORMERS. (*Electrical World*, 76, p. 104, July 10th, 1920.)

A short illustrated note describing a transformer with a ratio of 4 to 15 wound on a laminated iron core and with primary and secondary resistances of 1,000 and 5,000 ohms respectively, manufactured by A. H. Corwin and Company, New Jersey.

1285. THE DESIGN AND CONSTRUCTION OF A WAVEMETER AND TUNING SET. A. D. Kent. (*Wireless World*, 8, pp. 8—12, April 3rd, 1920.)

Dimensions and constructional details are given for a simple wavemeter having five fixed condenser units which may be connected in parallel and a variometer type of inductance for tuning purposes.

1286. TELEGRAPHING WITH INVISIBLE RAYS OF HEAT. J. Stuart. (*Popular Science Monthly*, 97, p. 51, September, 1920.)

A short illustrated description of photophonic apparatus utilising heat rays. For reception purposes a small platinum-tellurium thermo-electric couple is described for use in conjunction with a three-valve amplifier. The thermo-couple is enclosed in a glass cell with a fluorite window. See also RADIO REVIEW Abstract No. 71, November, 1919.

1287. LIGHT-SENSITIVE ELECTRIC DEVICE. T. W. Case. (*French Patent* 499913, September 24th, 1918. Published February 26th, 1920.)

An electric resistance sensitive to light rays both visible and invisible is formed of a compound of thallium and sulphur, preferably, thallium oxy-sulphide.*

1288. LIGHT-SENSITIVE ELECTRIC DEVICE. T. W. Case. (*French Patent* 499914, September 24th, 1918. Published February 26th, 1920.)

A light-sensitive resistance comprising a compound of thallium and sulphur is spread over a disc of quartz or silica at a high temperature. Preferably, thallium oxy-sulphide is employed. The disc may be enclosed in a vessel from which moisture is removed and which may be exhausted.†

1289. A COMPENSATED SELENIUM CELL. W. S. Gripenberg. (*Elektrotechnische Zeitschrift*, 41, pp. 453—454, June 10th, 1920. *Technical Review*, 6, p. 786, September 28th, 1920—Abstract.)

A new form of selenium cell is described which is provided with three electrodes one of which is opaque and the other cut up into strips to allow the light to pass through to the selenium film beneath. The third electrode which is mounted underneath the selenium film forms

* See also British Patent 133403—RADIO REVIEW Abstract No. 460, June, 1920.

† See also British Patent 133404—RADIO REVIEW Abstract No. 460, June, 1920.

the common electrode, and the selenium film is thus divided into two branches connected differentially to the output circuit. The normal current through the indicating apparatus can thereby be reduced to zero.

1290. ON THE RECORDING AND REPRODUCING SOUNDS BY MEANS OF LIGHT. A. O. Rankine. (*Proceedings of the Physical Society of London*, 32, pp. 78—83, February 15th, 1920. *Science Abstracts*, 23A, p. 351, Abstract No. 895, June 30th, 1920—Abstract.)

1291. THE FESSENDEN OSCILLATOR. E. T. Jones. (*Electrical Experimenter*, 7, pp. 1020 and 1090, February, 1920.)

An illustrated description giving details of the construction of the Fessenden oscillator for submarine sound signalling.

1292. AN ELECTRICAL SIGNALLING METHOD FOR GUIDING AERIAL AND MARINE CRAFT. R. H. Marriott. (*Proceedings of the Institute of Radio Engineers*, 8, pp. 345—357, October, 1920.)

Paper read before the Institute of Radio Engineers, November, 1919—see RADIO REVIEW Abstract No. 578, July, 1920, for abstract.

1293. AN OSCILLOGRAPHIC INVESTIGATION OF MICROPHONES FOR UNDER-WATER RECEPTION. P. Ludewig. (*Physikalische Zeitschrift*, 21, pp. 305—311, June 15th, 1920.)

1294. GUIDING SHIPS BY ELECTRIC CABLES. N. Tevis. (*Scientific American*, 123, pp. 123 and 138, August 7th, 1920.)

Refers to an installation at Portsmouth of the method of guiding ships in and out of harbour by means of a submerged cable carrying alternating current.

1295. FLYING IN MIST AND FOG. H. Harper. (*Times Trade Supplement*, 7, p. 66, October 2nd, 1920.)

The great utility of wireless telephony installations for commercial aircraft is referred to together with the good results recently obtained in this direction on the cross-Channel air services.

1296. WIRELESS TELEGRAPHY IN SPITZBERGEN. (*Elektrotechnische Zeitschrift*, 41, p. 514, June 30th, 1920.)

According to Article 4 of the Spitzbergen agreement between the allied and neutral powers, any public wireless station erected on the island by the Norwegian Government or under their protection, shall work without distinction with ships of all the signatory powers. Landowners in Spitzbergen have the right to erect private stations and work with other fixed or moving stations including those on ships or aircraft.

1297. CLASSIFICATION OF FREQUENCIES. (*Bulletin de la Société Belge des Electriciens*, 34, p. 187, August, 1920.)

The French delegates to the International Electrotechnical Commission have recommended the following classifications for currents of various frequencies, the figures given being cycles per second :—Very low frequency, 1—10 ; low frequency, 11—100 ; medium frequency, 101—1,000 ; high frequency, 1,001—10,000 ; very high frequency, 10,001—100,000 ; extra high frequencies, above 100,000.

1298. CLASSIFICATION FOR SUBJECTS IN RADIO SCIENCE. (*Journal of the American Institute of Electrical Engineers*, 39, p. 341, April, 1920.)

Refers to a proposed classification scheme for articles, books, MSS., etc., dealing with radio work. Reference is made to the main classification headings but the details are not given.

1299. RADIO RESEARCH. (*Electrician*, 85, p. 187, August 13th, 1920.)

In connection with the Department of Scientific and Industrial Research and the Radio Research Board four sub-committees have now been established dealing respectively with the propagation of wireless waves, with atmospherics, with directional wireless and with thermionic valves. The membership of these committees is set out in this note.

1300. THE WORLD'S LARGEST RADIO STATION. (*Telegraph and Telephone Age*, 38, p. 332, June 1st, 1920. *Electrical World*, 75, p. 1209, May 22nd, 1920; also 76, p. 146, July 17th, 1920—Abstract. *Technical Review*, 6, p. 659, August 3rd, 1920—Abstract. Also *Scientific American*, 123, pp. 79—92, July 24th, 1920. *Telegraph and Telephone Age*, 38, pp. 421—423, August 1st, 1920—Abstract. *Electrical Review*, 87, p. 16, July 2nd, 1920—Abstract. *L'Électricité*, 2, p. v, August 15th, 1920—Abstract. *Elektrotechnische Zeitschrift*, 41, p. 716, September 9th, 1920.)

Reference is made to a proposal for the installation of what will be the largest radio station in the world at Rocky Point, L.I. It is stated that the station will have five separate communication routes, viz., with Argentina, with France, with Scandinavia, with Germany and with Italy.

1301. WIRELESS TELEGRAPHY, FRANCE. (*Electrical Review*, 87, p. 241, August 20th, 1920. *L'Électricité*, 2, pp. III—V, June 15th, 1920. *La T.S.F. Moderne*, 1, p. 167, August, 1920—Abstract. *Scientific American*, 123, p. 149, August 4th, 1920—Abstract. *Electrical Industries*, 20, pp. 758—759, June 16th, 1920—Abstract.)

A short note referring to a recent statement by M. Deschamps on the subject of the French wireless network for linking up France with its colonies and with other countries of the world.

1302. WIRELESS IN THE ILES DE TONGA. (*Journal Télégraphique*, 44, p. 16, January 25th, 1920. *Elektrotechnische Zeitschrift*, 41, p. 573, July 22nd, 1920—Abstract.)

Refers to a contract made with the Amalgamated Wireless (Australasia), Ltd., for the establishment of a complete wireless network.

1303. WIRELESS IN FOREIGN TRADE. (*Wireless Age*, 7, pp. 10—11, January, 1920.)

Refers to the valuable influence of radio-communication in promoting international commerce and deals with the proposed programmes of the Radio Corporation of America.

1304. WIRELESS IN CHINA. (*Scientific American*, 123, p. 207, August 28th, 1920. *Times Trade Supplement*, 7, p. 33, September 25th, 1920. *Wireless Age*, 8, p. 9, October, 1920.)

A short note referring to the opening of a new wireless station at Temple of Heaven in Peking. It is also stated that a station at Urga in Mongolia is expected to be ready for service some time in October.

1305. WIRELESS TELEGRAPHY IN INDO-CHINA. (*Elektrotechnische Zeitschrift*, 41, p. 573, July 22nd, 1920.)

A note referring to the establishment of direct wireless communication between the Eiffel Tower and stations in Indo-China and South China.

1306. SHIP MESSAGES COVER 6,339 MILES. (*Wireless Age*, 7, p. 9, February, 1920.)

Reference is made to a record signalling range from a Pacific mail liner.

1307. THE ELECTRICAL TRANSMISSION OF PICTURES. P. R. Coursey. (*Nature*, 106, pp. 115—116, September 23rd, 1920.)

A brief summary of the various methods including a reference to the possibilities of radio transmission.

1308. WIRELESS INCENDIARY? (*Scientific American*, 122, p. 701, June 26th, 1920.)

Correspondence relative to the possibility of induced currents from powerful wireless stations causing fires at oil wells.

1309. INTERPLANETARY WIRELESS. G. Pessioni, Q. Majorana. (*L'Elettrotecnica*, 7, pp. 354—355, July 5th, 1920.)

Correspondence relative to the article by Q. Majorana on this subject.*

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* See RADIO REVIEW Abstract No. 855, September, 1920.

1310. WIRELESS WAVES AND WAVE MOTION. (*Wireless World*, 8, April 3rd, 1920.)

1311. C.W. TIME SIGNALS. (*La Nature*, 48, Supplement, p. 177, June 12th, 1920. *Wireless World*, 8, p. 279, July 10th, 1920.)

Particulars are given of the time signals sent daily to the *Aldebaran* at 8.45 from Lyons Station, on 15,500 metres, and from Nantes at 8.23 and 20.23 on 9,000 metres, and at 10.23 and 20.53 on 11,000 metres.

1312. RECEPTION OF W/T TIME SIGNALS AT THE ROYAL OBSERVATORY, GREENWICH. W. Bowyer. (*Monthly Notices of the Royal Astronomical Society*, 80, pp. 648—650, May, 1920.)

Time signals transmitted by wireless telegraphy were received at the Royal Observatory in 1912 when a two-circuit receiving set with crystal detector was erected by the Admiralty. The possibilities of automatic registration of the signals were considered in 1914 using Brown relays and a syphon recorder but this work was suspended until late in 1919 when a new installation was fitted. The apparatus at present installed consists of a Marconi seven-valve amplifier with a range of 600 to 5,000 metres wavelength using naval pattern R5 valves, and a seven-valve R.A.F. pattern amplifier covering a range from 4,000 to 18,000 metres using French valves. A separate heterodyne is used for C.W. reception. Aerial—two wire total length about 260 yards. Capacity—about 0·0023 microfarad; total tuning inductance 20,000 microhenries; total tuning capacity in parallel with inductance 0·018 microfarad. Intermediate circuit—total inductance 20,000 microhenries; variable condensers 0·018 microfarad. Circuit to grid of first valve—total inductance 70,000 microhenries; variable condensers of total capacity 0·018 microfarad. A three-circuit receiver is employed. A number of tables are given of readings comparing the Eiffel Tower signals with each other and with the standard clocks at Greenwich the differences in most cases being very small, but in some instances rather large discrepancies were observed for which no explanation has been found.

1314. AUTOMATIC SENDING DEVICE INSTALLED IN THE ALIPUR OBSERVATORY, CALCUTTA. (*Radio Review*, 1, pp. 432—434, June, 1920. *Technical Review*, 6, p. 659, August 3rd, 1920—Abstract.)

1315. WIRELESS COMMUNICATION BETWEEN GERMANY AND HOLLAND. (*Elektrotechnische Zeitschrift*, 41, p. 778, September 30th, 1920.)

A regular twenty-four-hour service is now established between Düsseldorf and Rotterdam; the tariff is the same as for line telegraphy.

1316. WIRELESS WEATHER SERVICE. J. Georgi. (*Telefunken Zeitung*, 4, No. 21, pp. 38—42, July, 1920.)

A review of the application of wireless telegraphy to the collection and distribution of meteorological reports (1) before, (2) during, and (3) after the war.

1317. EXPERIMENTS ON THE DISTRIBUTION OF REPORTS BY WIRELESS TELEPHONY. W. Hahn. (*Elektrotechnische Zeitschrift*, 41, pp. 727—729, September 16th, 1920.)

Experiments made in April and May by sending out reports from Königswusterhausen (near Berlin) by means of a Poulsen-Lorenz arc. The height of the aerial is 150 metres, the wavelength 3,700 metres and the aerial current varied between 10 and 30 amperes when speaking. Frame aerials cannot be used for reception in towns owing to the disturbing factors which affect the amplifiers, therefore elevated antennæ were employed. Telephony does not demand such a highly trained personnel for reception as telegraphy. The results obtained at twenty-three stations up to a distance of 600 km were that (*a*) the loudness was sufficient, (*b*) the method of first reading the report quickly and then slowly for copying, spelling names, etc., was found satisfactory, (*c*) men's and women's voices are equally good, (*d*) detectors without amplifiers were not successful above 250 km; (*e*) practice is necessary in receiving to obtain the best results, (*f*) the greatest trouble was caused by spark stations causing interference.

1318. THE AMATEUR'S GUIDE TO THE ETHER. (*Wireless World*, 8, pp. 97—98, May 1st, 1920; also p. 116 and p. 134, May 15th, 1920.)

A table of the principal transmission times for the most important wireless stations. Wave-lengths, time of transmission and other particulars are given.

1319. THREE-VALVE RESISTANCE AMPLIFIER. R. Quentin. (*L'Électricien*, 51, p. 382, September 1st, 1920.)

A short note describing the constructional arrangement of a three-valve resistance capacity coupled amplifier and giving also winding details and dimensions for an inter-valve transformer for a low frequency amplifier.

1320. SUBMARINE SOUND SIGNALLING. M. I. Pupin. (*British Patent* 139498, February 25th, 1920. Convention date, February 4th, 1918. Patent not yet accepted but open to inspection.)

Part of the arrangement is a multi-stage valve amplifier comprising filtering circuits for cutting out low frequency impulses and transmitting high frequency ones, using resistances shunted by inductive leaks,—see also RADIO REVIEW Abstract No. 1174, November, 1920. A similar filter circuit for transmitting low frequency currents and stopping high frequency ones is also described. In this case a number of equal resistances are joined in series, while equal shunting condensers are provided to drain off the high frequency impulses, the arrangement being similar to that described in Abstract No. 1174 with the resistances and condensers interchanged.

1321. VACUUM TUBE AMPLIFICATION. P. H. Boucheron. (*Electrical Experimenter*, 7, pp. 1158—1159 and 1204—1205, March, 1920.)

Various arrangements of cascade multi-stage amplifiers are described. The use of resistance-capacity, choke coil, and transformer intervalve coupling is dealt with both for high and low frequencies.

1322. V.T. DETECTOR AND FOUR-STAGE AMPLIFIER RESISTANCE COUPLED. C. R. Keutz. (*Wireless Age*, 7, pp. 24—26, January, 1920.)

Constructional details are given of four and five-stage resistance capacity coupled amplifiers, together with illustrations of instruments built to the plans described.

1323. PHOTOELECTRIC PHOTOMETER. A. H. Compton. (*Transactions of the Illuminatin Engineering Society*, 15, pp. 28—33, February 10th, 1920. *Electrical World*, 75, p. 1100, May 8th, 1920—Abstract.)

Refers to the use of a triode amplifier for magnifying the readings of a photo electric cell used for photometry.

1324. AMPLIFIER FOR ALTERNATING CURRENTS. F. Skaupy. (*German Patent* 310012, June 9th, 1918. Patent granted October 17th, 1919. *Jahrbuch Zeitschrift für drahtlose Telegraphie*, 15, pp. 169—170, February, 1920.)

An amplifier in which the so-called Hall effect is used. The current to be amplified circulates in a coil C, Fig. 6, thus providing a magnetic field in which is situated a conducting surface

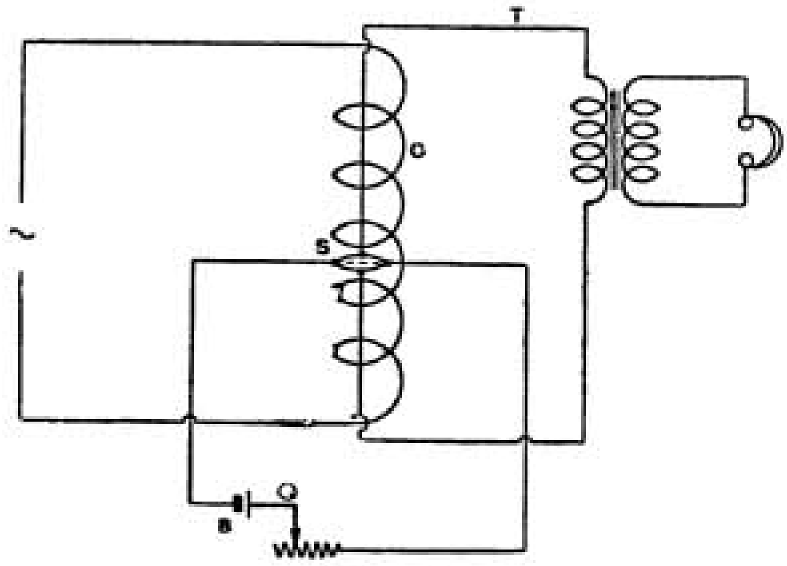


FIG. 6.

S of tellurium or bismuth through which a current from a local battery B flows. The action of the magnetic field is to produce a transverse electromotive force in the conducting surface. This electromotive force acts in the telephone circuit T in which the amplified current flows (see Fig. 6).

1325. HIGH FREQUENCY TELEPHONY IN HIGH VOLTAGE OVERHEAD POWER DISTRIBUTING SYSTEMS. Gewecke. (*Elektrotechnische Zeitschrift*, 41, pp. 670—672, August 26th, 1920.)

The author is an engineer of the Telefunken Company and he gives an illustrated description of a system which they have developed and installed in a number of power stations. The sending and receiving apparatus is of the ordinary type employing thermionic valve generators and detectors. The power required is only 10 to 20 watts and no amplification has been found necessary for a distance of 135 kilometres between the power station at Golpa and the substation at Rummelsburg. The antenna consists of a wire supported between two of the masts underneath the power lines, the earth terminal being connected to one of the masts. The power lines pick up and guide the waves. The valves only burn when speaking, the calling device consisting of a crystal detector operating a relay and trembling bell, which is operated as soon as the transmitting valve is set oscillating. Speech is little affected by the breakage of two of the three power lines and is still practicable, if the remaining wire is earthed at some intermediate point or even if intermittent discharges and arcs are occurring which would make ordinary wire telephony impossible. The system is economical and as simple to operate as ordinary telephony; the author considers that it has a large future.

1326. MULTIPLE TELEGRAPHY AND TELEPHONY WITH HIGH-FREQUENCY CURRENTS. (*Annales des Postes, Télégraphes et Téléphones*, 9, pp. 155—174, March, 1920.)

An article abstracted from *Telegraphen- und Fernsprech-Technik*, June, 1919, outlining the historical development of the transmission of telegraph and telephone signals by high frequency currents along wires, including Ruhmer's experiments in 1909. The arrangements due to Fassbender and Habann are dealt with in detail, and a summary is given of the tests of multiple telephony carried out by the Gesellschaft für drahtlose Telegraphie. The various filtering circuits used with the apparatus are described, and a number of curves and tables are also given of the high frequency resistance of various telephone line wires for different frequencies. It is stated that when using an earth return trouble was experienced by interference from high-power wireless stations working on the same wavelength, but that this was eliminated with complete metallic circuits.

1327. MULTIPLEX TELEPHONY WITH HIGH-FREQUENCY CURRENTS. Béla Gáti and K. W. Wagner. (*Elektrotechnische Zeitschrift*, 41, pp. 518—519, June 30th, 1920.)

Correspondence in which Gáti maintains that Wagner opposed him when he proposed this system ten years ago, whereas Wagner now writes in support of it. Wagner replies that Gáti's system was quite different from that now adopted.

1328. THE APPARATUS FOR HIGH-FREQUENCY WIRE TELEPHONY. (*Telefunken Zeitung*, 4, No. 21, pp. 63—66, July, 1920.)

A brief but well illustrated description.*

1329. HIGH-FREQUENCY WIRE TELEGRAPHY AND TELEPHONY. (*Telefunken Zeitung*, 4, No. 21, pp. 67—69, July, 1920. *Elektrotechnische Zeitschrift*, 41, p. 455, June 24th, 1920—Abstract.)

Account of lecture given by Dr. Mayer in Berlin.

* See RADIO REVIEW Abstract No. 1159, also pp. 715—716, November, 1920.

1330. INTERNATIONAL TELEGRAPHIC AND RADIOTELEGRAPHIC CONFERENCE. (*L'Électricité*, 2, pp. v—vi, August 15th, 1920.)

A brief report of an international conference held in Paris from July 7th—13th, 1920, all the European States being represented. As a result of the deliberations it was decided that each country should remain entirely free in the choice of its radio communications and of the method of effecting them, provided that the transmission did not interfere with the working of other stations. Special press and other services could also be arranged. It was recommended that all commercial services should as soon as possible be effected exclusively with undamped waves and that when the traffic exceeded 20,000 words per day high-speed automatic apparatus should be employed with facilities for simultaneous transmission and reception.

2. Books.

ÉTUDE DE QUELQUES PROBLÈMES DE RADIOTÉLÉGRAPHIE. By H. de Bellescize. (Paris: *Gauthier-Villars et Cie.* 1920. Pp. 174. Price 16 frs.)

This is a collection of papers on various branches of the subject written and, in some cases, published during the last six years. They are arranged in chronological order without any regard to the nature of the subjects. The author's work is well known to all who are acquainted with the recent development of radiotelegraphy in France and is a guarantee of the value of this collection of papers. The first deals with the predetermination of the radiation of an antenna from the current distribution along it by the application of the ordinary Hertzian formulæ. The calculations for seven different aerials were checked by reception on a bolometer or thermal galvanometer at a distant station. Although the results were proportional to the calculated values no attempt seems to have been made to measure the actual radiated power. The statement that the bolometer abstracted the maximum possible amount of energy from the wave would not be true unless its resistance were suitably adjusted to the antenna. The author's statement that the loading coil is assumed to have no capacity is also untrue; it is assumed to have the same ratio of capacity and inductance per unit length as the aerial. The second paper contains a theoretical investigation of the efficiency of spark transmitters under various conditions. The third paper deals with methods of eliminating disturbances due to heavily damped waves.

The following paper is devoted to a theoretical study of the efficiency of various methods of coupling the receiver to the antenna and the effect of varying degrees of coupling and various resistance ratios, etc. Confirmatory experiments are also described. A paper dated December 1916 describes a resistance coupled amplifier for acoustic frequencies together with a study of the causes of the various troubles met with in such amplifiers. This is followed by a note on the adjustment of wavelength and coupling in an impulse transmitter; in our opinion this note suffers from an absence of explanation. In the following paper the author investigates the errors introduced into the reception of wireless signals by the various stray capacities such as those introduced by anode batteries and the observer's body through the telephone receiver. The next paper deals with the design of small frame aerials. In a paper on the application of Austin's formula to transmission problems a number of numerical values are given for the calculated electric field strength at various receiving stations due to distant high-powered stations and these figures are compared with the quality of the reception. The author concludes this paper with the remark that while authors discuss differences of 30 per cent. in transmission formulæ, those engaged in the transmission experience variations of 500 to 1,000 per cent. He also expresses the belief that improvement will not come by the invention of any method absolutely preventing interference, but by the accumulation of detail improvements. The following paper deals with the errors in the direction as determined by a rotating loop and with various methods of compensating the capacity to earth through the detecting apparatus. The two diagrams in Fig. 1 on p. 138 are obviously wrongly described. The concluding paper is probably the most important in the book; it is a study of the effect of the insulation of the towers on the radiation from the antenna. It is well known that in some cases in which great care has been taken to insulate the towers from earth, it has subsequently been found that the transmission is better with the towers earthed. It is important therefore to investigate the problem and be in a position to predetermine the effects of insulating or earthing the feet of the towers. When a tower is insulated its upper part may be regarded as forming an air condenser with the aerial, whilst its lower part forms a condenser with the earth. The effect of the current in the tower on the radiation and the effect of the losses in the insulation and earth at the foot of the tower on the efficiency of the station can be calculated approximately by making certain simplifying assumptions. The author applies his results to an actual station and gives experimental data illustrating and confirming the applicability of the method.

Although the various articles are so entirely disconnected and although in many cases they appear to be incomplete and call for further investigation, they will well repay careful study. They were obviously written for the most part to solve problems which arose during the war and which called for an immediate practical solution rather than an elaborate theoretical investigation.

G. W. O. H.

VOCABULAIRE EN CINQ LANGUES AVEC LES DÉFINITIONS OFFICIELLEMENT ADOPTÉES ET UN RÉPERTOIRE ALPHABÉTIQUE. By Henri Viard. (Paris: *Gauthier-Villars et Cie.* 1920. Pp. x + 108. Price 7 fr. 50.)

The text of this book consists of five parallel columns, corresponding to the English, French, Italian, Spanish and German versions of the various terms dealt with, broken up by numerous paragraphs in English and French, these being definitions pure and simple. Thus the work is in reality a vocabulary and a small dictionary and should prove very useful to those who try to read foreign radio literature with only a small amount of linguistic knowledge to their credit. One would not desire to administer too rigorous a treatment to the first edition of such a work. Nevertheless it is in the interest of all concerned that we call attention to a few omissions. The vocabulary does not include the following terms :—grid, plate, dynatron, pliodynatron, loop (or frame) aerial, filament, saturation, regeneration. An alternation is defined as half a cycle; this is not universally accepted.

E. BLAKE.

RADIOTÉLÉGRAPHIE PRATIQUE ET RADIOTÉLÉPHONIE. By P. Maurer. (Paris: *H. Dunod.* 1920. Pp. 386. Price 21 fr.)

This is a text-book of the class that gives a general description of the characteristics of electromagnetic oscillations and waves, and the circuits by which they may be produced and detected, without entering very deeply into the theory underlying the various phenomena.

The object of the author, as stated in the introduction, is to draw up a practical ensemble easy to understand, and containing as few formulæ as possible, holding the mean, between the advanced text-book which makes wireless telegraphy a collection of arid mathematical formulæ, and a purely practical volume containing simply that which is necessary to set up a receiving station.

The first chapter is an elementary study of the properties of electrical oscillations. Commencing with the alternating current, and circuits having inductance and capacity, it proceeds to give the conditions for an oscillatory discharge; the various sources of loss of energy are set out, and the consequent damping of the oscillations explained.

The propagation of electric waves along wires leads up to the action of an excited aerial. A number of mechanical analogies are used to illustrate certain of the phenomena. The next chapter, on the principles of wireless telegraphy, opens with a brief historical sketch and then gives a description of the properties of coupled circuits, the various types of coupling. The explanation of the relationships of the currents in two coupled circuits is rendered clearer by a number of diagrams showing the current amplitudes for various cases. Damping and resonance are also dealt with.

The aerial and earth circuits, with an outline of the theory of propagation of waves round the earth is given, and the Austin-Cohen formula for transmission is set out.

The third chapter on transmission gives a description of the action of the supply circuit on the oscillating circuit, with the principle of low frequency resonance in the former.

The action of the induction coil and the various forms of interrupter used therewith are given, with the arrangements used for manipulation. The condensers, inductances and dischargers used are described.

In the chapter on reception, the various forms of detector,—coherer, magnetic, electrolytic, and crystal are given and the three-electrode valve with the method by which it functions, is fully dealt with. A number of relays for automatic reception are described including some not usually referred to in English text-books. Several circuits for using the three-electrode valve, including high frequency and low frequency amplifiers are given, but it would have greatly increased the utility of the description if details of the sizes of the condensers, inductances, etc., had been included. In some of the diagrams the circuits to which the incoming signals are applied are not clearly marked and Fig. 128 is printed upside down.

Chapter V. deals with continuous waves both in transmission and reception. The production of continuous oscillations by means of the arc, various types of high frequency alternator and three-electrode valve, is described. The Marconi smooth disc and the quenched spark methods are also dealt with in this chapter together with the various static frequency transformers. The principal methods for reception by the tikker, valve heterodyne circuits, etc., are also included.

The next chapter gives an account of the directional production and reception of waves, including the various types of aerials which have been used for directive transmission, with the Bellini-Tosi and moving frame methods for determining the direction of received signals.

In Chapter VII. is a description of the principal systems of wireless telegraphy. As may be expected the circuits employed by the French companies are given in more detail than others, the American systems receiving very scanty treatment. Amongst others may be noted the Marconi timed-spark method for producing continuous waves and several static frequency transformer circuits are described.

Chapter VIII. deals with radiotelephony and gives several of the principal systems which have been used such as the Colin-Jeance, Vanni, Ruhmer, Telefunken systems with a short description of the Alexanderson and Nixdorff magnetic amplifier and the various types of microphone.

Chapter IX. on "utilisation" gives details of the sets used by the French military and air forces, including details of several alternators designed for the latter. A number of ship sets are described and a short reference made to the direction finder.

Time signals and circuits for distant control by wireless are also dealt with and a list given of the principal stations with details of their times, etc., of working. The last chapter is on tracing faults in apparatus and methods for making measurements. The latter includes descriptions of wavemeters and bridges for measuring capacity, inductance and resistance.

The usual method for measuring strength of signals by the shunted telephone method is given, without any statement as to the need for using the total impedance of the telephone receiver in place of its direct current resistance. The formula is incorrectly given as audibility $= \frac{R_o + S}{3}$ where $R_o =$ D.C. resistance of the telephones and S that of the shunt.

The methods for determining the characteristics and constants of three-electrode valves are also described.

The book includes a table of contents but no index, and there is a complete absence of all references. The information given appears to be well selected and well put together but the work naturally suffers from the impossibility of trying to treat the whole of wireless telegraphy in a single volume. In the description of the various systems, many have only the briefest reference.

Many of the diagrams are not clearly lettered, the lettering being in hand-written italics which are in several cases illegibly thin. In a few cases the scale on which the diagram has been reproduced is too small. The printing has not been well executed, in the copy sent for review several pages are imperfectly struck off.

W. H. NOTTAGE.

Books Received.

THE CONSOLIDATED RADIO CALL BOOK. (New York: *The Consolidated Radio Call Book Company, Inc.* Second Edition. 1920. Pp. 160. Price $1.25.)

A COURSE OF MODERN ANALYSIS: An Introduction to the General Theory of Infinite Processes and of Analytic Functions; with an Account of the principal Transcendental Functions. By E. T. Whittaker, Sc.D., F.R.S., and E. N. Watson, Sc.D., F.R.S. (Cambridge: *The University Press.* Third Edition. 1920. Pp. 608. Price 40*s.* net.)

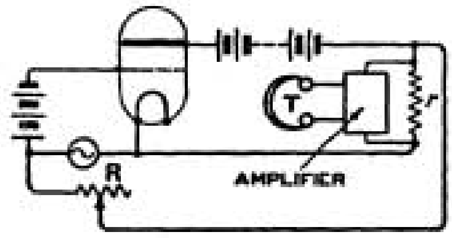
PRACTICAL AMATEUR WIRELESS STATIONS. By J. A. White. (New York: *Wireless Press Inc.* 1920. Pp. 133. 5*s.* net.)

Correspondence.

MUTUAL CONDUCTANCE MEASUREMENT.

TO THE EDITOR OF THE "RADIO REVIEW."

SIR,—The circuit proposed by W. Schottky in *Telegraphen- und Fernsprech-Technik*, May, 1920,* for the measurement of the mutual conductance of a triode valve is the one suggested in England two years ago. (See J. A. Fleming's "The Thermionic Valve and its Developments in Radiotelegraphy," p. 142, and R. Stanley's "Wireless Telegraphy," Vol. 2, p. 348.) In using current of telephonic frequency with this circuit it is obviously undesirable to include the reactive telephone receiver coils directly in the anode and alternator circuits. This may be avoided by using a non-reactive resistance and a low frequency amplifier as shown in the accompanying figure.



For minimum sound in the telephone the mutual conductance $\partial i_a/\partial v_g$ is given by $1/(R + r)$, so long as the alternator impedance is large compared with the resistance r. If, however, the alternating voltage is introduced into the circuit by means of a few turns of wire of small impedance, linked electromagnetically to the alternator circuit, the value of $\partial i_a/\partial v_g$ is given still more simply as $1/R$.

E. V. APPLETON.

St. John's College, Cambridge.
October 20th, 1920.

* RADIO REVIEW Abstract No. 876, October, 1920.

Radio Review, Vol. I. October 1919—December, 1920.

General Index.

Book Reviews.

Name Index of Authors.

Index to Abstracts of Articles and Patents.

(NOTE.—*The numbers shown under each heading are the Abstract Nos.*)

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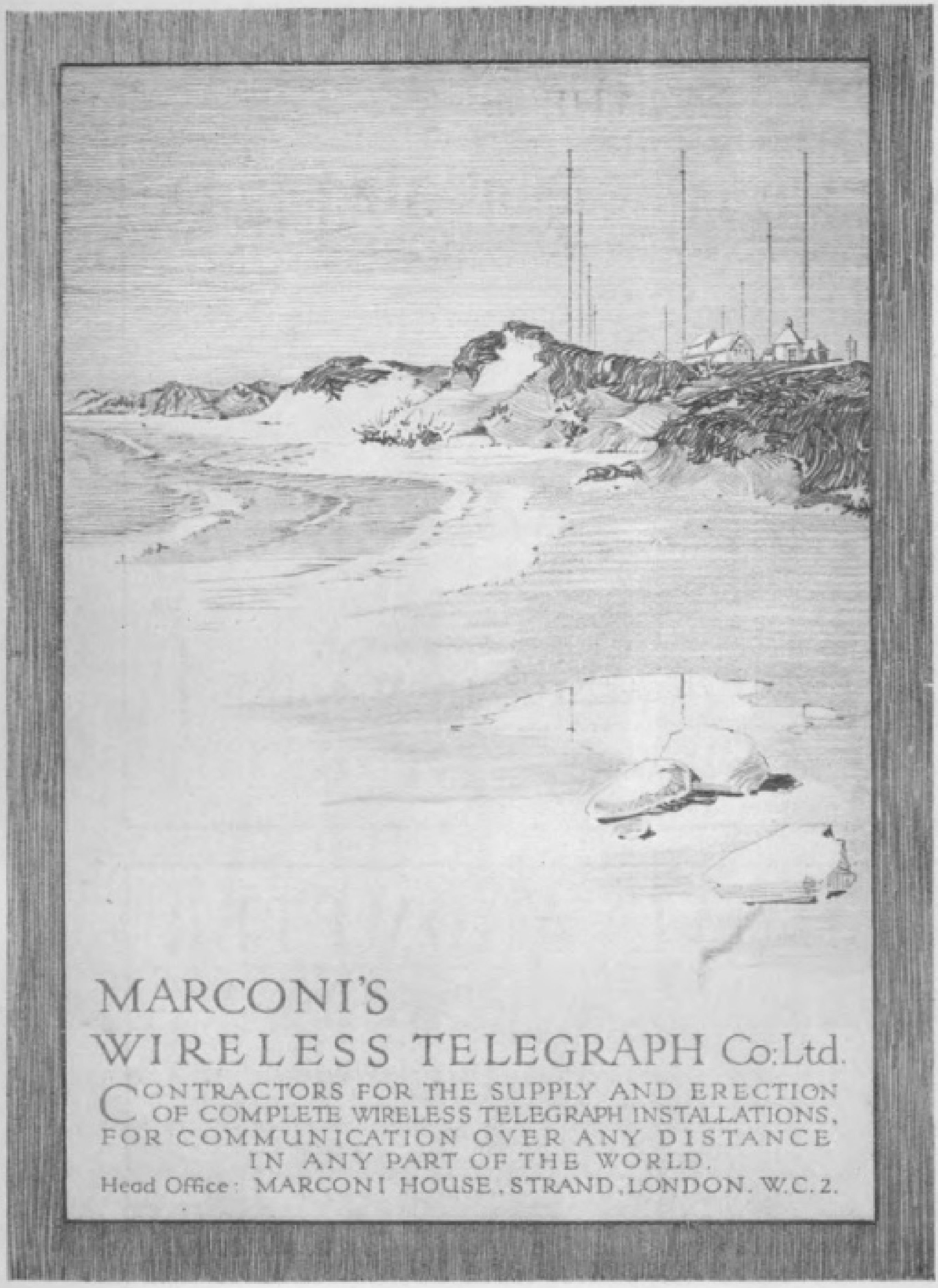
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THE

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