THE RADIO REVIEW

A MONTHLY RECORD OF SCIENTIFIC PROGRESS IN RADIOTELEGRAPHY AND TELEPHONY

VOL. II SEPTEMBER, 1921 No. 9

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Editor: Prof. G. W. O. HOWE, D.Sc., M.I.E.E. Asst. Editor: PHILIP R. COURSEY, B.Sc., A.M.I.E.E.

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THE

RADIO REVIEW

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Harmonics and Normal Modes of Vibration.

By THE EDITOR.

In his recent paper before the Wireless Section of the Institution of Electrical Engineers, Professor Townsend emphasised the distinction between these two entirely different things. They are so often confused that we feel justified in returning to the matter. If an oscillatory system such as an aerial with distributed inductance and capacity has an E.M.F. induced in it by the current in a neighbouring circuit, and the frequency of this current be varied, a number of frequencies will be found for which the current produced in the aerial is abnormally large. Although it is usual to speak of these frequencies as the third, fifth, etc., harmonics, they do not bear any such simple relation to the fundamental frequency. It should be noted, moreover, that if the source be a pure sine wave of any given frequency, an oscillation of this frequency only will be set up in the aerial. The frequencies at which abnormal response is found in the aerial correspond to its normal modes of vibration, or in other words, correspond to stationary wave distributions having a current node at the top and a potential node at the base.

If such an aerial were coupled to a radio frequency alternator the E.M.F. curve of which contained a pronounced third harmonic the current set up in the aerial would consist of a fundamental and a third harmonic, that is, one having exactly three times the fundamental frequency. This would not, in general, correspond to the normal mode of vibration sometimes called the third harmonic of the aerial. If this were not so, the wave form of the aerial current would undergo gradual changes.

The problem is not so obvious when the source is an arc or valve transmitter, the frequency of which is controlled by the characteristics of the aerial. If, however, it be assumed that each oscillation is of the same wave shape—depending on the aerial and on the arc—all frequencies other than exact harmonics of the fundamental are impossible.

It would be of interest to know whether, in an arc transmitter with tuning inductance between the arc and the aerial and with the arc itself shunted with a condenser as is now sometimes the case, any trace can be found of one of the normal modes of vibration other than the fundamental with its true harmonics. This cannot be tested on a dummy aerial with concentrated capacity, but only on a system having distributed capacity.

L L

The multivibrator of Abraham and Bloch is said to give a wave form which is rich in harmonics. What is meant by this statement? If a circuit consisting of a battery and a non-inductive resistance is closed for a very short time, say a millionth of a second, with great regularity a thousand times per second, the diagram showing the current plotted to a time base would consist of a number of narrow rectangular humps widely separated from each other (Fig. 1).

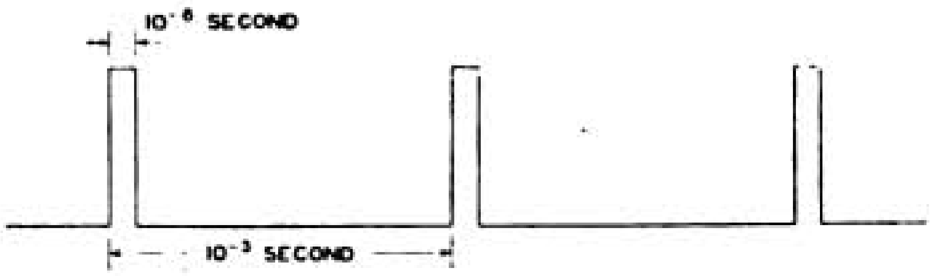


FIG. 1.

Now this is a wave form very rich in harmonics. Although physically there is nothing to suggest any frequency other than 1,000, the wave form could be analysed by Fourier's theorem into a steady current, a fundamental sine wave with a frequency of 1,000 and an infinite number of harmonics both odd and even. It is well to recognise that the currents obtained from oscillating valve systems are only rich in harmonics in this sense.

In the case considered above a wavemeter tuned to a frequency of 20,000 would receive an impulse every twenty oscillations and then be left to itself for a thousandth of a second. That it is being acted upon the whole time by an infinite number of currents of different harmonic frequencies is really nothing more than a mathematical fiction.

When one looks at the wave form of the voltage of an alternator and recognises clearly a ripple of a definite frequency one sees that the harmonic is present in a more real physical sense than in the above diagram. Mathematically, however, the difference is due to the absence from the voltage wave of the infinite number of harmonics which go to make up the diagram given above.

A Method of Measuring the Specific Inductive Capacity of Air.*

By E. W. B. GILL, M.A., B.Sc.

The accurate comparison of the wavelength of two circuits enables various measurements of capacity, inductance, etc., to be made, and one of the most convenient methods of estimating the equality of wavelength of two circuits is by the well-known "beat method" of reception.

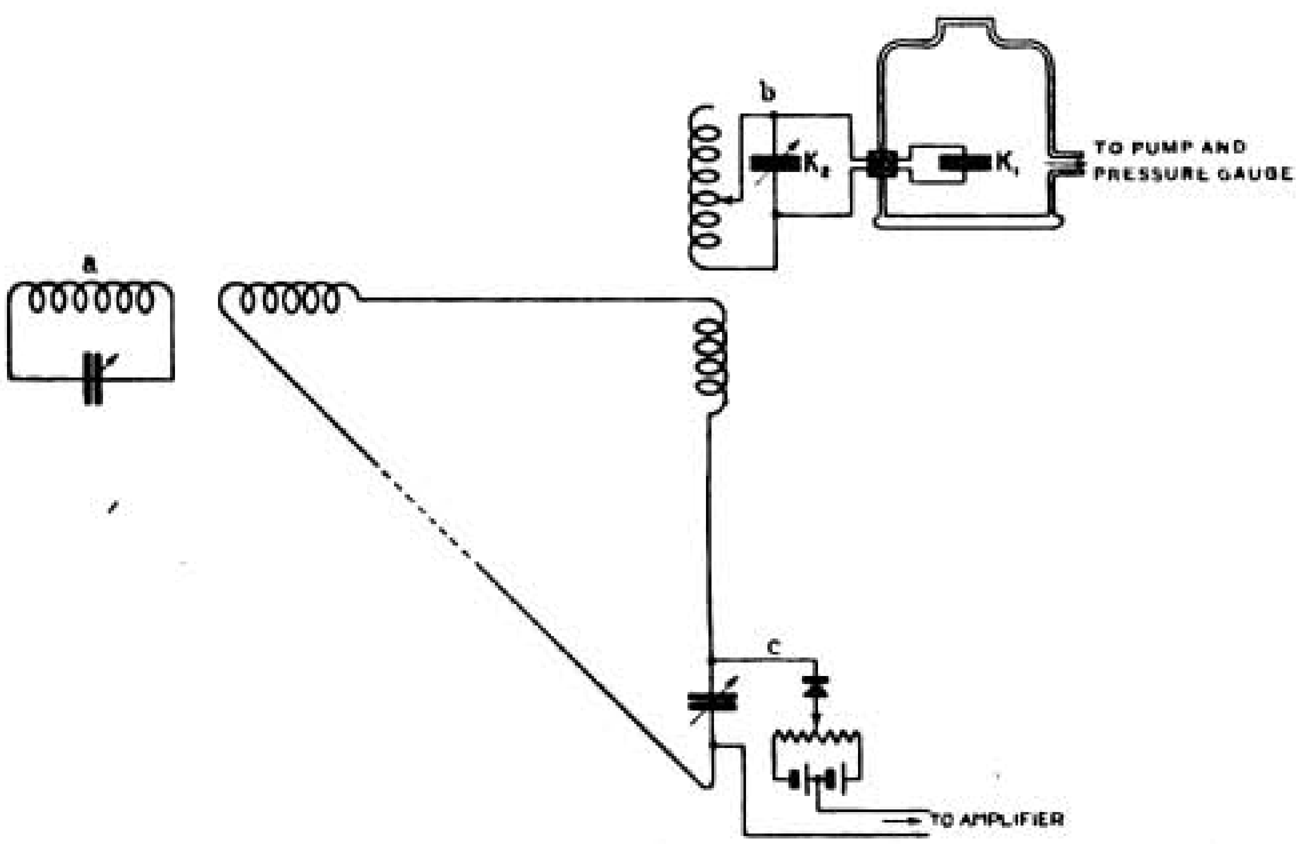
* Received March 3rd, 1921.

For the very greatest accuracy however a difficulty arises which can be seen by considering the beat method more closely. If two undamped waves of wavelength λ_1 λ_2 and frequencies n_1 n_2 are received simultaneously on a third circuit the frequency of the audible note heard is $n_1 - n_2$. Thus if λ_2 is fixed and λ_1 is varied from a value slightly larger than λ_2 to one slightly less the note heard goes from high to low, disappears over a range, reappears again and goes from low to high. The equality of wavelength occurs at the middle point of this inaudible range, and this cannot be accurately found owing to the great difficulty of telling where the sound dies away and reappears. An alternative is to find λ_1 in terms of λ_2 for some point of the audible range by estimating the frequency of the beat note $n_1 - n_2$ (this was virtually the method employed by Pungs and Preuner—*Physikalische Zeitschrift*, December, 1919) which at once gives $\lambda_1 - \lambda_2$.

The determination of a note frequency is however not easy and in any case involves extra apparatus and for this reason it was thought worth while to publish a simple method of producing the desired result and capable of very considerable accuracy.

In this method there are various ways of arranging the apparatus but only the actual one used will be described; the object of the research being to measure the specific inductive capacity of air, or other gases.

Arrangement of Apparatus.—Two entirely separate valve transmitting circuits of the ordinary type were set up some distance from one another, these circuits being referred to in what follows as **a** and **b**. A third circuit **c** was used as a receiver its inductance consisting of two coils in series, the first coupled fairly tightly to **a** and the second to **b**. All the



a and **b** = Transmitters (valves, reaction coils, batteries, etc., not shown).
c = Crystal Receiver.

rest of this circuit except the coils and their leads was removed as far as conveniently possible from **a** and **b**.

To prevent any chance of the circuit **c** generating an oscillation no valves were used in it but only a carborundum crystal, though probably this was an excess of precaution. (Later a low-frequency amplifier was used after the crystal.) This arrangement of apparatus fulfils the first requisite for accurate work that the experimenter should be some distance from the circuits **a** and **b** as any near movement affects their wavelength; as it is, wearing the telephones puts a variable earth on circuit **c** which affects **a** and **b** through the coupling coils and it is therefore better not to wear the telephones but to make the signals sufficiently loud by a L.F. amplifier to be read with the telephones on the table.

Effects Observed on Tuning.—If now circuit **a** be put at a certain wavelength, **c** tuned roughly to it, and the tuning of **b** then varied the usual ascending and descending musical scale is heard with the inaudible interval; but instead of the "fringes" of the inaudible interval being indistinct it will be found that as the note gets lower it turns into a rattle of fairly high frequency and if the tuning is continued very slowly the frequency of the rattle rapidly decreases (it can with care be adjusted to give two or three "ticks" a second) disappears and reappears on the other side of the inaudible range giving the same phenomena in the reverse order.

The disappearance of the rattle is very sharply marked and hence instead of the old difficulty of trying to estimate where a sound becomes inaudible we have a very simple and accurate method of telling when the wavelengths of **a** and **b** differ by a definite amount.

The explanation of the preceding effect is not quite clear but it is probably due to the fact that circuits **a** and **b** are coupled through **c** and therefore as **b** is tuned more closely to **a** the interaction between the circuits increases with the result that the oscillations in one circuit (the weaker oscillator) are quenched out and restarted a certain number of times per second, the stopping and starting causing the rattle.

In the actual experiment the circuit **b** had two condensers in parallel K_1 and K_2. K_1 was an ordinary air type parallel plate condenser and was enclosed in a bell jar, the connecting wires passed through a cork waxed to a hole in the jar, from which the air could be removed by a pump. A mercury pressure gauge was also attached to give the pressure.

K_2 was a very small condenser consisting of two coaxial cylinders, the capacity of which could be varied by sliding the inner one in and out. The actual size of this was not required but only difference in capacity for small movements. By always working with the inner one about half way in the *variation* in capacity for a small movement could be calculated from the simple formula as the edge errors will cancel. The calculated variation was 1·1 electrostatic units per centimetre. The inner cylinder was moved backwards and forwards by a screw of twenty turns to the centimetre.

In an actual experiment some particular size of the inductance in **b** was selected. The bell jar was pumped to a low pressure and then **a** was roughly tuned to **b** by the heterodyne method. The final adjustment was made on the condenser K_2 till the rattle was just on its disappearing point. Air was then admitted to **a** and it was found that a fresh adjustment of K_2 was necessary to get the rattle to the same disappearing point.

It is evident then, whatever the theory of the rattle, that the circuit **b** must be electrically exactly the same in the two cases, *i.e.*, the change in K_1 must have been equal and opposite to that of K_2. But the change in K_1 is due only to the specific inductive capacity of the extra air admitted, the change in K_2 is calculable and therefore the specific inductive capacity of air can be found.

By choosing different sizes of inductance the specific inductive capacity can be found for various wavelengths, the actual wavelengths used were 920, 1,300, 1,760, 4,000 metres.

Sensitivity of Method.—The disappearance of the rattle was so marked that it could be easily measured to one-quarter of a turn of the screw motion of the condenser K_2. This was equivalent to a movement of $\frac{1}{80}$ of a centimetre of the inner cylinder or to $\frac{1 \cdot 1}{80}$ E.S. units. The condenser K_1 being 2 mmfd = 1,800 E.S. units this is equivalent to a variation of about 1 part in 100,000 of the total capacity (or in wavelengths a variation of one in 50,000 can be measured).

Precautions Necessary.—It was speedily found that in dealing with such small capacity variations any small extraneous capacity would vitiate the results. The chief source of trouble, viz. the operator himself has been already referred to, even when far off it is desirable not to move about much and it was necessary to turn the screw adjusting K_2 by a very long ebonite handle.

Another possible source of error is the movement of the mercury up and down the gauge when the pressure varies if the gauge is anywhere near **b** and the gauge and pump were therefore about 10 feet from **b** and joined to the bell jar by rubber tubing which had previously been cleared of occluded gases.

All these precautions are however unavailing unless one can be certain that an oscillating circuit emits waves which will remain constant to at least 1 part in 50,000. It is not necessary to go through the experiments to ascertain if this was so but the final result was that the only variation of this order was due to the slow heating of the rheostat wires controlling the filament currents and that when these were replaced by more substantial wires with larger cooling surface the oscillating circuits came to an admirable degree of constancy in about five to ten minutes. (The H.T. batteries consisted of small accumulators.)

Calculation of Results.—If the dielectric constant of a vacuum be taken as 1, then over the ranges of temperature and pressure used $K-1$ is proportional to the density, K being the specific inductive capacity of the air. The experiment gives the variation in capacity of a 2 milli-microfarad condenser when the air pressure is reduced from p_1 to p_2, the temperature remaining constant at $\theta°$. But the above law being true it is a simple matter to estimate what the capacity change would be if the pressure was reduced by 760 and the temperature was 0°; for it is the above variation multiplied by $\frac{760(273+\theta)}{(p_1-p_2)273}$ and thus the specific inductive capacity of air at 0° and 760 mm pressure is obtained.

The following table gives the results for various wavelengths taking the specific inductive capacity of a vacuum as 1.

They are the means of several consistent experiments and as these were taken over various pressure ranges they incidentally confirm the law $K-1$ is proportional to density.

Wavelength.	Dielectric Constant.
920 metres	1·000658
1,300 "	1·000654
1,760 "	1·000654
4,000 "	1·000653

No particular reliance should be laid on the last figure as it is not claimed that these results are accurate to more than 1 per cent.

Over the wavelengths used therefore there is no reason to suppose that any variation occurs with wavelength. Previous values found however for steady and not alternating fields are given in Kaye and Laby's tables as

1·000586 (at 0°-Klemencic, 1885).
1·000576 (at 20°-Tangl, 1908).

Attempts were made to see if the specific inductive capacity of air could be altered by various methods such as the application of a magnetic field, and the passage of a beam of light but such effects if they exist are a good deal less than 0·1 per cent. as no variation could be detected. The specific inductive capacity was also independent of the electric force over a large range, the oscillating current in **b** being varied from 0·1 to 1·5 amps without any change being detected, thus varying the electric force in the condenser by the factor 15 makes no difference.

My thanks are due to Professor Townsend, F.R.S., in whose laboratory these experiments were conducted.

Notation for Electron Tube Circuits.*

By J. H. DELLINGER,
Physicist, Bureau of Standards.

It has become difficult to read papers on electron tube theory and applications because of the large number of quantities and circuits for which symbols must be used. Naturally there has been considerable diversity in the notation employed. This diversity is not so great, however, but that

* Received January 12th, 1921.

certain well-defined practices have become common, and it appears possible to establish a reasonably consistent notation which may be employed as a basis for all discussions on electron tubes. While there is no way of avoiding an elaborate and complicated appearance in a set of notation which aims to be useful in all sorts of electron tube discussions, the present paper nevertheless has simplification in mind. Current practice and consistency are retained as far as possible. Only parts of this notation will be used in any one paper or discussion. A number of explanatory notes are given after the definitions below.

e_p, e_g = Instantaneous alternating E.M.F. in plate-filament and grid-filament circuit, respectively. (The term "alternating" has the usual meaning of periodic, with average value zero.)

E_p, E_g = Effective alternating E.M.F. in plate-filament and grid-filament circuit, respectively. (The source of E.M.F. is indicated in Fig. 1 as being inside the tube. The notation is not changed if it is outside the tube, or the sum of E.M.F.'s outside and inside.)

v_p, v_g = Instantaneous alternating voltage between plate and filament, and between grid and filament, respectively. (See Fig. 1.)

V_p, V_g = Effective alternating voltage between plate and filament, and between grid and filament, respectively. (See Fig. 1.)

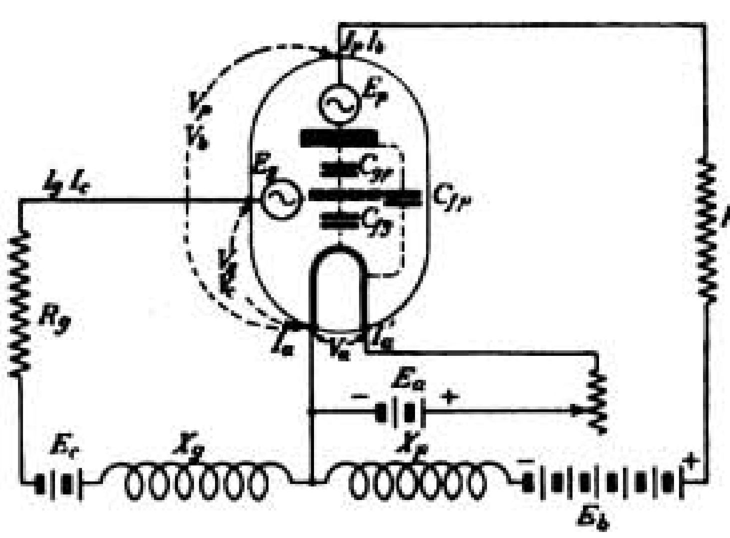


FIG. 1.

i_p, i_g = Instantaneous alternating current to plate and to grid, respectively.

I_p, I_g = Effective alternating current to plate and to grid, respectively.

E_{pm}, E_{gm}, V_{pm}, V_{gm}, I_{pm}, I_{gm} = Maximum values of quantities for which the symbols without the subscript m indicate the effective values.

e_p', e_g', E_p', E_g', v_p', v_g', V_p', V_g', i_p' i_g', I_p', I_g' = Total values of quantities for which the corresponding symbols above indicate the alternating portions. (When a discussion deals with total values extensively and exclusively, the primes may be omitted, in such cases statements being made to keep the reader clear as to which quantities are meant.)

e_{p_1}, e_{g_1}, E_{p_1}, E_{g_1}, ϵ_{p_1}, ϵ_{g_1}, V_{p_1}, V_{g_1}, i_{p_1}, i_{g_1}, I_{p_1}, I_{g_1} = Fundamental component of alternating quantities indicated by corresponding symbols above. The subscript 1 may be written before instead of after the main symbol if preferred, thus, ${}_1E_p$. The subscripts for other harmonics than the fundamental are similarly treated. (When a discussion deals with the fundamental component extensively and exclusively, the subscript 1 may be omitted, in such cases statements being made to keep the reader clear as to which quantities are meant.)

E_a, E_b, E_c = Direct E.M.F. in filament circuit, plate-filament circuit, and grid-filament circuit, respectively.

V_a, V_b, V_c = Direct voltage between terminals of filament, between plate and filament, and between grid and filament, respectively. (V_b and V_c are measured from that filament terminal to which the tube circuits are connected. This is ordinarily the negative terminal when D.C. is used to heat the filament.)

I_a, I_a' = Direct current through filament at the negative and positive terminals, respectively.

I_b, I_c = Direct current to plate and to grid, respectively. (*Note.*—E_a, E_b, E_c, V_a, V_b, V_c, I_a, I_a', I_b, I_c, are average values or the readings of D.C. instruments. The values of V_b, V_c, I_b, I_c, are in general not the same when alternating current is present as when it is not.)

I = Direct current through filament, with no space current flowing.

V = Direct voltage on filament, with no space current flowing.

I_e = Emission current from filament.

ΔV_b, ΔV_c = Change in direct voltage between filament and plate, and between filament and grid, respectively, when a signal voltage is impressed on the grid of a detector tube.

ΔI_b, ΔI_c = Change in direct current to plate, and to grid, respectively, when a signal voltage is impressed on the grid of a detector tube.

P_a, P_b, P_c = Average power supplied by filament battery, plate battery, and grid battery, or their equivalents, respectively.

P_f, P_p, P_g = Average power consumed by filament, plate, and grid, respectively.

R_p, R_g = Resistance inserted in series with plate and grid, respectively.

L_p, L_g = Inductance inserted in series with plate and grid, respectively.

X_p, X_g = Reactance inserted in series with plate and grid, respectively.

Z_p, Z_g = Impedance inserted in series with plate and grid, respectively.

r_p, r_g = Internal output resistance and internal input resistance of tube. (The term " internal output resistance " means the resistance in the tube between plate and filament.)

c_g, x_g, z_g = Input capacity, input reactance, and input impedance of tube, respectively.

C_{fg}, C_{gp}, C_{fp} = Individual internal capacities between filament and grid, between grid and plate, and between filament and plate, respectively.

R_o = Resistance of output oscillatory circuit of electron tube acting as a generator. (The output oscillatory circuit is the circuit in which the alternating-current power is produced and may be utilised.)

i_o, I_o = Respectively, instantaneous and effective alternating current in output device or output oscillatory circuit of electron tube acting as a generator. (When the current is not the same in parallel branches of the output oscillatory circuit, or when it is not the same at different points because of distributed capacity, it may be necessary to specify more closely at what point the current is measured.)

e_o, E_o = Respectively, instantaneous and effective alternating E.M.F. in output oscillatory circuit of electron tube acting as a generator. (When the current is not different in different parts of the output oscillatory circuit, $E_o = R_o I_o$.)

P_o = Average power output in output oscillatory circuit of electron tube ($P_o = R_o I_o^2$).

$g_m = \frac{\partial i_p}{\partial v_g}$ = Mutual conductance of grid to plate.

$g_p = \frac{\partial i_p}{\partial v_p}$ = Internal output conductance of tube $= \frac{1}{r_p}$.

$g_n = \frac{\partial i_g}{\partial v_p}$ = Mutual conductance of plate to grid.

$g_g = \frac{\partial i_g}{\partial v_g}$ = Internal input conductance of tube $= \frac{1}{r_g}$.

μ = Amplification coefficient $= \frac{g_m}{g_p}$.

μ_n = Reaction coefficient $= \frac{g_n}{g_g}$.

μ_r = Voltage amplification ratio $= \frac{\partial v_{z_p}}{\partial v_g} = \mu \frac{R_p}{R_p + r_p}$

(where v_{z_p} = instantaneous voltage across Z_p).

μ_i = Current amplification ratio $= \frac{\partial i_{z_p}}{\partial i_g}$.

μ_p = Power amplification ratio.

It is to be noted that the symbols f, p, g, indicate alternating current values; while symbols a, b, c, indicate direct current values. This convention is already in very extended use.

The use of V rather than E is a matter upon which there will probably not be unanimous agreement. Some writers prefer to use E both for impressed or generated electromotive force and for potential difference (the reading of a voltmeter). When this is done the two cannot be distinguished except by the use of subscripts, and it would be unfortunate to complicate the notation with additional subscripts. The need of the symbol V to designate potential difference is shown by its use by a great many writers on radio and electron tube subjects. Some papers which do not use any distinction in symbols between an impressed E.M.F. and a potential difference are harder to follow on that account.

The notation for harmonics is given (as suggested under definition of e_{p_1}, e_{g_1}, etc.) by adding as a subscript the number giving the order of the harmonic. This may be written either after or before the main symbol, thus—E_{p_5} or ${}_5E_p$. The maximum value of amplitude of a harmonic is indicated by the additional subscript m; but when the discussion deals with the maximum values extensively and exclusively, the m may be omitted, in such cases statements being made to keep the reader clear as to which quantities are meant. For example, $E_{p_{5m}}$ can in such cases be abbreviated to E_{p_5}.

Too much stress cannot be laid upon the need of great care in keeping distinct the instantaneous, effective, maximum, total, total alternating, and the fundamental (or first harmonic) values of the various quantities. The same symbol has been used for all of these in the writings of various authors. This makes it difficult to read papers by different people. The present notation provides separate symbols for all these but avoids cumbersomeness, providing that the special subscripts may be dropped in cases where there would be no confusion. Writers in particular branches of the electron tube field may, on first thought, deny that all of these quantities need to be provided for. Their necessity is apparent, however, when one considers all of the various types of discussion which are being published. The complete symbols for these various values and the symbols to which they may be abbreviated are shown in the following tabulation, for grid current.

The symbols I, V, are used when considering the characteristics of the filament purely as a filament. They are probably of use only in efficiency studies on tubes.

The definitions of g_m, g_p, g_n, g_g are in accordance with definitions given by E. V. Appleton in the RADIO REVIEW, Vol. I, p. 368, April, 1920.

The n used in the symbol g_n is arbitrarily chosen—simply suggested by the symbol m in g_m. Similarly, the use of n in μ_n is simply by analogy in the use of n in g_n.

The symbol μ_o has sometimes been used for amplification coefficient. It seems better to use the simpler symbol μ for this quantity which is one of

		Total.	Alternating part of Total.	Fundamental Component*	Harmonics (5th, for example*).
Complete Notation	Instantaneous	i_g'	i_g	i_{g_1}	i_{g_5}
	Effective	I_g'	I_g	I_{g_1}	I_{g_5}
	Maximum	I_{g_m}'	I_{g_m}	$I_{g_{1m}}$	$I_{g_{5m}}$
Abbreviated Notation	Instantaneous	i_g	i_g	i_g	${}_g i_5$
	Effective	I_g	I_g	I_g	I_{g_5}
	Maximum	I_{g_m}	I_{g_m}	I_{g_m} or I_{g_1}	I_{g_5}

the principal fundamental properties of the tube, and to use subscripts upon the μ for related ratios.

It will be found necessary to supplement this notation by the adoption of additional conventions for certain kinds of discussions. This will be necessary, for example, in diagrams having many tubes, in some cases of parallel power supply, in plate or grid circuits having sources of E.M.F. both inside and outside the tube, and in the case of coexistence of conductive and capacitive current flow in the tube. In most of these cases additional subscripts will be necessary.

Washington, D.C., U.S.A.,
December 8th, 1920.

Clifden.

By H. J. ROUND,

Marconi Research Department.

The old spark transmitter at Clifden, which has been used for the Canadian wireless service for some years, has never been very exactly described. Figures, therefore, giving a few of the constants of the circuits will be of value as they will enable a comparison to be made with those of the valve transmitter now operating there.

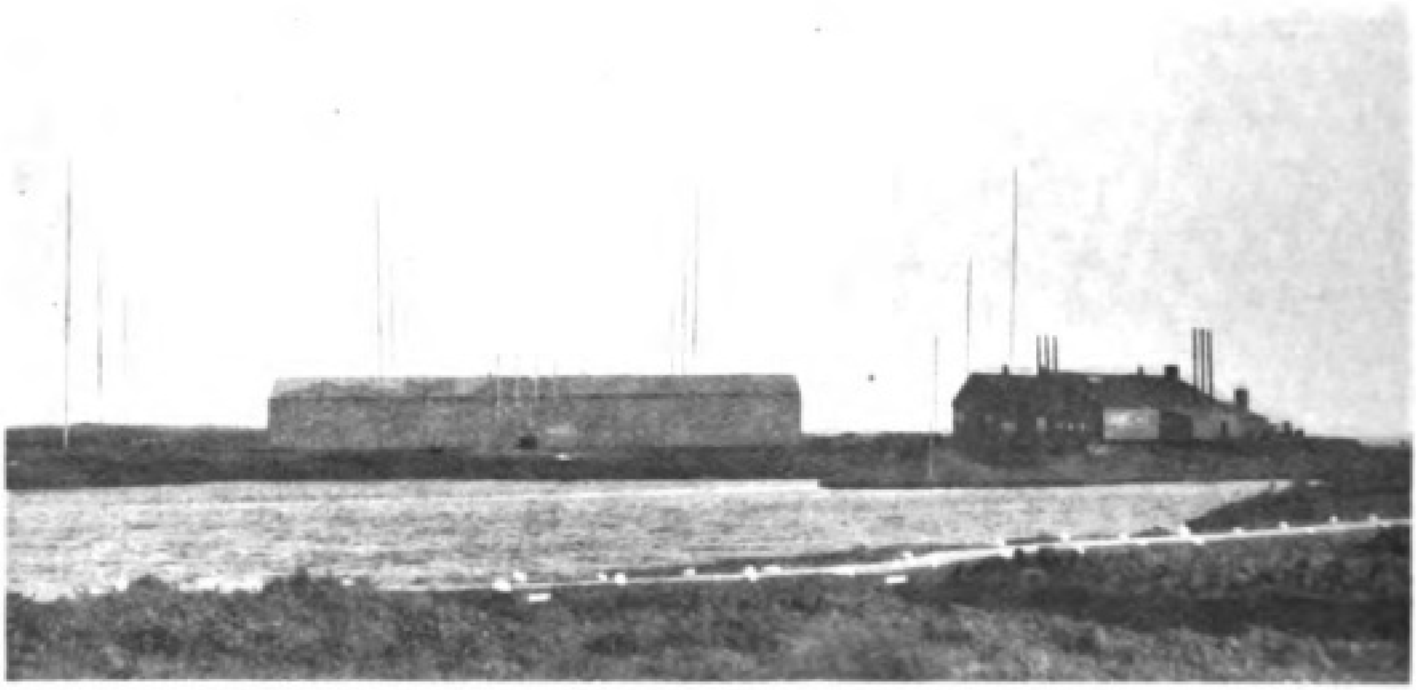
The antenna has an effective average height of about 100 feet and is supported on wooden masts varying from 180 to 220 feet.

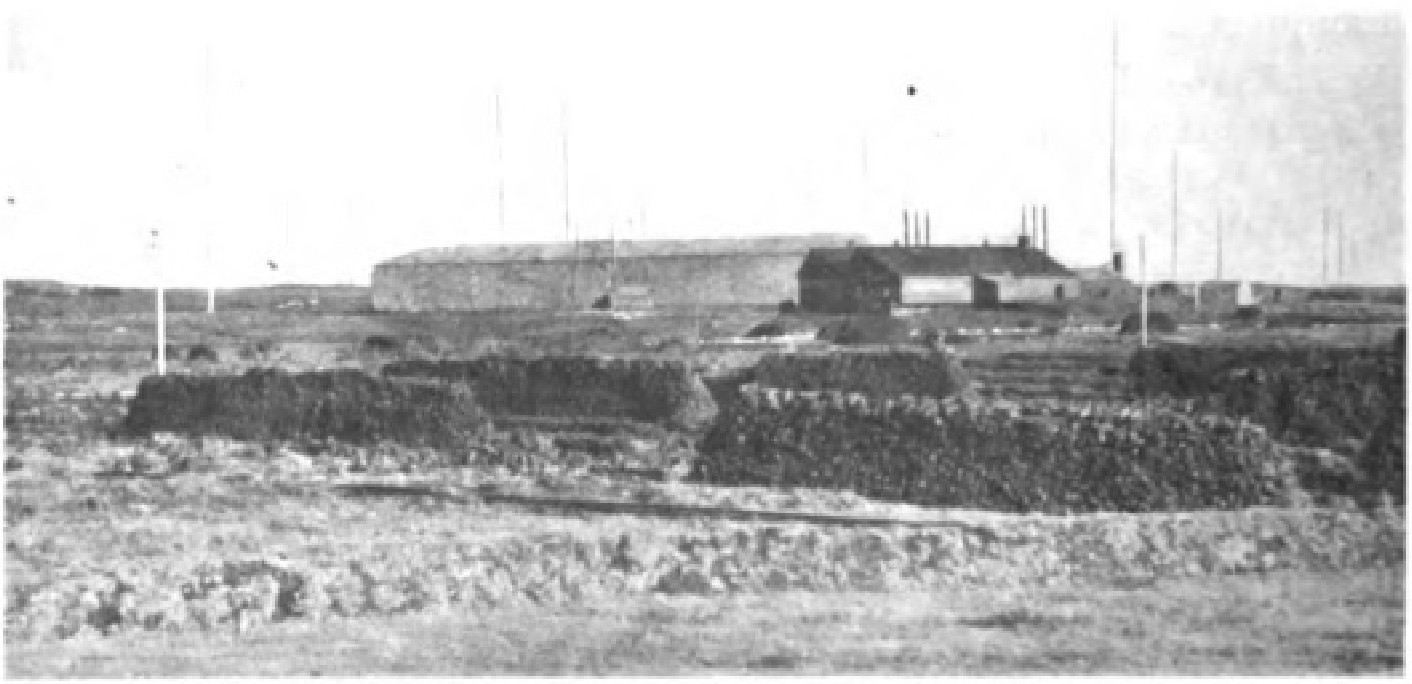
The length is about 2,500 feet, the average breadth about 1,200 feet, and

* The subscript denoting the order of the harmonic may be put in front of the main symbol if desired, thus $_1i_g$, $_5I_{gm}$.

the number of wires is 32. The capacity is approximately 0·035 microfarad.

The aerial resistance, using the old earth plates, was about 4·5 ohms at 5,700 metres. In comparison with many modern aerials it will be seen that





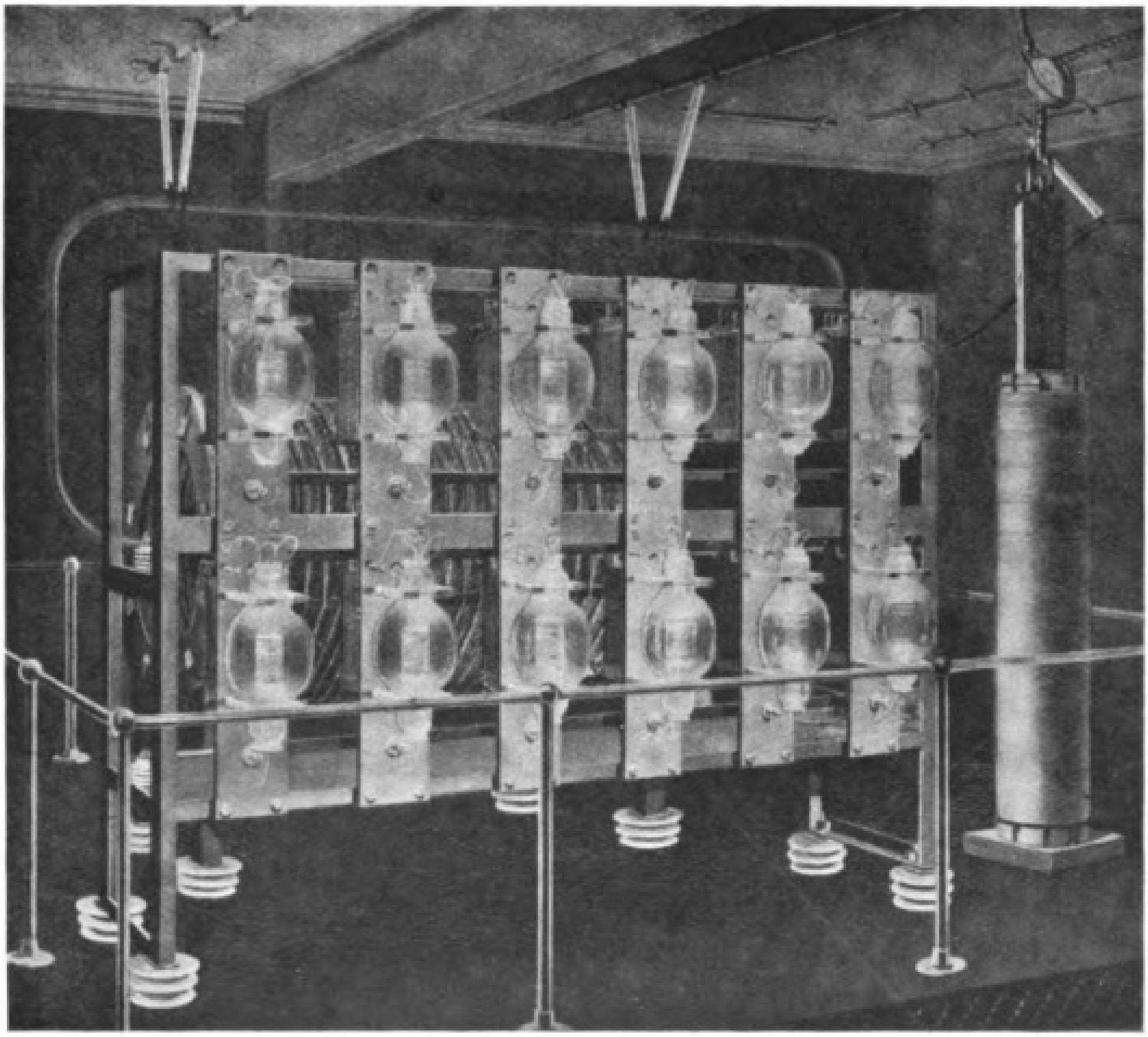
Two Views of Clifden Radio Station.

the effective height is extremely small and also that the resistance is very considerably greater than modern practice will allow.

The primary spark circuit has a logarithmic decrement of about 0·06 per complete period, so that the loss in the primary circuit is not great. The coupling value is about 1 per cent. An input of 80 to 100 kW from the high tension D.C. machines at 10,000 volts gives about 100 amperes in the antenna. This power can be increased up to about 150 kW if necessary.

The efficiency from input primary circuit power to the aerial power is thus about 50 per cent.—but the radiated power is only about 1 per cent. owing to the low effective height and high aerial resistance. This was obviously a place for great improvement.

Actually the total radiation may be considered larger if radiation in direc-



The New Valve Transmitting Apparatus at Clifden.

tions other than that of normal propagation were considered—but this would seldom be of advantage at the receiving end.

A counterpoise earth of the new type, called the "Earth Screen," was erected early last year and the actual resistance of the aerial has now been reduced to 0·6 ohm including the loading coil, thus bringing the radiation efficiency up to 8 per cent.

It is hoped that the actual efficiency can be raised to 40 per cent. and experiments are being continued in this direction. The successful reduction of the aerial resistance to 0·6 ohm decided the introduction of a valve transmitter. Everything else was favourable to the plan. Direct current up to 20,000 volts was available—the aerial had so small a loading coil that very little change in the natural period of the aerial would be expected during high winds. The station also had the advantage that its distance from important short wave stations was sufficiently great to permit of a plain aerial circuit, without the accompanying harmonics causing trouble. This very considerably simplified the arrangements to be made.

The whole of the apparatus for the change from spark to valve working was taken out by passenger train—this was of course necessitated by the difficulties of transport in Ireland, but it is actually a tribute to the simplicity of the change to valves.

A valve panel of 12 Marconi MT2 valves was erected and put into operation. Owing to the shortage of valves, only 9 valves were used in the initial tests and the accompanying figures were obtained with the 9 valves.

CLIFDEN VALVE SET TESTS.

September 12th, 1920.

Resistance of aerial: 0·7 ohm. (This has since been reduced.)
Wavelength = 5,600 m. Nine MT2 valves in use.
Total filament current: 90 amperes at 20 volts.

Valve Feed Current.	Aerial Current.	D.C. Voltage.	Kilowatts.		Efficiency Neglecting Filament Current.
			Feed.	Aerial.	
amps.	amps.				
1·55	117	7,700	11·9	9·6	80·5 per cent.
1·85	140	9,500	17·5	11·3	65 ,,
2·2	165	11,400	25·1	19·1	76 ,,
2·75	200	14,000	38·4	28	73 ,,
3·03	222	15,400	46·7	34	73 ,,
3·3	236	16,800	52·8	39·2	74·2 ,,
3·52	250	18,000	60	43·7	73 ,,

The circuit in use is that shown in Fig. 1. It was found necessary, in order to prevent exceedingly high potentials being produced while signalling, to shunt the signalling keys (which incidentally are the same keys as those used for the spark set) with a high resistance and allow the valve set to oscillate weakly during the spacing sign. The actual spacing current is about one-tenth the signalling current but even this value is complained of by Canadian receiving stations and it will have to be considerably reduced in the future.

Except on the comparatively rare occasions when the wind blows directly across the aerial, Clifden's wavelength is exceedingly constant and during several hours working will not show a variation of 1 in 7,000. The usual working current is about 180 amperes.

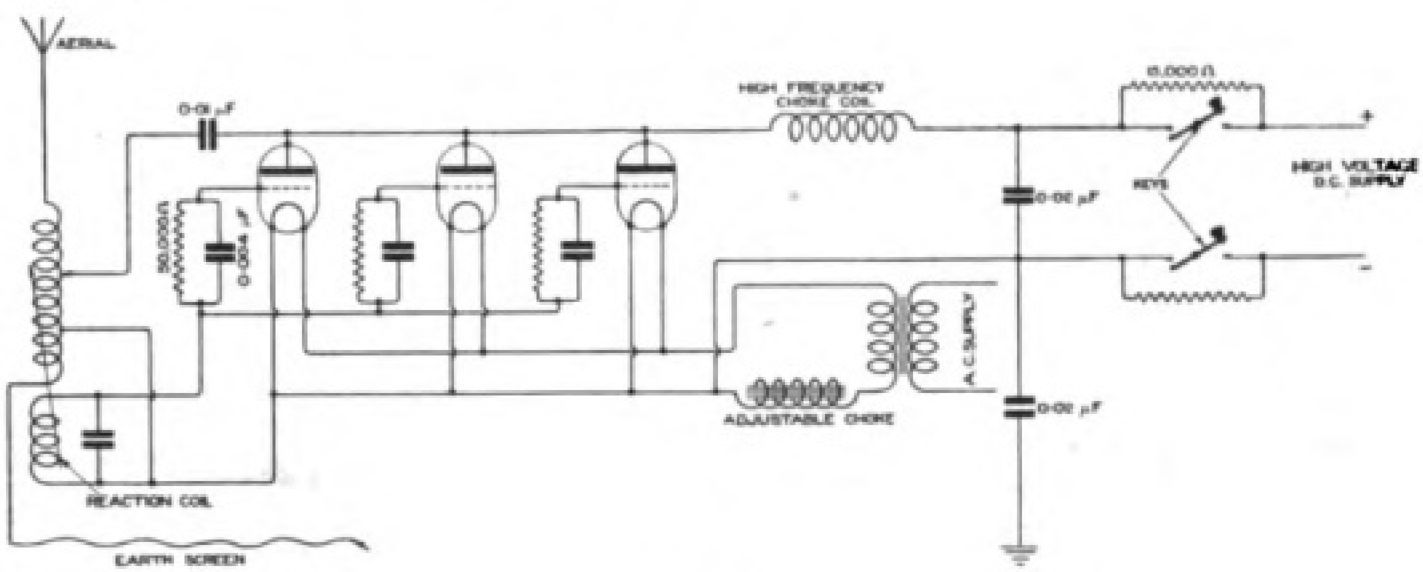


FIG. 1.

Various improvements are being made now and others are projected but at the moment the greatest improvement expected is that due to the installation at Glace Bay of a similar set. The new transmitter at Clifden has now been working successfully for nine months and has provided valuable information and experience in connection with the use of valves under commercial conditions.

The Nature and Nomenclature of Electric Discharges.*

Different types of electric discharge have recently become known which combine in each certain of the characteristics which formerly distinguished the known types of discharge from one another (vacuum discharge, glow discharge, arc, etc.).

For example, in the new neon arc lamp the discharge raises the temperature of points of the cathode to incandescence and vaporisation as in an arc lamp; special means are adopted, however, to prevent the cathode products spreading up the main discharge column in which one has consequently nothing but electrons and ions of the rare gas at a low temperature as in a glow discharge. In another case one has an artificially heated cathode in a gaseous space; in addition to the electrons emitted by the hot cathode, gas ionisation occurs as in glow discharges, which increases the electronic current. Again, the

* From an article by W. Schottky in the *Zeitschrift für technische Physik*, 1, p. 208, September, 1920.

positive ions on colliding with the cathode can cause a further emission of electrons as in a glow discharge, or they may cause local heating of the cathode and lead to a kind of arc discharge.

Under such circumstances it is a waste of words to argue whether any discharge should be classed under one or other of the formerly distinguished types. To characterise a discharge it is necessary to state as many properties of the phenomenon as can occur independently of one another.

The most obvious proposal appears to be, to state (1) the point at which the discharge originates (cathode, gas or anode) and (2) the nature of the cause which originates it (thermal or otherwise). (3) In addition to this it should be stated whether the energy required to produce the electrons is supplied from the discharge itself or from some external source.

(1) On this plan discharges would be divided into cathodic, anodic, or gas path discharges, together with various combinations of these three depending on the character of the discharge. (2) If in a cathodic discharge, the emission of electrons is due to the heating of the cathode one could call the discharge **cathothermal.** If, however, the electrons are produced at the cathode by the incidence of a wave or of corpuscular radiation or by chemical action, the name **cathodrome** might be applied (*δρόμος* = a course). In the same way, the production of ions and electrons in the gas path could be called **hodo-thermal** (*ὁδός* = path) if due to heat and **hododrome** if due to the incidence of waves or of corpuscles or to chemical action. Although little is known of such processes, the words **anothermal** and **anodrome** could be applied if the discharge originated at the anode.

(3) To distinguish between the cases in which the energy required to produce the electrons is supplied from the discharge itself and those in which it is supplied from a separate source, the words **auto** and **allo** could be introduced.

Whether or not this suggested nomenclature be adopted, it is important that some method be introduced whereby discharges can be correctly characterised.

The following are given as examples of the application of these suggestions :

The neon arc lamp—catautothermal and hodautodrome;

Ordinary glow discharge—catautodrome and hodautodrome;

Ordinary thermionic bulbs—catallothermal with more or less hodautodrome, catautodrome and catautothermal.

Discharge in flames—hodallothermal with hodallodrome effects due to chemical reaction in the flame and moreover in some cases hodautodrome effects due to ionisation by collision in strong fields, and catallothermal and anallothermal effects if the electrodes are not cooled. In the carbon arc probably all the "auto" effects will be represented, whilst in the mercury vapour lamp we shall have catautothermal and hodautodrome (no appreciable hodautothermal or anode effects).

Further subdivision would be necessary to characterise completely the nature of the discharge as indicated by the following:—the vapour of the cathode or anode may or may not take an appreciable part in the discharge; the relation between mean free path and ionisation potential is of importance as is also the character of the gas in which the discharge occurs.

Discharges may also be grouped according to certain external characteristics, as " burning," " striking " or " disruptive."

It would seem, however, that the above suggested subdivision is necessary as a basis for the correct description of an electric discharge. Much misunderstanding and patent litigation might be obviated if technical physicists would always explain to which of the above described distinguishing characteristics they wished to refer.

G. W. O. H.

An Analytical Method for Comparing the Rectifying Properties of Three-electrode Valves.*

By L. S. PALMER, M.Sc., Ph.D.

SYNOPSIS.

1. Introduction.—The following investigation was undertaken with the object of testing the validity of certain assumptions as to the form of the curved portion of the plate current—grid voltage characteristic of three-electrode valves. It was thought that an analysis based on these assumptions might yield some simple expression involving the known valve constants by which the rectifying properties could be predetermined. Somewhat similar investigations have been carried out by Van der Bijl,† Ballantine,‡ Carson,§ Breit,|| and others using the generally accepted equations for the characteristic, but a comparison of the curves of the first and second derived equations with the curves obtained experimentally ¶ shows that the usual equations do not represent the changes of curvature of the characteristics with much accuracy.

The present work was suggested by Dr. B. Hodgson, who in 1916 carried out some measurements similar to those described on p. 472. During the course of the work Mr. E. V. Appleton ** obtained some first differential characteristics with his slope-meter and pointed out the use of such curves for indicating the amplifying and rectifying properties of valves.

* Received in final form June 24th, 1921.

† *Proceedings of the Institute of Radio Engineers*, 7, p. 603.

‡ *Proceedings of the Institute of Radio Engineers*, 7, p. 129.

§ *Proceedings of the Institute of Radio Engineers*, 7, p. 187.

|| *Physical Review*, 16, pp. 387, 408.

¶ *Proceedings of the Institute of Radio Engineers*, 7, pp. 609, 610.

** *Proceedings of the Cambridge Philosophical Society*, 20, p. 239.

M M

2. Nomenclature.—The following nomenclature has been adopted throughout this paper :—

General Symbols.

V = Plate voltage.
v = Grid voltage.
v_f = Filament voltage.
I = Plate current.
i = Grid current.
i_f = Filament current.
θ = Angle of slope of straight portion of the (I, v) characteristic.
ϕ = Angle of slope of straight portion of the (I, V) characteristic.

$$\alpha_m = \text{Maximum value for } \frac{dI}{dv} = \tan\theta.$$

$$\beta_m = \text{Maximum value for } \frac{dI}{dV} = \tan\phi.$$

$$\lambda = \frac{\beta}{\alpha} = \text{Voltage amplification factor.}$$

$$r_\alpha = \frac{1}{\alpha} = \text{Filament-grid resistance.}$$

$$r_\beta = \frac{1}{\beta} = \text{Filament-plate resistance.}$$

Special Symbols.

v_x = Grid voltage for any point x on the (I, v) characteristic.
v_w = Grid volts for which rectification is a maximum for any given plate voltage, *i.e.*, the best working grid voltage for detection.
v_0 = Value in volts between the grid potential for which the plate current is zero, and the potential at which the (I, v) characteristic becomes a straight line (Fig. 1), *i.e.*, $(v_{I=0} - v_{dI/dv=\text{const}})$, or the range in grid volts over which rectification can occur.
I_R = The nett or effective rectified plate current produced by an alternating input voltage on the grid.

For simplicity in the following equations that characteristic is considered for which the dotted line D.M. (Fig. 1) coincides with the plate current axis. This avoids the necessity for the introduction of superfluous constants.

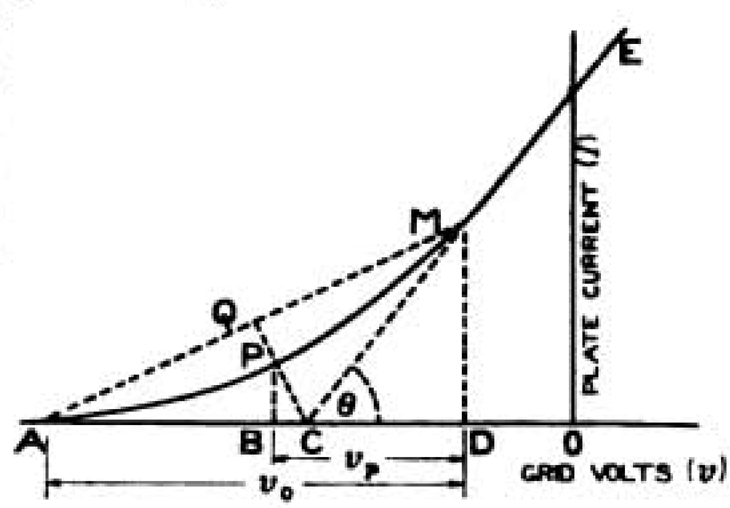


FIG. 1.

3. Theoretical Discussion.—Since rectification without a grid condenser depends upon the fact that the (I, v) characteristic of a three- electrode valve does not obey

Ohm's law, it will be necessary to obtain the equation of the curved portion of the characteristic before any quantitative method for measuring rectification can be determined. The two following equations, depicted graphically in Figs. 2 and 3 respectively, were found to represent conveniently the lower curved portion of the $(I,\ v)$ characteristics.

$$v^2 + I^2 + 2v_0 v - \frac{2v_0}{\alpha_m}(1 + \alpha_m^2)^{\frac{1}{2}} I + v_0^2 = 0, \quad . \quad . \quad . \quad (1)$$

where α_m measures the characteristic slope at the point M (Fig. 2).

$$v^2 + 2\alpha_p I v + \alpha_p^2 I^2 + 2v_0 v - \frac{\alpha_p^4 + 1}{\alpha_p} v_0 I + v_0^2 = 0, \quad . \quad . \quad (2)$$

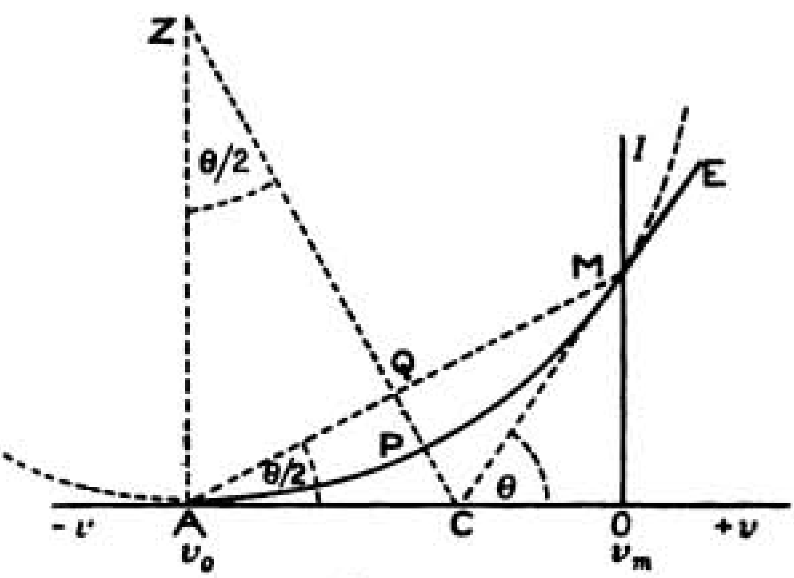


FIG. 2.

where α_p measures the slope of the characteristic at the point P (Fig. 3).

Equation (1) is that of the circle A P M of radius $\frac{v_0}{\alpha_m}(1 + \alpha_m^2)^{\frac{1}{2}}$ tangential to the straight line C M E at M and tangential to the grid voltage axis at A (Fig. 2). This form was found to coincide approximately with the characteristics of soft valves.

Equation (2) is that of the parabola *which has Q C as axis*, and which is also tangential to the straight line C M E at M and to the grid voltage axis at A (Fig. 3). Its minimum radius of curvature is at the point P and is half the length of the latus rectum, that is, it is given by $\frac{v_0}{2\alpha_p}(1 + \alpha_p^2)^{\frac{3}{2}}$. This curve approximates very closely to the experimental characteristics of hard valves.

Using these equations the "detection constant," $\frac{\delta v^2 \,.\, f''(v)}{2}$ (obtained from the Maclaurin expansion of $I + \delta I = f(v + \delta v)$ *) can now be evaluated in terms of the known valve constants. This can be done most readily by writing the above expression in the form :—

$$I_R = \frac{\delta v^2}{2R}\left[1 + f'(v)^2\right]^{\frac{3}{2}} \quad . \quad . \quad (3)$$

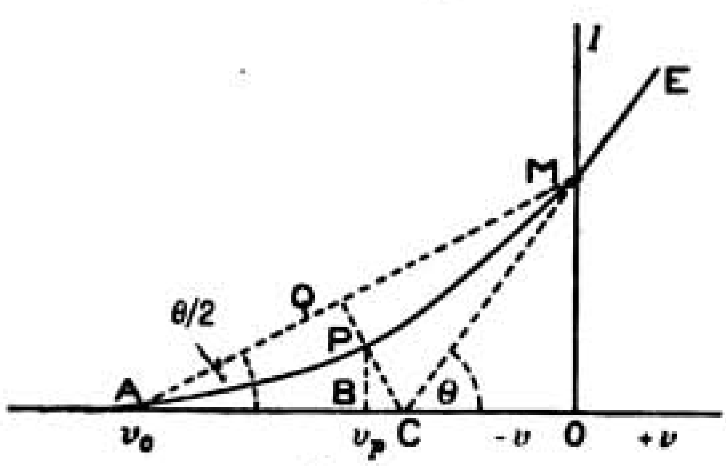


FIG. 3.

* *Proceedings of the Institute of Radio Engineers*, 7, p. 129.

where R is the radius of curvature and $f'(v)$ the slope of the static characteristic at the particular working point, which, for maximum I_R, is that point where $f''(v)$ is a maximum.

For the circular form of the characteristic given by equation (1) the best working point (where $f''(v)$ is a maximum) is at M (Fig. 2), that is, $v_w = v_m$. For this point the values of R and $f'(v)$ are known (see p. 466) and substituting the values in equation (3) we get

$$I_R = \frac{\delta v^2(\alpha_m + \alpha_m^3)}{2v_0} \quad . \; . \; . \; . \; . \; . \; . \; . \; . \; . \quad (4)$$

With the parabolic form of the characteristic (equation (2)) the best working point lies somewhere between P and M (Fig. 3), for which R and $f'(v)$ are not easily determined. In practice the best working grid voltage (v_w) with hard valves was found to coincide very closely with v_p; that is, $v_w = v_p$ approximately (see Table II. and p. 473). For this point (v_p), R and $f'(v)$ are known (see p. 466) and when substituted in equation (3),

$$I_R = \frac{\delta v^2(\alpha_p + \alpha_p^3)}{v_0} \quad . \; . \; . \; . \; . \; . \; . \; . \; . \; . \quad (5)$$

If α_m is less than unity $\left(\text{as when measured in } \frac{\text{milliamps}}{\text{volts}}\right)$ both these expressions approximate to $\frac{\delta v^2 \, . \, \alpha_m}{2v_0}$. Thus, if the assumptions involved in the foregoing analysis are sufficiently exact, and if the input grid voltage change (δv) be constant, then the expression $\frac{\alpha_m}{v_0}$ serves to measure *relatively* the value of I_R for any valve whose constants α_m and v_0 are known or can be determined. In other words, the expression $\frac{\alpha_m}{v_0}$ is a convenient measure of the relative rectifying efficiencies of three-electrode thermionic valves.

4. Experimental Work.—In order to test both equations (1) and (2) and the formula $\frac{\alpha_m}{v_0}$ the first and second differential characteristics were obtained experimentally (Figs. 4B and 5B) and compared with those plotted from the first and second differentials of equations (1) and (2) respectively (Figs. 4A and 5A). The curves of Fig. 4A are given by

$$\frac{dI}{dv} = -\frac{v + v_0}{I - \frac{(1 + \alpha_m^2)^{\frac{1}{2}}}{\alpha_m} \, . \, v_0} \qquad \text{from equation (1)}$$

and by $$\frac{dI}{dv} = -\frac{v + \alpha_p I + v_0}{\alpha_p \left(v + \alpha_p I - \frac{\alpha_p^4 + 1}{2\alpha_p^2} v_0\right)}$$ from equation (2).

The corresponding equations plotted in Fig. 5A are, from equation (1) :—

$$\frac{d^2I}{dv^2} = -\frac{v_0^2(1 + \alpha_m^2)}{\alpha_m^2}\left[I - \frac{(1 + \alpha_m^2)^{\frac{1}{2}}}{\alpha_m} \cdot v_0\right]^{-3}$$

or $= -\frac{R^2}{(I - R)^3}$ where R is the radius of the circle, and from equation (2) :—

$$\frac{d^2I}{dv^2} = -\frac{v_0^2(1 + \alpha_p^2)^4}{4\alpha_p^5}\left[v + \alpha_p I - \frac{(1 + \alpha_p^4)}{2\alpha_p^2} v_0\right]^{-3}$$

The similarity between these theoretical curves and the experimental curves of Figs. 4B and 5B justifies the original assumptions leading to equations (1) and (2) for the normal (I, v) characteristic.

In order to test experimentally the relative detecting efficiency of different valves, the plate potentials and filament voltage were kept constant at 40 volts and 3·5 volts respectively; that is, the detecting efficiencies under similar conditions were measured and not the maximum efficiency of any particular valve. Thus 3·5 volts on the filament of the N.P.L. No. 2 valve was too high, whilst the Moorhead tube would have been a much better detector than indicated if the filament volts had been raised to 5 or 6. All characteristic slopes were measured in $\frac{\text{amperes} \times 10^{-3}}{\text{volts}}$, this ratio being convenient both for graphical and numerical work.

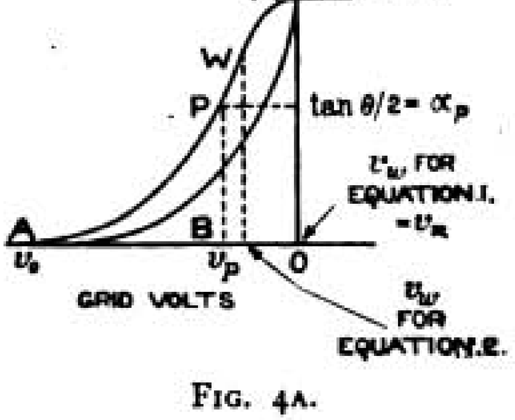


FIG. 4A.

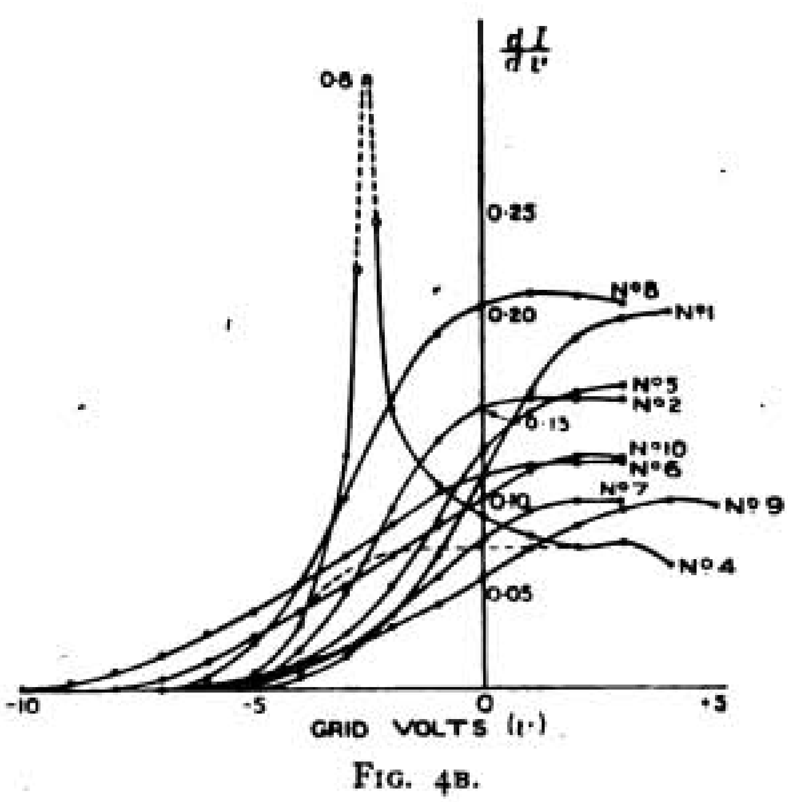


FIG. 4B.

The actual ability of a given valve to receive signals was obtained by measuring the maximum distance (*d*) at which signals from a buzzer wave meter could be detected. For any two valves (1 and 2) suppose the maximum distances at which signals could be heard were d_1 and d_2 respectively. Then since signals could just be distinguished in the 'phones in each case:—
$I_{R_1} = I_{R_2}$, whence, using equation (4),

$$\frac{(\alpha_{m_1} + \alpha_{m_1}{}^3)v_{0_2}}{(\alpha_{m_2} + \alpha_{m_2}{}^3)v_{0_1}} = \frac{\delta v_1{}^2}{\delta v_2{}^2} = \frac{d_1{}^3}{d_2{}^3}.^*$$

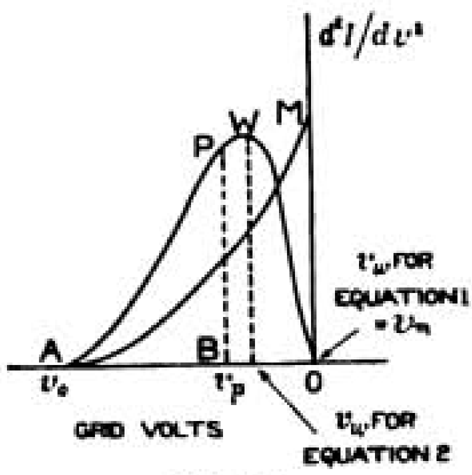


FIG. 5A.

Thus we can compare the relative detecting efficiencies calculated from either equations (4) or (5) with the relative efficiency determined by direct experiment. The results are given in Table I.

v_w was measured experimentally by noting the grid voltage for which d was a maximum for any given valve.

v_0 can also be measured approximately by determining the range in grid volts over which signals can be heard. It is, however, more accurate to read v_0 from the second differential characteristic, whilst α_m (and hence α_p) can be readily obtained from the height of the horizontal portion of the first differential characteristic, which, incidentally, is a measure of the amplifying properties of the valve. The data from these various methods is compared in Table II.

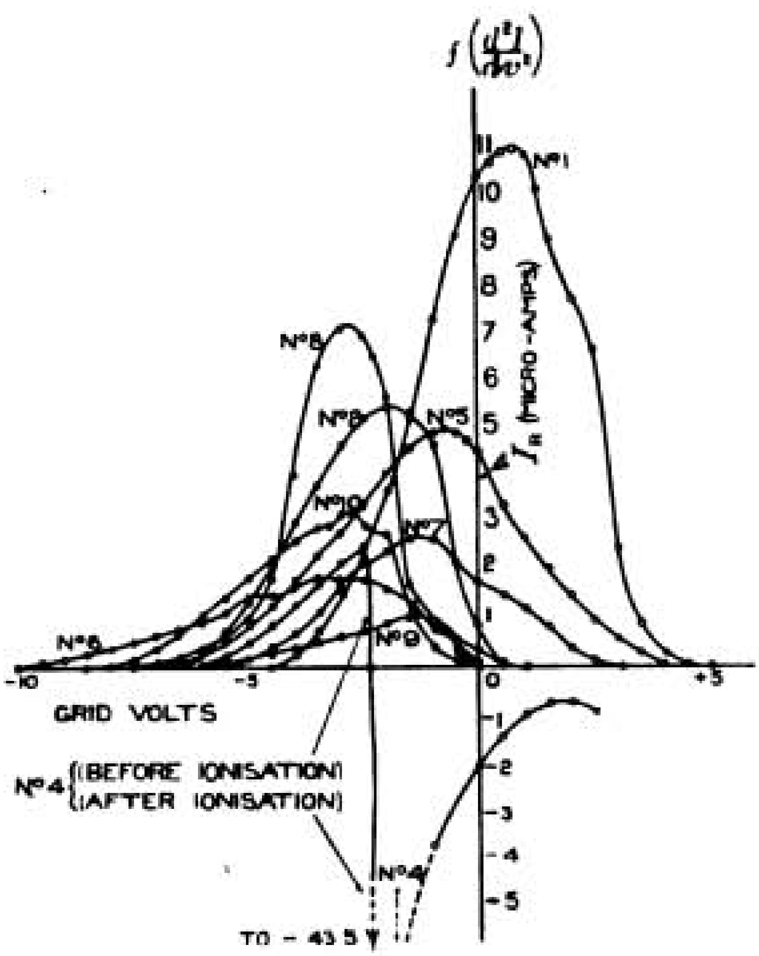


FIG. 5B.

I_R is given directly by the maximum ordinate of the second differential curves.

The $\left(\frac{dI}{dv}, v\right)$ characteristic was obtained experimentally by measuring the value of λ, the voltage amplification factor, by a method previously described by the author † and by measuring β $\left(i.e. \frac{dI}{dV}\right)$ for varying grid voltages (v). The ratio $\frac{\beta}{\lambda}$ $\left(i.e. \frac{dI}{dv}\right)$ was plotted with v (Fig. 4B). A simpler more direct method is that described by Appleton.‡

* See Neumann, Maxwell, and also Butterworth, *Philosophical Magazine*, 31, p. 276.
† RADIO REVIEW, 1, p. 525.
‡ *Proceedings of the Cambridge Philosophical Society*, 20, p. 241.

TABLE I.

Valve.		Distance.			$\frac{dI}{dv}$		Values of I_R.				Relative Values. Experimental.		Relative Values. Calculated.		
No.	Description	d (max.)	d^3	$-v_g$ (volts)	α_m	α_p	Experimental from $\left(\frac{d^2I}{dv^2}r\right)$	$\frac{\alpha_m}{2v_g}$	$\frac{\alpha_m+\alpha_m^3}{2v_g}$	$\frac{\alpha_p}{v_g}$	d^3	I_R from $\left(\frac{d^2I}{dv^2}, r\right)$	$\frac{\alpha_m}{2v_g}$	$\frac{\alpha_m+\alpha_m^3}{2v_g}$	$\frac{\alpha_p}{v_g}$
							μ amps.								
1	Mullard, F. (soft)	14·0	2,740	8·0	0·200	0·101	+11·1	0·0125	0·0130	0·0126	2·3	1·95	1·10	1·14	1·14
2	Mullard, R. (hard)	10·6	1,190	7·0	0·155	0·077	+ 5·7	0·0113	0·0114	0·0110	1·00	1·00	1·00	1·00	1·00
3	N.P.L. No. 2 (soft)	24·8	(Valve "Glued" with voltages used.)									—	—	—	—
4	R.2A. (soft)	8·0 20·0	512 8,000	7·0 2·5	0·080 0·800	0·040 0·350	+ 2·5 − 43·5	0·0057 0·1600	0·0057 0·525	0·0057 0·1400	0·43 6·70	0·44 7·5	0·50 14·1	0·50 46·0	0·50 (*) 14·2 (†)
5	Sedding, R. J. W. (hard)	10·0	1,000	7·5	0·160	0·079	+ 5·1	0·0107	0·0109	0·0105	0·84	0·90	0·94	0·95	0·95
6	Telefunken, D.R.P., F.V.N. 171 (medium)	7·5	422	10·5	0·120	0·060	+ 1·9	0·0059	0·0059	0·0056	0·35	0·33	0·52	0·51	0·51
7	Siemens and Halske (medium)	8·2	551	7·5	0·100	0·049	+ 2·8	0·0067	0·0067	0·0065	0·46	0·49	0·59	0·58	0·59
8	Fotos, R. (French) (hard)	12·0	1,730	6·5	0·210	0·104	+ 7·4	0·0162	0·0168	0·0160	1·45	1·30	1·43	1·47	1·45
9	Moorhead (American) (soft)	6·0	216	12·5	0·100	0·049	+ 1·1	0·0039	0·0040	0·0038	0·18	0·20	0·34	0·35	0·34
10	Mullard, K. (hard)	8·6	636	8·5	0·121	0·061	+ 3·3	0·0071	0·0072	0·0071	0·53	0·58	0·63	0·63	0·64

* Measurements before IONISATION occurred.
† Measurements after IONISATION occurred.

The second derived characteristics $\left(\frac{d^2I}{dv^2}, v\right)$ were obtained by keeping a buzzer wavemeter close to the induction coil of the jigger circuit and noting the increase (or decrease) in the plate current as the grid volts were changed. The variation in plate current was greatest when the grid volts equalled v_w. The resulting curves are shown in Fig. 5B. Dr. Hodgson, by measuring the sound intensity in the 'phones, had obtained similar curves in 1916.

From the results of the experiments recorded in Table I. it can be seen that equations (4) and (5) give roughly the same values for I_R, but that these values agree with those obtained by direct experiment in order of magnitude only. This indicates that the two original assumptions as to the form of the (I, v) characteristic were only very approximate. The calculated values differ most from those observed in the case of soft valves in which ionisation must be occurring. The ionisation currents imposed upon the thermionic current tend to prevent the characteristic following the parabolic path which it apparently does in the case of hard valves. The variations in the gas pressure of soft valves also lead to different numerical values from day to day, whilst the hard valves remain fairly constant. The formula $\frac{\alpha_m}{v_0}$ does, however, give sufficiently accurate results to enable most valves to be classified according to their rectifying efficiencies.

The case of valves Nos. 7 and 10 illustrates the importance of the term

TABLE II.

Valve.		Values of v_m			Value of r_p	Values of v_w		
No.	Description.	Max. Limit of v_0 by sound.	From $\left(\frac{dI}{dv}, v\right)$	From $\left(\frac{d^2I}{dv^2}, v\right)$		Grid Volts for max. sound.	From $\left(\frac{dI}{dv}, v\right)$	From $\left(\frac{d^2I}{dv^2}, v\right)$
1	Mullard, F. (soft)	+3·5	+3·0	+3·5	+2·0	+1·0	+0·8	+0·3
2	Mullard, R. (hard)	+1·0	+1·0	+1·0	−2·4	−2·0	−2·0	−2·0
3	N.P.L. No. 2 (soft)	—	—	—	—	—	—	—
4	R.2A. (soft)	— +1·5	−2·2 (?) +1·0	−2·2 +0·5	−2·9 −2·0	— −2·1	−2·5 −2·0	−2·5 * −2·0 †
5	Seddig, R. J. W. (hard)	+2·5	+2·5	+2·0	−1·2	−1·0	−1·2	−1·4
6	Telefunken, D.R.P., E.V.N. 171 (medium)	+1·6	+1·0	+1·0	−3·6	−3·3	−3·5	−3·5 (?)
7	Siemens and Halske (medium)	+2·0	+1·5	+1·0	−1·6	−1·2	−1·2	−1·0
8	Fotos, R. (French) (hard)	−0·5	0·0	0·0	−3·0	−2·8	−2·7	−3·0
9	Moorhead (American) (soft)	+4·9	−1·0	−1·0	−1·4	−1·1	−1·1	−1·7
10	Mullard, K. (hard)	+1·0	+0·5	+1·0	−2·8	−2·7	−2·7	−2·7

* Measurements before IONISATION occurred.
† Measurements after IONISATION occurred.

α_m, for from consideration of v_0 (the term proportional to R in equation (3)) valve No. 7 should be a better rectifier than No. 10. The reverse was found to be the case both by experiment and by calculation. From the values of α_m only (the term proportional to $f'(v)$ in equation (3)) valve No. 6 should rectify better than No. 7. The calculated values from either formula show No. 7 to be the better, which is also in agreement with the experimental order of efficiency.

From Table II., the discrepancy between v_w found experimentally and v_w taken from the experimentally derived characteristics is quite small, whilst v_p differs from v_w considerably in the case of soft valves such as Nos. 1 and 4, but agrees much more closely in hard valves where the difference is practically negligible.

5. Application to the Complete Characteristic.—(1) *Symmetrical Characteristics.* — Assuming the ordinary characteristic of a valve to have similar bends at Y and Z (Fig. 6), and neglecting any effects due to grid current, the derived characteristics would take the forms indicated in the figure. In practice these curves are modified in three ways :—

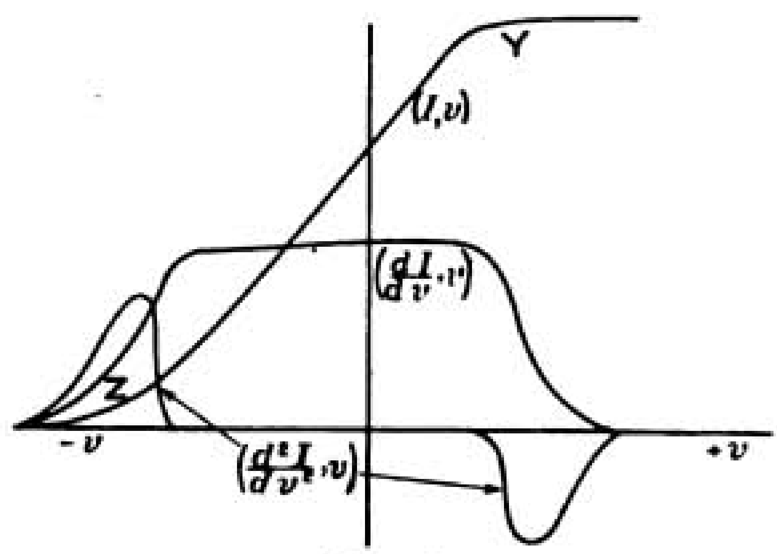


FIG. 6.

(*a*) The attainment of saturation, in the case of hard valves, takes place more suddenly than the growth of the current from zero. In other words the bend Y is usually of greater curvature than the bottom bend Z, *i.e.*, v_0 at Y is less than v_0 at Z.

(*b*) The presence of a grid current tends to decrease the rate of increase of the plate current for positive values of grid potential. This reduces the value of α_m at the upper bend Y.

(*c*) The presence of a gas in the valve tends to prevent saturation and may very considerably reduce α_m at Y whilst at the same time increasing v_0. This, of course, assumes ionisation is taking place.

(2) *The Hard Valve Characteristics.*—The effect (*b*), in the case of hard valves is, in general, less than the effect (*a*), *i.e.*, the reduction in the value of α_m is comparatively less than the reduction in v_0. Hence the combined effect is to make $\frac{\alpha_m}{v_0}$ for the upper bend Y greater than $\frac{\alpha_m}{v_0}$ for the bend Z. This is clearly seen in Appleton's curve and in the hard valve characteristics of Fig. 7, where the slope of the first derived curve for positive grid volts is steeper than that for negative grid volts. This means that the upper bend of a hard valve characteristic is a better rectifying region than

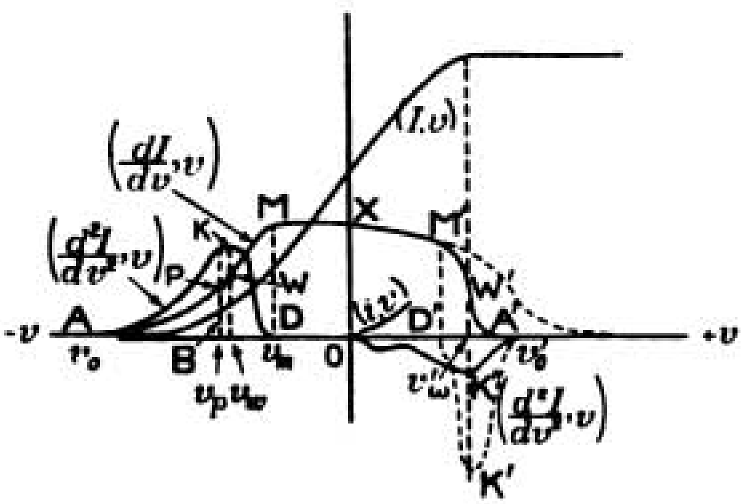


FIG. 7.

the lower bend. Ballantine * states the reverse to be the case, and was therefore using soft valves; a fact which is borne out by the "hump" on his first derived characteristics given on page 181 of the discussion on his paper.

In practice, however, the presence of a grid current damps the incoming oscillations and the actual result at Y is much less than that at Z. This difficulty was first realised by Dr. Hodgson who designed one amplifier in which the bend Y was brought to zero grid volts by reducing the filament temperature, a method now in common practice. Thus the experimental second differential curve, as indicated by sound intensity, takes the form indicated in Fig. 7; the lower dotted curve being the theoretical curve deduced from the first differential curve.

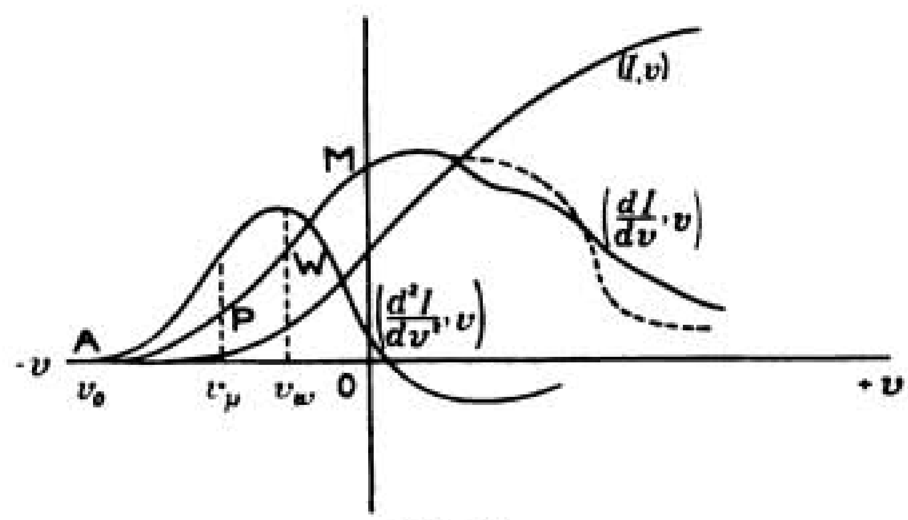


FIG. 8.

The amount of this reduction due to the flow of grid current can be approximately calculated by considering the filament-grid to be a high resistance (r_a) shunted across the condenser of the closed oscillatory circuit (Fig. 9). Suppose a current i_1 ($= I \sin \omega t$) be received in the aerial circuit which is coupled to the jigger circuit, the coefficient of mutual inductance of which is M. If at any instant the condenser charge be q; then $(\overline{V}_A - \overline{V}_B)$ (*i.e.*, the potential difference across the condenser) is given by:—

$$L\frac{dx}{dt} + Rx + M\frac{di_1}{dt} = r_a \cdot y \quad \ldots \ldots \quad (6)$$

and by

$$\frac{V}{C} \text{ or } -\frac{i_2}{C}\,dt = r_a y \quad \ldots \ldots \quad (7)$$

where i_2 is the current from the condenser and divides into x and y in the jigger and valve circuits respectively (Fig. 9). That is,

$$L\frac{dx}{dt} + Rx + MI\omega \cdot \cos \omega t = r_a y.$$

* *Proceedings of the Institute of Radio Engineers*, 7, p. 137.

and from (7) putting $i_2 = x + y$

$$r_a \frac{dy}{dt} + \frac{x + y}{C} = 0 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$

Substituting the value of y from (6) in equation (8)

$$L\frac{d^2x}{dt^2} + \left(R + \frac{L}{Cr_a}\right)\frac{dx}{dt} + \frac{1}{C}x = -M\frac{d^2 i_1}{dt^2} - \frac{M}{Cr_a}\frac{di_1}{dt}.$$

Putting $\omega^2 LC = 1$ for resonance, the particular integral x is given by

$$\frac{MI}{\left(R + \frac{L}{Cr_a}\right)}\left[\frac{1}{Cr_a}\sin\omega t - \omega\cos\omega t\right]$$

Substituting this value for x in equation (6), $(\overline{V}_A - \overline{V}_B)$ is equal to :—

$$r_a y = \frac{LMI}{\left(R + \frac{L}{Cr_a}\right)}\left[\frac{\omega}{Cr_a}\cos\omega t + \omega^2\sin\omega t\right] +$$

$$+ \frac{RMI}{\left(R + \frac{L}{Cr_a}\right)}\left[\frac{1}{Cr_a}\sin\omega t - \omega\cos\omega t\right] + MI\omega\cos\omega t$$

$$i.e., \ (\overline{V}_A - \overline{V}_B) = \frac{MI}{\left(R + \frac{L}{Cr_a}\right)}\left[\frac{2\omega L}{Cr_a}\cos\omega t + \left(\omega^2 L + \frac{R}{Cr_a}\right)\sin\omega t\right]$$

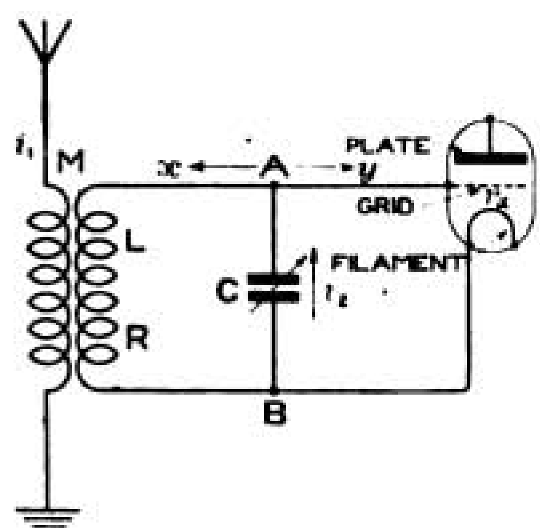


FIG. 9.

which reduces to $\left(\frac{MI}{RC}\right)\sin\omega t$ when r_a becomes infinite, or when no grid current is flowing. Hence the maximum value of the potential difference across the condenser when a grid current is flowing (using the fact that $(\omega^2 LC = 1)$) is given by :—

$$\frac{MI}{\left(R + \frac{L}{Cr_a}\right)}\left[\left(\frac{R}{r_a} + 1\right)^2\frac{1}{C^2} + \frac{4L}{C^4 r_a^2}\right]^{\frac{1}{2}} \quad . \quad (9)$$

reducing to MI/RC when $r_a = \infty$ . . . (10)

It has been shown that rectification depends on the square of the grid voltage change (equation (3)), the maximum amplitude of which is given by (9) when a grid current is present in the valve or by (10) when no grid current flows. Hence, the reduction in rectification due to a grid current is given by $\left(\frac{\text{expression 9}}{\text{expression 10}}\right)^2$; this is by—

$$\frac{R^2C^2}{\left(R+\frac{L}{Cr_a}\right)^2}\left[\left(\frac{R}{r_a}+1\right)^2\frac{1}{C^2}+\frac{4L}{C^3r_a^{\,2}}\right] \text{ or } \frac{\left[(R+r_a)^2+4\frac{L}{C}\right]}{\left[r_a+\frac{L}{RC}\right]^2} \quad . . (11)$$

In general, r_a is large compared with R or with $\sqrt{\frac{L}{C}}$, hence the reduction factor is approximately equal to

$$\frac{1}{\left(1+\frac{L}{r_aRC}\right)^2} \quad . . . . (12)$$

With $L = 2 \times 10^{-4}$ henries (2×10^5 e.m. units)
$C = 5 \times 10^{-10}$ farads (5×10^{-19} e.m. units)
$R = 10$ ohms (1×10^{10} e.m. units)
$r_a = 10^5$ ohms (1×10^{14} e.m. units)
} for a wavelength of 600 metres

both expressions (11) and (12) are equal to 0·51, that is, the actual rectification is only about half that expected from the slope of the first differential characteristic. If the grid current increases and reduces r_a to 10,000 ohms then the reduction factor drops in value to 0·04, in which case the valve almost ceases to detect on the upper characteristic bend. On the other hand if r_a increases to a million ohms the rectification is only reduced in the ratio of 1 to 0·92 and becomes unity when r_a is infinite. In other words there is no reduction in rectification when no grid current flows.

The expression (12) also indicates that as the capacity is increased with a corresponding reduction in the inductance, then the effect of the grid current is less appreciable. For example, if $C = 1 \times 10^{-18}$ e.m. units and $L = 1{\cdot}02 \times 10^5$ e.m. units (for a wavelength of 600 metres) the correction factor increases from 0·51 to 0·82. This effect was quite noticeable in practice.

From Fig. 7 the expected ratio of rectification at v_w' to that at v_w is given by—

$\frac{M'D'}{A'D'} \times \frac{AD}{MD}$ from the first derivative or $\frac{v_w'K'}{v_wK}$ from the second derivative.

These ratios are greater than unity, but in practice the actual value is given by $\frac{v_w' \,.\, K''}{v_w \,.\, K}$ which is, as a rule, much less than 1, owing to the damping effect of the grid current discussed above.

When the filament was first heated the valve was slightly softer and gave the modification of the first derived characteristic indicated by the dotted portion of this curve (see also p. 477 and Fig. 8).

The bend at zero grid volts (Fig. 7) indicates a poor rectifying point which is hardly noticeable in the normal characteristic but is clearly seen in the fall XM′ in the $\left(\frac{dI}{dv}, v\right)$ characteristic, and by the portion OD′ in the $\left(\frac{d^2I}{dv^2}, v\right)$ curve.

(3) *The Soft Valve Characteristics.*—The effects (*a*) and (*b*) discussed above are but secondary effects when compared with (*c*), that due to the presence of a residual gas. Not only are soft valves less reliable in their action, but the foregoing theory does not give results in keeping with experiment, since the ionisation currents superimposed on the normal thermionic current cause the characteristics to vary considerably from any regular law. This was noted in valves Nos. 1 and 4 in particular. A typical set of characteristics from a soft valve are shown in Fig. 8. They all indicate that the upper bend is useless as a rectifying point owing to the small value of α_m and the very large value of v_0. In addition the $\left(\frac{dI}{dv}, v\right)$ curve often exhibits a "hump" for negative values of grid volts when ionisation occurs in the valve. This, according to Ballantine, is "apparently inexplicable," but is actually an indication of an abnormal increase in plate current when ionisation sets in.

The dotted curve was obtained after the filament had been heated for an hour and indicates a slight hardening of the valve with use. The same effect, but in the opposite direction, was noted in the case of the hard valve (Fig. 7). This change of slope depends on the varying amount of ionisation produced in the valve and upon the occlusion from the hot filament or absorption by the cold glass of the contained gas. The change is thus a test of the gas pressure similar in principle to the ordinary "back lash" test or to the principle underlying the ionisation gauge described by Dushman and Found.* In this way the change in slope of this portion of the $\left(\frac{dI}{dv}, v\right)$ characteristic is a sensitive measure of the change in the gas pressure in the tube.

6. Summary.—(1) The lower curved portion of the (I, v) characteristic of a three-electrode valve was assumed to approximate to (*a*) an arc of a circle, (*b*) a parabola.

(2) The first and second derived characteristics based upon these assumptions were compared with actual curves obtained experimentally from ten different valves. The parabolic form of the (I, v) characteristic yielded differential curves approximating fairly closely with the experimental curves of hard valves. The circular form of the (I, v) characteristic corresponded more closely with the soft valve characteristic, but the similarity was much less.

(3) The formula $\frac{\alpha_m + \alpha_m^3}{2v_0}$ deduced from assumption (*a*) above, and

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* *Journal of the Franklin Institute*, 188, p. 819, December, 1919.

the formula $\frac{\alpha_p + \alpha_p{}^3}{v_0}$ deduced from assumption (*b*) above, were found to give the same values for the relative rectifying efficiency. Also these two formulæ, together with the more approximate expression α_m/v_0 were sufficiently exact to enable the valves to be classified in the order of their efficiency as detectors.

(4) The absolute values given by the above formulæ when compared quantitatively with those obtained by direct experiment agreed approximately in the case of hard valves only.

(5) The formula $\frac{1}{\left(1 + \frac{L}{r_a RC}\right)^2}$ was deduced in order to evaluate the grid damping factor.

(6) The extension of the investigation to the complete characteristic is discussed in the last section. It was found that the variation in the slope of the $\left(\frac{dI}{dv}, v\right)$ characteristic for positive grid volts was a sensitive indication of the change in the gas pressure in the valve.

This work was carried out in the Physics Department of the University of Bristol. My best thanks are due to Dr. B. Hodgson whose preliminary work, leading to this investigation, was placed at my disposal; and also to Mr. H. G. Hughes of this University who assisted with the experimental work.

The expenses entailed in this research were defrayed by a grant from the University Colston Research Fund.

The French and German valves were lent by the Board of Industrial and Scientific Research.

Berlin—London Wireless Service.*

On January 26th a duplex wireless service was opened between London and Berlin for a period of three hours daily, from 4 p.m. till 7 p.m.

The Stonehaven Wireless Station (**GSW**), being the only medium-power station available is used for the transmitting station on the British side, while Königswusterhausen (**LP**) Wireless Station is used on the German side, the respective wavelengths being 4,600 and 5,250 metres.

The transmitter at Stonehaven consists of an Admiralty 25-kW arc, which is operated from London by means of the telegraph land line. The receiving station in England is situated in a special room in the G.P.O. West, together with the land line apparatus and Wheatstone transmitter for operating the wireless key on the Stonehaven arc transmitter.

The signals from Berlin are recorded on an ordinary Wheatstone receiver,

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* Abstracted from *The Post Office Electrical Engineers' Journal* (see Abstract No. 2314 in this issue for references).

which is introduced in the local circuit of a special form of sensitive "bow-contact" relay actuated directly by the wireless signals. Trials are now being made of reception on the Creed apparatus.

Difficulties were at first experienced on account of the slight variations of wavelength emitted by Berlin and Stonehaven but the constancy of the waves of the two transmitting stations has been improved.

Atmospherics on these higher wavelengths are more violent than those experienced on the shorter waves below 2,000 metres, but little interference is experienced on this account owing to the use of highly selective receiving devices. By these devices the high-power station at Moscow, which uses a spark transmitter on approximately the same wavelength, is effectively eliminated from the tape records.

The following example shows the traffic passed to and from London between 4 p.m. and 7 p.m. on February 25th, which is a fair example of the normal working.

	Messages.	Words.
Received from Berlin	120	2,142
Sent to Berlin	85	1,373
	205	3,515

The average speed of transmission and reception varies between twenty-five and fifty words per minute. On account of the short period of the daily service greater reliability and quicker disposal of live traffic is obtained at these speeds than would be the case if higher speeds were employed.

The service is now extended to cover the periods from 1 a.m. till 5 a.m., 6 a.m. till 8 a.m., and 2 p.m. till 7 p.m. in connection with the Reparations Conference.

Electric Oscillations along Straight Wires and Solenoids.*

By Professor J. S. TOWNSEND, F.R.S.

The author described a number of experiments made in conjunction with Mr. J. H. Morrell to determine the relations between the frequencies of the normal oscillations of such systems. He explained the difference between these non-harmonic modes of oscillations or overtones and the harmonics of a non-sinusoidal oscillation, two things which are sometimes confused. He described a method of accurately calibrating wavemeters which consisted in setting up a valve oscillator to generate waves say of 5 metres length, the length being accurately determined by means of stationary waves on a Lecher wire system loosely coupled with the oscillating system. Another oscillating valve set say of 500 metres wavelength with a telephone receiver coupled to its anode circuit is loosely coupled with the 5-metre wave set and adjusted until exact resonance is obtained with its hundredth harmonic, the coincidence between the harmonics and the 5-metre wave being indicated by clicks in the telephone receiver. The exact order of the harmonic can be found by counting the number of coincidences in an octave, that is, n is determined by counting the difference between n and $2n$. The connections are shown diagrammatically in Fig. 1.

* Abstract of paper read before the Wireless Section of the Institution of Electrical Engineers, June 8th, 1921.

In the discussion which followed, Professor Howe drew attention to somewhat similar measurements on a solenoid recently described in the *Archiv für Elektrotechnik* (Vol. 9, p. 1) which were made to test the theoretical results obtained by Lenz. In reply to questions

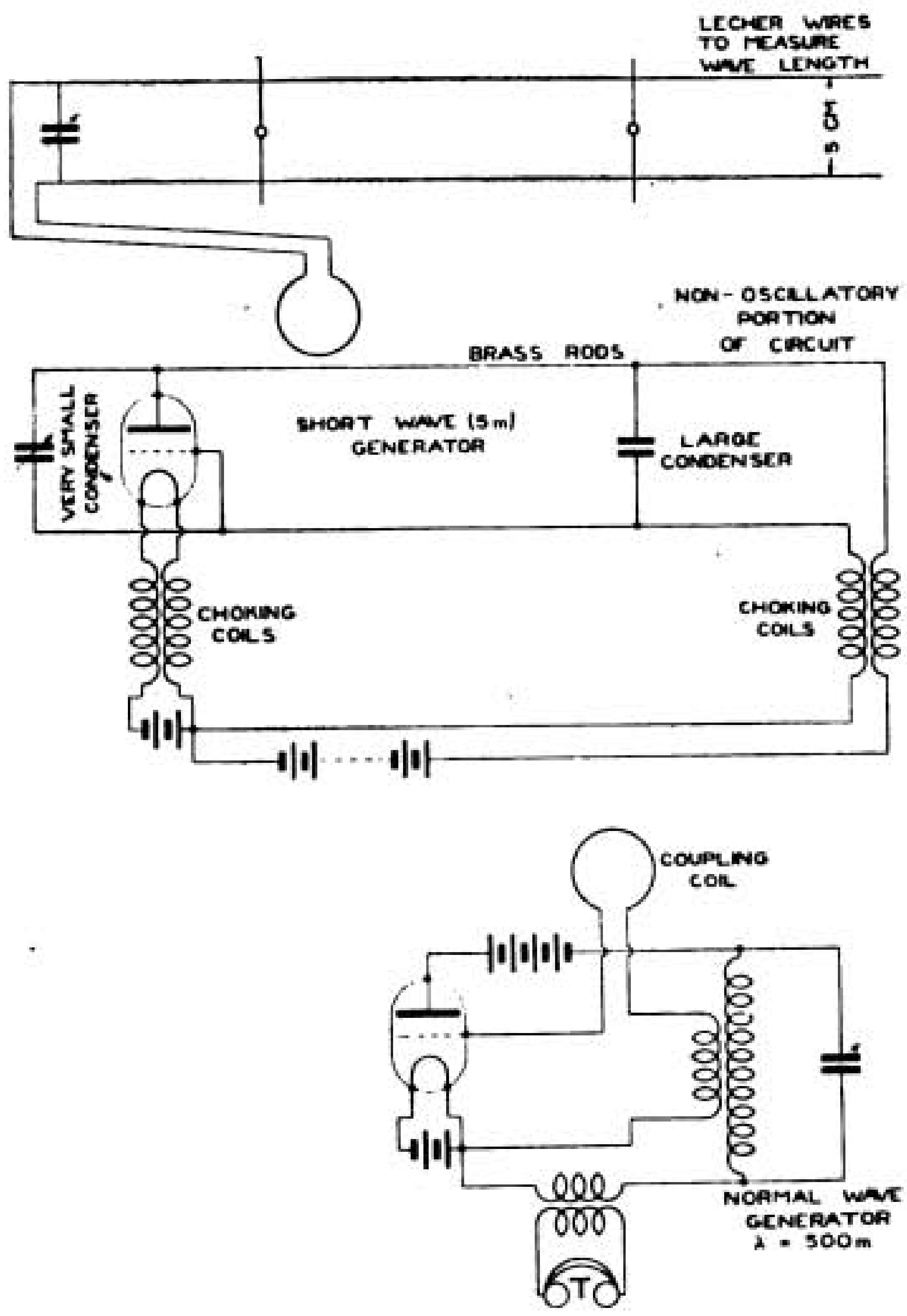

FIG. 1.

raised by several speakers Professor Townsend said that the distance between the Lecher wires could be varied within wide limits but that it was necessary to keep them away from anything likely to affect the waves.

The Piezo-Electric Properties of Rochelle Salt Crystals.

A demonstration of these properties was given by Mr. Philip R. Coursey, B.Sc., at the meeting of the Wireless Society of London held on June 27th, 1921. The apparatus that was shown was lent by Mr. E. Kilburn Scott, who had brought it from America, where many experiments on the subject have been carried out by Mr. McLean Nicolson, of the Western Electric Co.

Rochelle salts ($C_4H_4O_6NaK \cdot 4H_2O$) in common with many other crystalline substances possess the property of becoming electrified when subjected to torsion or pressure. This property may be shown in a striking manner with a crystal mounted between two alum plates, held together by springs, one of them being fitted with a needle which could take the place of an ordinary gramophone needle and sound box.

On applying the instrument to a gramophone record, sufficient voltage was generated to operate a loud-speaking telephone through a three-valve low frequency amplifier. The music was quite loudly reproduced and could be heard throughout the hall.

The apparatus is not a microphone operated by sound waves from the record, but transforms the vibrations of the needle directly into E.M.F.'s which can operate the amplifier.

The reverse action was also shown, a crystal mounted between two plates, and enclosed in a cylindrical parchment diaphragm, reproduced sounds spoken to a microphone in the primary circuit of a step-up transformer, across the secondary of which the crystal was connected.

In both cases the connections to the crystal were made between a tinfoil band round its centre, and its two ends which were connected together.

The Design of Resistance Coupled Amplifiers.

A paper by Lieut. N. H. Edes, R.E., with the above title was read at a meeting of the Wireless Society of London on June 27th, 1921. The paper pointed out that in most resistance-coupled amplifiers as now used there is no clear differentiation between the actions of amplification and rectification, and that it is usually assumed that the rectification is more or less distributed throughout the valves. When this is the case there must be considerable loss of efficiency, since owing to the reversal of phase with each valve, when grid current and damping are present each valve is in a position to amplify that halfwave of the oscillation which has been most damped by the preceding valve. To avoid this effect it is recommended that the amplifying valves should all have a negative potential on their grids, and that the rectifying valve should have a separate grid potentiometer.

From a consideration of the vector diagram representing the network of any one valve, it is shown that the value of the grid coupling condenser is immaterial as long as it is large compared with the grid-filament capacity of the valve, but that for efficient operation the resistance of the grid leak should be reduced for the shorter wavelengths.

Experimental Wireless Telephony.

A paper dealing with wireless telephony from the experimental point of view, and in particular treating of methods of modulation, was read before the Wireless Society of London by Mr. Philip R. Coursey, B.Sc., on May 2nd, 1921.

Descriptions were given of all the recognised methods of control and in addition a new arrangement was described under the name of "saturated valve" control. This arrangement makes use of the well-known fact that when the voltage applied between the plate and filament of a valve is steadily increased there comes a time when the anode current no longer rises with further increase of anode voltage. By suitably controlling the filament current this "saturation" of the valve can be brought about for almost any value of applied anode voltage. In the arrangement described such a saturated valve was employed to take the place of the ordinary choke coil in the "choke control" method, the saturated valve having the property of maintaining constant the flow of current through it and being practically independent of changes in the resistance of the circuit in which it is included. Demonstrations of the methods of modulation described were given.

A Universal Amplifier suitable for all Wavelengths.

A paper was given before the Wireless Society of London, on June 1st, 1921, by Mr. A. A. Campbell Swinton describing a Universal Amplifier suitable for all Wavelengths. The paper dealt with the practical design and construction of a six and a two-valve amplifier. The six-valve set had the first three valves operating at radio-frequency and transformer coupled, the fourth valve was the detector unit and the last two valves served as note magnifiers. In the two-valve set the first valve was operated at radio-frequency and the second was the detector valve.

The particular point of interest about the sets was the interchangeable radio-frequency transformers, several sets of these being employed for different wavelengths.

Notes.

Personal.

The Institute of France has awarded the Triennial Osiris Prize of 100,000 francs to **General Ferrié**, Director of the French Wireless Service during the war. [3475]

Mr. E. P. Edwards, who has been assistant manager of the lighting department of the General Electric Company for a number of years past, has been made responsible for the radio activities of the company. Mr. Edwards will have immediate supervision of radio engineering, manufacturing and selling ; negotiations with the Radio Corporation of America and other companies, and will in general direct the efforts of the company in the field of radio communication. [3601]

Mr. Douglas R. P. Coats has been appointed publicity manager of the Marconi Wireless Telegraph Co., Ltd., of Canada. [3606]

Colonel L. R. Krum, former superintendent of marine installations of the International Radiotelegraph Company, has joined the radio sales staff of the Westinghouse Electric and Manufacturing Company. [3607]

Mr. L. R. Robinson, formerly of the International Radiotelegraph Company, has severed his connection with the organisation. [3608]

Mr. R. A. Watson Watt has been appointed superintendent of the Radio Research Board wireless station at Aldershot. [3694]

Sir J. J. Thomson was recently elected honorary Professor of Natural Philosophy of the Royal Institution of Great Britain. [2677]

New Wireless Services, etc.

WIRELESS FOG SIGNALS are now transmitted continuously during thick or foggy weather from the following American light vessels :—Ambrose Channel light vessel, N.Y. ; Fire Island light vessel, N.J. ; Sea Girt lighthouse, N.J. These installations will also transmit the fog signals daily between 1400 and 1430 and between 2000 and 2030 on a wavelength of 1,000 metres to enable vessels to determine their positions from these stations. [3605]

MARKET REPORTS BY RADIOTELEPHONE.—The test of the Westinghouse radiophone made by the Bureau of Standards has been reported satisfactory and as a result the United States market reports will be sent broadcast through the Westinghouse radiotelephone station **KDKA** at East Pittsburg, each evening (except on Sundays) at about 9.30 p.m. E.S.T., on 300-metre wavelength. [E.S.T. = 5 hours earlier than G.M.T.]

It is possible for farmers within a distance of several hundred miles of East Pittsburg to learn of the agricultural market conditions and prices immediately after the closing of the market. [3596]

At the request of the Portuguese Government, arrangements are in progress for opening up wireless communication between Australia and the Portuguese East Indies. [3602]

The French Postal Telegraph Department has opened a public wireless service between France and Norway. [3031]

According to *The Times* a wireless receiving station has been erected at the Observatory, Perth, Western Australia, with which signals can be received over a distance of 12,500 miles. [3033]

According to a note in *Radio Nieuws* of May 1st, 1921, the Dutch military station at Soesterberg sends out a weather report by wireless telephony at 3.55 and 7.55 p.m. daily. [3632]

INTERCOLLEGIATE RADIO SERVICE.—The University of Texas at Austin and the Texas Agricultural and Mechanical College at College Station now exchange college news by wireless, and it is planned to extend the interchange of information to take in colleges in other States, including Harvard and Yale. [3655]

THE RADIO STATION AT BORKUM (latitude 53° 35 N., longitude 6° 40 E.) now transmits synoptic weather bulletins three times daily on a wavelength of 1,250 metres. The call letters are **KBN** and the times of transmission 0730, 1340 and 1915 G.M.T. [3662]

TELEPHONY FROM NAUEN.—It has been announced that the Nauen Telefunken station has succeeded in establishing wireless telephonic communication with the S.S. *Babia Blanca* over a range of 2,712 miles, and that the Königswusterhausen station similarly maintained communication with the vessel over a range of 2,185 miles. [3489]

RECEPTION OF BORDEAUX IN AUSTRALIA.—Signals from the new Bordeaux station (Lafayette) are regularly received for a period of at least twelve hours per day at the radio station at Koo-wee-rup (Victoria), owned by the Amalgamated Wireless (Australasia), Ltd. [3593]

Commercial and General.

COMPAGNIE GÉNÉRALE DE TÉLÉGRAPHIE SANS FIL.—The report recently issued stated that the company had obtained authority from the Argentine Government to establish and work a large radio station to ensure communication between Argentina and all other countries of the world. Similar negotiations have been made with other South American Governments —Ecuador, Colombia, Peru and Venezuela. The Compagnie d'Exploitation Radioélectrique which was formed in 1919 for working shipping installations is yielding favourable results and its scope of action is now beginning to extend beyond France. A contract has been concluded with the French Government for the construction and erection of radio stations for European and transocean communication, and a separate company—Compagnie Radio-France—was constituted in June, 1921, with a share capital of 60 million francs for the working of these stations which are now under erection in the neighbourhood of Paris. [3604]

ASSOCIATED MANUFACTURERS OF ELECTRICAL SUPPLIES, U.S.A.—A Radio Appliance Section has been added to this Association as a result of a convention of radio manufacturers held in New York City in March of this year. The section is under the chairmanship of **D. R. Murdoch**, of the W. J. Murdoch Company, Chelsea, Mass. The secretary is **G. J. Eltz**, of the Manhattan Electric Supply Company in New York City. Permanent committees will be formed to deal with the different phases of radio work. [3511]

WIRELESS TELEPHONE PROGRESS.—All the Instone "air liners" which are used regularly on the London-Paris service are now equipped with wireless telephony. Continuous practice is being carried out in direction finding and the general use of the radiotelephone gear. It is contemplated that a new ground installation will soon be required at Croydon to deal solely with radiotelephone messages from aircraft. [3495]

THE FEDERAL RADIO STATION AT SHANGHAI.—The new station at Shanghai, China, to be erected by the Federal Telegraph Company, will have the same kilowatt capacity as that of the Lafayette station at Bordeaux, but it will have six masts each 1,000 feet high as compared with the eight 826-foot masts at Bordeaux. [3487]

WIRELESS IN CHINA.—It has been stated that the United States intends to support the rights of the Federal Telegraph Company under its contract with the Chinese Government for the erection of wireless stations at Shanghai and elsewhere notwithstanding the protests of the British, Danish and Japanese Governments. [3603]

CALL SIGNALS.—The call signal **KSBV** has been assigned as a general call for all United States Shipping Board vessels and the call signal **KSPC** has been assigned as a general call for all vessels owned by the Standard Oil Company of New Jersey. [3597]

OPENING OF LEAFIELD (OXFORD) WIRELESS STATION.—The first British Station of the Imperial Wireless Chain was formally opened by the Postmaster-General on Thursday, August 18th, 1921. Congratulatory messages to British and foreign wireless stations were sent out. In a short speech the Postmaster-General stated that the station at Abu Zabal (Cairo) was being proceeded with rapidly, and that the delay in the completion of the stations had been due mainly to labour difficulties. A commission of experts was considering the design of the other stations recommended by the Imperial Wireless Telegraphy Committee. Pending the construction of these stations arrangements were being made for the further transmission to and from places beyond Egypt of telegrams forwarded by wireless between the Leafield and the Abu Zabal stations. [3695]

WIRELESS INSTALLATIONS ON FRENCH VESSELS.—The French Government has published the following decision—" It is decided in France that ships of at least 500 tons shall be fitted with a receiving station. From 1,500 tons the ships shall have a complete receiving and transmitting station." [3693]

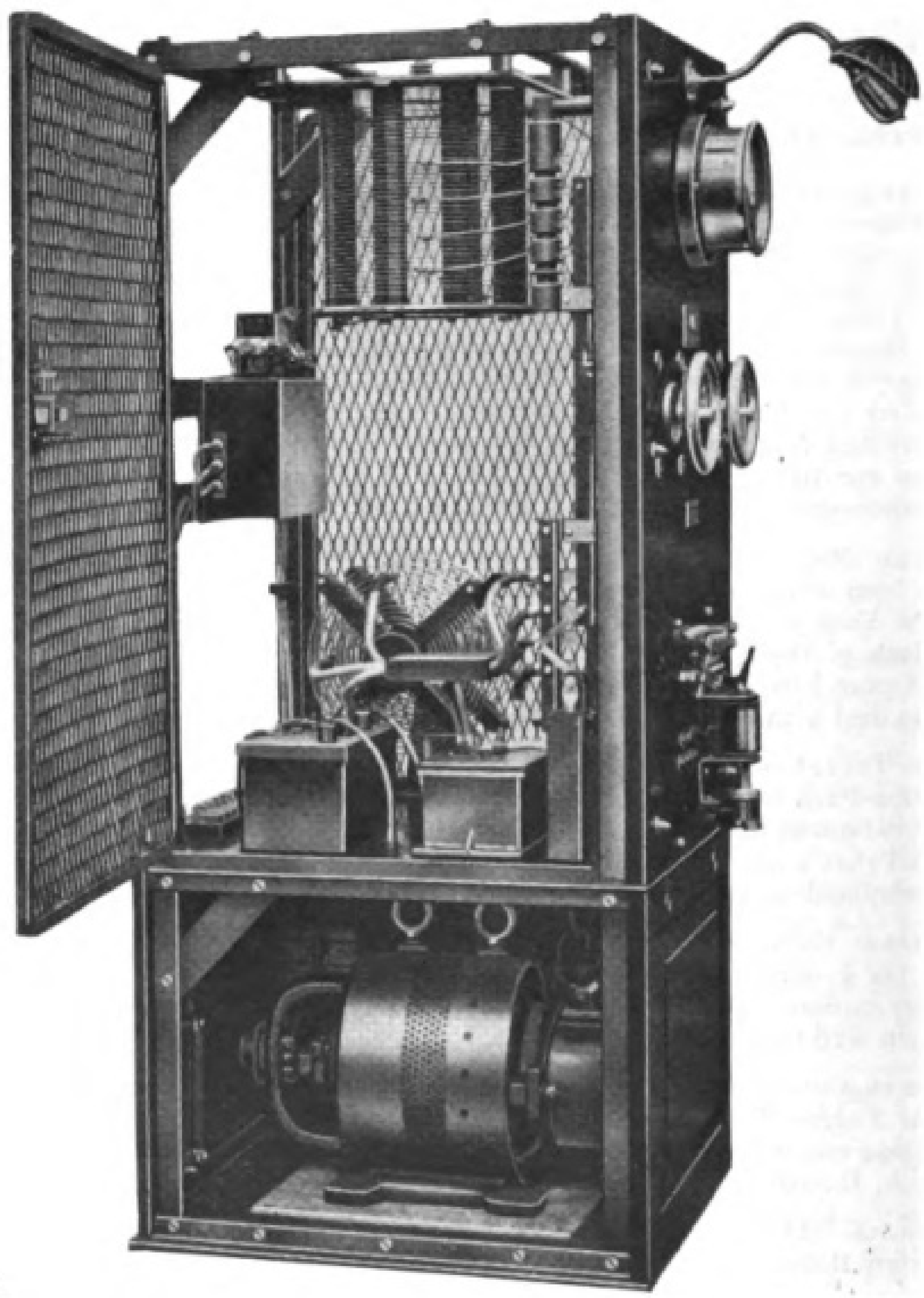

FIG. 1.

INTERNATIONAL WIRELESS CONFERENCE IN PARIS.—The International Radio Conference in Paris was formally opened on June 21st, a large number of representatives from Great Britain, France, United States, Italy and Japan being present. The purpose of the Conference is to harmonise the radio rules of the world and to consider a classification of the different wavelengths in accordance with their technical characteristics and to define the uses to be reserved for each, the distribution of wavelengths among the various services such as naval and aerial services, wireless telephony, etc., direction finding and meteorological services.

The names of the delegates attending the Conference are :—

Great Britain.—Colonel Blandy (President), Colonel Gardiner, Mr. Shaughnessey, Mr. Lee, Captain Echevarri.

United States.—Major-General Squier (President), Admiral Magruder, Captain Evans, Professors Austin, Cohen, Dellinger and Kennelly, Major Mauborgne, Commandants Loftin and Craven, and Mr. Gothric.

France.—General Ferrié (President), Inspector-General of Telegraphs Dennery, Professors Abraham and Mesny, Captain Lagorio, Commandant Noel, Captains Frank and Morcieau, and Engineer Perrin. In addition the following specialists are attached to the French delegation in the *rôle* of experts : Colonel Fracque, Commandants Chaulard, Jullien, Suberville and Le Breton, Captains Maistre and Bureau, Messrs. P. Brenot, Braillard and Viard.

Italy.—Professor Vallauri (President), Colonel Bardeloni, Commandants Biscia-Raineri and Gabetti and Signor Manzoni.

Japan.—General Shizuma, Captain Kiyokawa, Commandant Hattori and Captain Ishii.
[3484]

FIG. 2.

A DEMONSTRATION was recently given by the Radio Communication Co., Ltd., at their experimental wireless station at Slough, to members of the Wireless Society of London and their friends. The company's $1\frac{1}{2}$-kW installation for ships (Fig. 1) was explained in detail and shown in operation, including the emergency set which works with a " Wilson " motor-driven commutator interrupter, and is included in the same panel, so that the main oscillating and aerial circuits are available for both sets. The standard single-valve receiver used with this set is illustrated in Fig. 2.

Some experiments in wireless telephonic transmission were carried out using a valve transmitter, and the 25-kW arc set also was shown in operation. This arc installation as fitted up at Slough is shown in Fig. 3, in which photograph may also be seen the control desk, and the automatically operated switches which control the various auxiliary circuits of the arc. **[3697]**

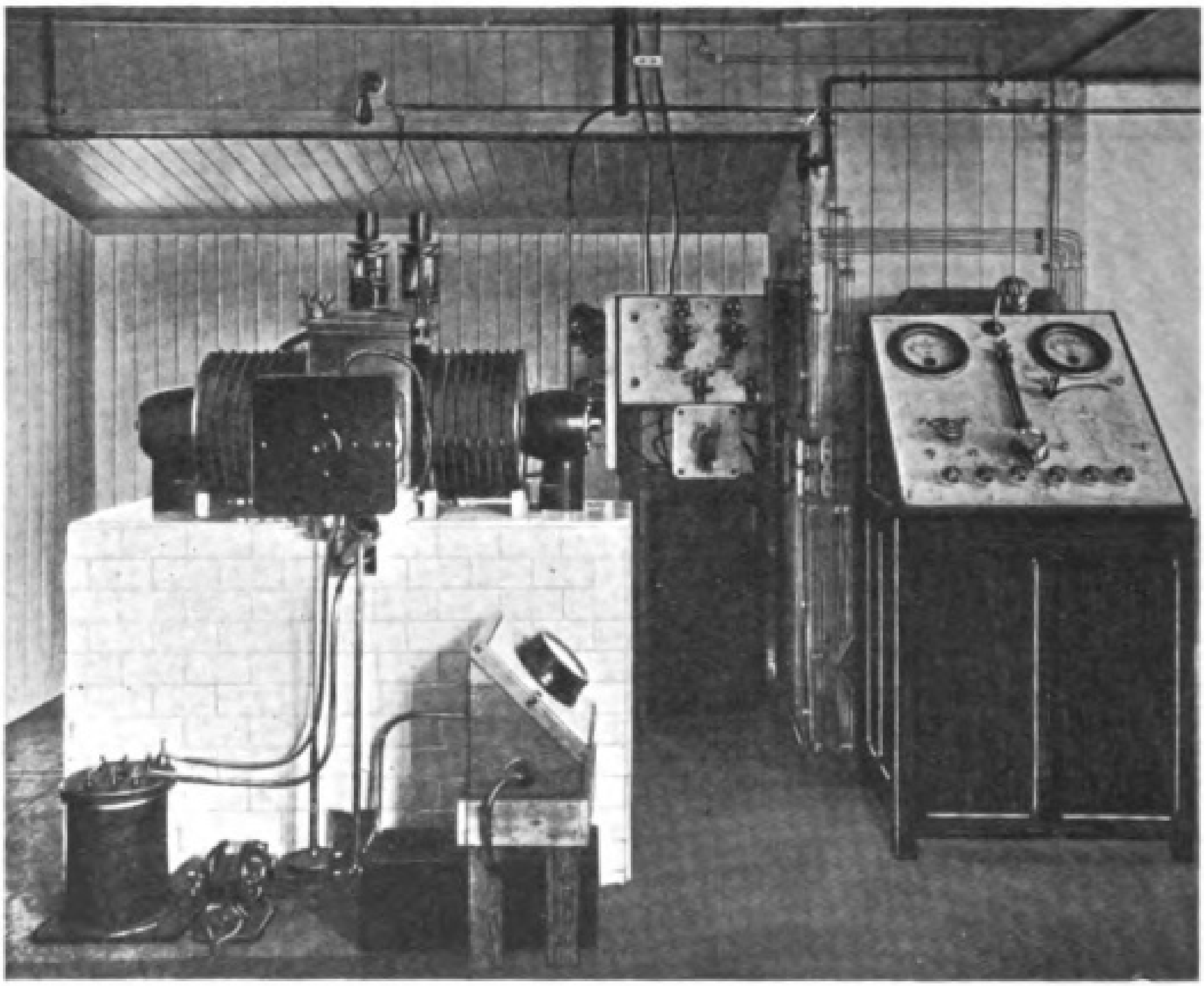

FIG. 3.

THE I.E.E. WIRELESS SECTIONAL COMMITTEE, 1921–22.—The following members have been nominated to serve on the Wireless Section Committee for 1921–22. Chairman: Dr. G. W. O. Howe. New nominations for committee: Major B. Binyon, O.B.E., Dr. W. H. Eccles, Messrs. G. H. Nash, C.B.E., and C. C. Paterson, O.B.E. The following will continue to serve as members of the committee: Sir Chas. Bright, F.R.S.E., Mr. R. C. Clinker, Professor C. L. Fortescue, Mr. A. Gray, Admiral of the Fleet Sir H. B. Jackson, G.C.B., Captain H. J. Round, M.C., Messrs. A. A. C. Swinton, F.R.S., and L. B. Turner. **[2995]**

THE STANDARDISATION COMMITTEE of the Institute of Radio Engineers is at work on a complete revision of the definitions of the technical terms which have come into use in the radio art within the past few years. It is expected that the committee's report will be ready for publication in book form in October or November of this year. **[3136]**

In order that Northern Manitoba may be brought into direct communication with other parts of the province, it is proposed that twelve wireless stations be installed immediately at a cost of £11,000. **[3035]**

Review of Radio Literature.

1. Abstracts of Articles and Patents.

(U.) Miscellaneous Methods of Communication.

(2) EARTH CURRENT SIGNALLING.

2215. Earth Current Telegraphy. (*L'Industrie Électrique*, 29, p. 199, 1920. *Elektrotechnische Zeitschrift*, 41, p. 415, August 5th, 1920—Abstract.)

2216. **C. H. Roe.** Transmission of Electrical Energy. (*Wireless Age*, 8, p. 21, November, 1920.)
An alternating current conduction method of wireless communication is described.

2217. **Arendt.** Overhearing, Its Prevention and Earth Telegraphy; also Measurements on Earth Antennæ. (*Telegraphen- und Fernsprech-Technik*, 10, pp. 42—46, April, 1921.)
Report of a lengthy discussion on a paper with the above title. (See RADIO REVIEW Abstract No. 1526, February, 1921.)

2218. **E. F. Huth.** Thermionic Valves. (*British Patent* 149012, July 12th, 1920. Convention date November 15th, 1917. Patent not yet accepted.)
A device used for earth current signalling consists of a thermionic valve having tuned grid and plate circuits, and the earth plates connected across the plate circuit inductance. Reaction may be provided when required between the grid and plate circuits.

2219. **L. de Forest.** Buried Aerial Systems. (*British Patent* 160430, June 17th, 1920. Convention date March 13th, 1920. Patent not yet accepted.)
The buried aerial wires are connected to earth plates at the bottom of borings between 1,000 and 2,000 feet deep.

2220. **L. de Forest.** Electric Signalling through the Earth. (*British Patent* 145476, June 21st, 1920. Convention date June 16th, 1917. Patent accepted June 30th, 1921.)

2221. **A. Carletti.** Earth Telephone Interception during the War. (*L'Elettrotecnica*, 8, pp. 189—196, March 25th, 1921.)
A well-illustrated account of the methods and instruments employed by the Italian Armies for intercepting enemy communications and also for preventing the enemy from intercepting Italian communications.

(3) SUBMARINE SIGNALLING (including "Leader Cables").

2222. **F. Aigner.** On the Most Economical Transmission Frequency for Sound Signals in Air and Water for the Reception of Signals by Ear. (*Zeitschrift für Physik*, 1, pp. 161—173, 1920. *Journal de Physik et la Radium*, 1, Abstract Supplement p. 34, August, 1920—Abstract.)
For the most sensitive conditions the author concludes that a frequency in the neighbourhood of 1,000 per second is the best.

2223. **Submarine Signal Company.** Sound Detecting. (*French Patent* 499873, August 30th, 1918. Published February 25th, 1920. *British Patent* 133375 (**R. A. Fessenden**), August 1st, 1918. Patent accepted October 16th, 1919.)
The specification describes means for eliminating disturbances in sound receiving apparatus.

2224. **Submarine Signal Company.** Sound Signalling. (*French Patent* 500068, October 28th, 1918. Published March 2nd, 1920. *British Patent* 139530 (**R. A. Fessenden**), August 26th, 1918. Convention date August 16th, 1917. Patent accepted February 26th, 1920.)
The specification describes apparatus for the transmission and reception of acoustic waves, which is particularly suitable for directional signalling and for the location of submarines and submarine signalling stations.

2225. **Submarine Signal Company.** Sound Detecting. (*French Patent* 503892, November 19th, 1917. Published June 19th, 1920.)

The apparatus described is for detecting low-frequency compressional impulses, particularly those emitted by submarines. The impulses are converted into electrical impulses which are rectified and observed with a direct current indicator. (See also **R. A. Fessenden,** *British Patent* 133081, of October 9th, 1917. Convention date May 21st, 1917. Patent accepted October 9th, 1919.)

2226. **A. Troller.** Submarine Signalling. (*La Nature,* 49(1), pp. 11—12, January 1st, 1921.)

2227. **R. L. Williams.** Microphone Transmitters. (*British Patent* 142096, April 19th, 1920. Convention date April 25th, 1918. Patent accepted October 7th, 1920.)

Describes a method of mounting a microphone on a thick diaphragm specially adapted for hydrophone use.

2228. **M. I. Pupin.** Sound Signalling. (*French Patent* 507608, December 20th, 1919. Published September 20th, 1920.

The specification describes apparatus for receiving high-frequency sound waves used for signalling and in which a crystal detector is employed.

For further particulars, see the *British Patent* 139496, RADIO REVIEW Abstract No. 1114, November, 1920.

2229. **P. Langevin.** Submarine Signalling. (*French Patent* 505703, September 17th, 1918. Published August 5th, 1920. *British Patent* 145691, June 30th, 1920. Convention date September 17th, 1918. Patent not yet accepted.)

The specification describes a transmitter or receiver for high-frequency vibrations used in directive subaqueous signalling. The device comprises a plate of quartz provided with metallic coatings to form a condenser. Pressure variations due to the received vibrations cause a potential difference between the two faces of the crystal and these can be detected electrically, for example by the heterodyne methods used in wireless signalling.

2230. **Signal Gesellschaft m.b.H.** Submarine Signals. (*French Patent* 506652, November 21st, 1914. Published August 27th, 1920.)

The specification describes receiving apparatus for acoustic submarine signals.

2231. **Signal Gesellschaft m.b.H.** Submarine Signals. (*French Patent* 506653, November 24th, 1914. Published August 27th, 1920.)

The specification describes receiving apparatus for acoustic submarine signals.

2232. **H. Lamb.** On the Vibrations of an Elastic Plate in Contact with Water. (*Proceedings of the Royal Society,* 98, pp. 205—216, November 3rd, 1920. *Science Abstracts,* 24A, p. 126, Abstract No. 285, February 28th, 1921—Abstract.)

2233. **A. Boutaric.** The Reception of Sounds under Water. (*Revue Scientifique,* 59, pp. 16—18, January 8th, 1921.)

2234. **J. J. Bennett.** The Leader Cable at Portsmouth. (*Engineering,* 111, pp. 187—190, February 18th, 1921. *Science Abstracts,* 24B, p. 208, Abstract No. 423, April 30th, 1921. *Electrical World,* 77, p. 951, April 23rd, 1921—Abstract.)

Photographic illustrations of the receiving apparatus are included with the description of the gear.

2235. **A. du Bois-Raymond, W. Hahnemann,** and **H. Hecht.** Development, Theory and Construction of the Submarine Sound Producer. (*Zeitschrift für Technische Physik,* 2, pp. 1—8, January, and 33—40, February, 1921.)

After a general discussion of the question, the oscillator constructed by the Signal Company of Kiel is described and illustrated. The damping and efficiency are discussed and it is shown how the mechanical oscillating system can be represented by an equivalent electric circuit. Two sizes are made with inputs of 250 and 800 watts respectively, the frequency is 1,000, the efficiency 50 per cent., and the weights 110 and 240 kgs. They are made to stand a pressure of 10 atmospheres.

2236. **W. A. Loth.** A New Method of Navigation for enabling a Ship to Enter or Leave a Harbour without Danger when the Ordinary Methods of Route Indications are not Available. (*Comptes Rendus,* 171, pp. 668—669, October 11th, 1920. *Scientific*

American Monthly, 3, p. 377, April, 1921. *Radioélectricité*, 1, p. 83D, January, 1921 —Abstract.)

2237. **A. Crossley.** Piloting Vessels by Electrically Energised Cables. (*Journal of the American Society of Naval Engineers*, 33, pp. 39—59, February, 1921. *Revue Générale de l'Électricité*, 9, pp. 645—655, May 7th, 1921—Abstract. *Engineer*, 131, pp. 567—568, May 27th, 1921—Abstract.)

After an historical *résumé* of the development of the method the author recounts some of the tests that have been made and gives a detailed description of the apparatus employed including a consideration of the cables and of their anchorages.

2238. **U. Bianchi.** A New Apparatus for Transmitting Photographs by Wire or Wireless. (*L'Elettricita*, pp. 33—36, March 1st, 1920. *Revue Générale de l'Électricité*, 7, pp. 202D —203D, June 26th, 1920—Abstract.)

An arrangement using valve amplifiers with selenium cells is described in detail.

2239. **Signal Gesellschaft.** Submarine Signalling. (*British Patents* 149324 and 149325, July 10th, 1920. Convention dates August 4th, 1919, and January 25th, 1917, respectively. Patents not yet accepted.)

2240. **Signal Gesellschaft.** Subaqueous Audible Signalling. (*British Patent* 149679, July 10th, 1920. Convention date October 1st, 1915. Patent not yet accepted.)

2241. **Signal Gesellschaft.** Sound Signalling Vibrators. (*British Patent* 144664, June 8th, 1920. Convention date October 23rd, 1915. Patent not yet accepted.)

A vibrator arrangement adapted to be unaffected by depth of immersion.

2242. **Signal Gesellschaft.** Receiving and Transmitting Sound. (*British Patent* 144673, June 9th, 1920. Convention date March 9th, 1916. Patent not yet accepted.)

A receiver for submarine signalling.

2243. **H. Lichte.** Electromagnetic Sound Producers. (*Zeitschrift für Technische Physik*, 2, pp. 12—17, January, 1921.)

A theoretical investigation based on Poincaré's equations for the telephone receiver. From the constants of the apparatus the author finds expressions for the damping and efficiency.

2244. **Signal Gesellschaft.** Sound Producers and Receivers. (*British Patent* 148759, July 10th, 1920. Convention date July 30th, 1919. Patent not yet accepted.)

Relates to the tuning of diaphragms for subaqueous signalling.

2245. **Signal Gesellschaft.** Submarine Signalling Apparatus. (*British Patents* 148974 [Convention date September 25th, 1917], 148975 [Convention date October 1st, 1917], 148972 [Convention date February 6th, 1915], 148973 [Convention date March 18th, 1916], 148976 [Convention date August 14th, 1918], 148977 [Convention date August 16th, 1918], 148978 [Convention date November 1st, 1918], 148979 [Convention date November 18th, 1918], 148980 [Convention date December 27th, 1918], 148982 [Convention date April 27th, 1917], 148985 [Convention date January 20th, 1920], 148986 [Convention date September 25th, 1917], 148987 [Convention date May 3rd, 1918], 148988 [Convention date May 19th, 1917], all filled July 10th, 1920. Patents not yet accepted.)

Describe various details of the transmitting and receiving apparatus for subaqueous audible signalling.

2246. **J. C. Manson.** Locating Submarine Cables. (*British Patent* 158923, August 29th, 1919. Patent accepted February 24th, 1921.)

Describes coils for navigational purposes using leader cables.

2247. **Signal Gesellschaft.** Indicating Fairways. (*British Patent* 159903, March 9th, 1921. Convention date March 12th, 1920. Patent not yet accepted.)

Deals with leader cables.

2248. **G. C. Evans** (Submarine Signal Company). Submarine Signalling Apparatus. (*British Patent* 151061, June 11th, 1919. Patent accepted September 13th, 1920.)

2249. **R. L. Williams** (Submarine Signal Company). Submarine Signalling. (*British Patent* 146125, June 23rd, 1920. Convention date June 24th, 1919. Patent accepted April 23rd, 1921.)

A combination of submarine and wireless signalling to enable the distance of the sending station to be determined by the receiver.

2250. **R. A. Fessenden.** Subaqueous Audible Signals. (*British Patent* 146152, June 24th, 1920. Convention date November 29th, 1918. Patent accepted December 23rd, 1920.)

2251. **R. A. Fessenden.** Detecting Submerged Vessels. (*British Patent* 146155, June 24th, 1920. Convention date December 12th, 1918. Patent not yet accepted.)

2252. **H. C. Haynes** (Steward Davit and Equipment Corporation, U.S.A.). Determining the Direction of Sound or Wireless Waves. (*British Patent* 146188, June 25th, 1920. Convention date June 25th, 1919. Patent not yet accepted.)

2253. **H. C. Haynes** (Steward Davit and Equipment Corporation). Subaqueous Audible Signalling. (*British Patents* 146189 and 146190, June 25th, 1920. Convention date June 25th, 1919. Patents not yet accepted.)

2254. **M. Mason** (Steward Davit and Equipment Corporation). Determining the Direction of Waves. (*British Patent* 146192, June 25th, 1920. Convention date June 25th, 1919. Patent not yet accepted.)

2255. **G. W. Pierce** (Steward Davit and Equipment Corporation). Determining the Direction of Sound or Wireless Waves. (*British Patent* 146193, June 25th, 1920. Convention date June 25th, 1919. Patent not yet accepted.)

2256. **R. D. Fay** (Submarine Signal Company). Sound Transmitters and Receivers. (*British Patent* 160798, March 24th, 1921. Convention date March 26th, 1920. Patent not yet accepted.)

2257. **E. A. Graham** and **W. J. Rickets.** Detecting and Locating Sounds. (*British Patent* 162034, January 9th, 1920. Patent accepted April 11th, 1921.)

2258. **Q. C. A. Craufurd** and **Mrs. L. O. Doughty-Wylie.** Inductive Signalling. (*British Patent* 154978, September 1st, 1919. Patent accepted December 1st, 1920.)

2259. **J. A. Burgess** and **G. B. Hutchings.** Sound Filters. (*British Patent* 144799, March 17th, 1919. Patent accepted June 17th, 1920.)

A selective arrangement for subaqueous signalling, for eliminating interfering sounds.

2260. **Signal Gesellschaft.** Transmitters for Subaqueous Sound Signals. (*British Patent* 148409, July 10th, 1920. Convention date, March 13th, 1915. Patent not yet accepted.)

An addition to *British Patent* 14218/1913.

2261. **Signal Gesellschaft.** Subaqueous Sound Receivers. (*British Patent* 148410, July 10th, 1920. Convention date September 8th, 1915. Patent not yet accepted.)

An addition to *British Patent* 147936 (RADIO REVIEW Abstract No. 2289 in this issue).

2262. **Signal Gesellschaft.** Subaqueous Sound Signalling. (*British Patent* 148411, July 10th, 1920. Convention date April 4th, 1916. Patent not yet accepted.)

An addition to *British Patent* 147935 (RADIO REVIEW Abstract No. 2289 in this issue).

2263. **Signal Gesellschaft.** Sound Producers and Receivers. (*British Patents* 148412, July 10th, 1920 [Convention date June 5th, 1917], 148414, July 10th, 1920 [Convention date February 22nd, 1918], and 148415, July 10th, 1920 [Convention date July 11th, 1918]. Patents not yet accepted.)

Patents of addition to *British Patent* 147937 (RADIO REVIEW Abstract No. 2289 in this issue).

2264. **Signal Gesellschaft.** Submarine Sound Signalling. (*British Patent* 148413, July 10th, 1920. Convention date September 17th, 1917. Patent not yet accepted.)

2265. **Signal Gesellschaft.** Sound Transmitters. (*British Patent* 148416, July 10th, 1920. Convention date April 14th, 1919. Patent not yet accepted.)

An addition to *British Patent* 147945.* A series choking coil and a shunt condenser between the alternator and the sound producer are used to suppress undesired harmonics.

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* RADIO REVIEW Abstract No. 2289 in this issue.

2266. **Signal Gesellschaft.** Receiving Subaqueous Signals. (*British Patent* 148417, July 10th, 1920. Convention date August 10th, 1917. Patent not yet accepted.)

An addition to *British Patent* 147947 (RADIO REVIEW Abstract No. 2289 in this issue).

2267. **Signal Gesellschaft.** Preventing "Clicks" in Telephones. (*British Patent* 148418, July 10th, 1920. Convention date March 30th, 1917. Patent not yet accepted.)

An addition to *British Patent* 147948.* Special switches are provided for changing over the receiving telephones to a number of circuits.

2268. **Signal Gesellschaft.** Ascertaining Direction of and Locating Sounds. (*British Patents* 148422 [Convention date May 29th, 1915], 148428 [Convention date November 5th, 1917] and 148429 [Convention date July 10th, 1915], July 10th, 1920. Patents not yet accepted.)

2269. **Signal Gesellschaft.** Submarine Signalling Apparatus. (*British Patents* 148423, 148424, 148425, 148426 and 148427, July 10th, 1920. Convention dates July 12th, 1915, November 29th, 1915, February 17th, 1916, March 15th, 1916, and March 3rd, 1917, respectively. Patents not yet accepted.)

2270. **H. Liehte.** Indicating Fairways. (*British Patent* 148430, July 10th, 1920. Convention date December 30th, 1918. Patent not yet accepted.)

Deals with leader cable arrangements.

2271. **R. A. Fessenden.** Submarine Signalling. (*British Patent* 148589, February 1st, 1919. Convention date February 1st, 1918. Patent accepted August 3rd, 1920.)

Relates to the screening of the apparatus from local noises.

2272. **A. Anderson.** Locating Sounds. (*British Patent* 148678, June 23rd, 1919. Patent accepted August 5th, 1920.)

2273. **Submarine Signal Company (U.S.A.).** Submarine Sound Generators. (*British Patent* 148703, September 25th, 1919. Patent accepted August 5th, 1920.)

2274. **Signal Gesellschaft.** Microphones. (*British Patent* 152616, October 16th, 1920. Convention date October 16th, 1919. Patent not yet accepted.)

Relates to a special construction of microphone to permit of uniform resonant qualities in different instruments made to the same general design.

2275. **R. A. Fessenden.** Acoustic Signals. (*British Patent* 146350, July 2nd, 1920. Convention date March 23rd, 1918. Patent not yet accepted.)

2276. **M. I. Pupin.** Sound Signalling. (*French Patent* 507609, December 20th, 1919. Published September 20th, 1920.)

The specification describes sound-generating apparatus in which electrical means are employed. See also *British Patent* 139497 (RADIO REVIEW Abstract No. 1174, November, 1920).

2277. **M. I. Pupin.** Sound Signalling. (*French Patent* 507610, December 20th, 1919. Published September 20th, 1920.)

The specification describes receiving apparatus for ultra-audible high-frequency vibrations. See also *British Patent* 139498 (RADIO REVIEW Abstract No. 1320, December, 1920).

2278. **R. A. Fessenden.** Sound Signals. (*British Patent* 146563, March 12th, 1919. Patent accepted June 12th, 1920.)

2279. **Signal Gesellschaft.** Sound Producers and Receivers. (*British Patent* 150265, August 16th, 1920. Convention date August 18th, 1919. Patent not yet accepted.)

2280. **J. Gardner.** Detecting Subaqueous Sounds. (*British Patent* 150379, May 2nd, 1919. Patent accepted September 9th, 1920.)

2281. **Siemens and Halske Akt. Gesellschaft.** Indicating Fairways. (*British Patents* 146959 [Convention date December 17th, 1918. Patent not yet accepted], 146960 [Convention date January 26th, 1916. Patent accepted March 17th, 1921], 146961 [Convention date December 16th, 1918. Patent accepted June 2nd, 1921], and 146962 [Convention date December 9th, 1918. Patent accepted February 24th, 1921], July 6th, 1920.)

A leader cable system.

* RADIO REVIEW Abstract No. 2289 in this issue.

2282. **Signal Gesellschaft.** Sound Transmitting and Receiving Apparatus. (*British Patent* 155569, October 29th, 1920. Convention date December 15th, 1919. Patent not yet accepted.)

An addition to *British Patent* 148972.*

2283. **A. U. Samwark.** Locating Subaqueous Sounds. (*British Patent* 156230, January 4th, 1921. Convention date December 1st, 1919. Patent not yet accepted.)

The distance of a station which emits simultaneous wireless and submarine sound signals is determined by observing the time between the arrival of the two signals. A thermionic valve is used both for detecting the wireless signals, and for amplifying the sounds.

2284. **J. A. Burgess** and **G. B. Hutchings.** Detecting Sounds. (*British Patent* 151662, March 17th, 1919. Patent accepted September 17th, 1920.)

2285. **Signal Gesellschaft.** Subaqueous Signalling. (*British Patents* 157229, 157230, 157231, 157232, January 8th, 1921. Convention dates, December 10th, 1914, October 2nd, 1915, December 31st, 1917, and December 20th, 1919, respectively. Patents not yet accepted.)

2286. **R. A. Fessenden.** Detecting and Transmitting Sounds. (*British Patent* 145812, December 31st, 1918. Patent accepted June 30th, 1920.)

2287. **Q. C. A. Craufurd** and **Mrs. L. O. Doughty-Wylie.** Detecting Submarines, etc. (*British Patent* 154347, September 1st, 1919. Patent accepted December 1st, 1920.)

The presence of a distant submarine or other vessel on which electrical machinery is running is detected by a circuit comprising a capacity connected to earth and coupled to tuned alternator and detector circuits. Energy picked up from the distant vessel by the capacity causes alterations in the character or tone of the sound heard in the telephones.

2288. **T. F. Wall.** Subaqueous Sound Signalling. (*British Patent* 154009, September 12th, 1919. Patent accepted November 25th, 1920.)

2289. **Signal Gesellschaft.** Subaqueous Signals. (*British Patents*, 147934 [Convention date December 16th, 1914], 147935 [Convention date May 8th, 1915], 147936 [Convention date June 14th, 1915], 147937 [Convention date February 29th, 1916], 147938 [Convention date November 1st, 1916], 147939 [Convention date March 10th, 1917], 147940 [Convention date August 6th, 1917], 147941 [Convention date November 27th, 1917], 147942 [Convention date February 25th, 1918], 147943 [Convention date May 4th, 1918], 147944 [Convention date May 30th, 1918], 147945 [Convention date August 12th, 1918], 147946 [Convention date August 12th, 1918], 147947 [Convention date October 26th, 1914], 147948 [Convention date March 20th, 1917], all of July 9th, 1920. Patents not yet accepted.)

2290. **W. A. Loth.** On the Electromagnetic Piloting of Ships. (*Revue Générale de l'Électricité*, 9, pp. 899—903, June 18th, 1921.)

Correspondence relative to an article by A. Crossley† and drawing attention to earlier experiments on this subject.

2291. **P. H. Boucheron.** The Invisible Radio Pilot. (*Radio News*, 2, p. 272, November, 1920.)

An illustrated description of a leader cable equipment.

(4) AND (5) ACOUSTIC SIGNALLING AND "ELECTROSTATIC" WIRELESS SIGNALLING.

2292. **L. Bianooli.** Sound Locating. (*French Patent* 500641, June 11th, 1919. Published March 18th, 1920.)

The invention consists of an acoustic apparatus to locate the position in space of an aeroplane or other flying machine. The sound waves emanating from the machine are received in two resonators which cause, through relays, the closing of a local circuit in which electromagnetic means act on an indicator which shows which resonator is the more strongly affected.

* RADIO REVIEW Abstract No. 2245.
† See RADIO REVIEW Abstract No. 2237.

2293. **R. A. Fessenden.** Sound Signa ling. (*British Patent* 151585, July 21st, 1920. Convention date July 19th, 1919. Patent accepted May 19th, 1921.)

Sound signalling apparatus for communication with aircraft or for subaqueous communication.

2294. **E. C. Hanson.** Wireless Telephone Apparatus. (*French Patent* 505499, October 28th, 1919. Published July 30th, 1920. *British Patent* 135504, November 10th, 1919. Convention date September 7th, 1915. Patent accepted April 11th, 1921.)

An arrangement for "electrostatic" wireless telephony not using a high-frequency carrier wave.

2295. **E. C. Hanson.** Wireless Telegraphic Apparatus. (*British Patents* 154530 and 154531, November 23rd, 1920. Convention dates August 27th, 1917, and June 4th, 1918, respectively. Patents not yet accepted.)

The apparatus uses audio-frequency currents only. Reception is effected by means of a thermionic valve.

2296. **E. C. Hanson.** Wireless Telephony. (*British Patent* 154537, November 23rd, 1920. Convention date June 18th, 1917. Patent not yet accepted.)

Valve amplifiers are used both for transmission and reception of the audio-frequency impulses.

(V.) Traffic Particulars of Radio Stations.

2297. Comparative Radiotelegraphic Statistics for 1919. (*Journal Télégraphique*, 45, pp. 26—35, February 25th, 1921.)

Tabular data with regard to the number of stations, the type of apparatus, number of operators, etc., in the various countries of the world.

2298. The Belgian Meteorological Bulletin. (*La T.S.F. Moderne*, 1, pp. 109—110, July, 1920.)

Details are given of the bulletins transmitted daily at 0725, 1315, and 1815 G.M.T. from the Royal Observatory, Belgium.

2299. **J. de Mare.** The Reception of Annapolis, NSS. (*La T.S.F. Moderne*, 1, pp. 110—112, July, 1920.)

Details are given of the time signals transmitted at 0255 and 1655 G.M.T. from this station.

2300. **P. Schereschewsky.** The International Meteorological Radio Telegrams. (*La Nature*, 49(1), pp. 268—271, April 23rd, 1921; pp. 275—279, April 30th, 1921.)

Refers to the international arrangements made for the distribution of meteorological information by wireless transmission from high-power stations in Europe and the co-ordination of results aimed at by the recent International Conference on Weather Telegraphy.* Details are given of the transmissions from Nauen, Königswusterhausen, Vienna, Copenhagen, Madrid, Great Britain, Holland, Italy, Norway, Poland, Sweden, Czecho Slovakia and Russia, and a chart is given with the reference Nos. of the meteorological observatories from which reports are collected.

2301. The Meteorological Radio Telegrams of the United Kingdom. (*Radioélectricité*, 1, pp. 473—474, February; pp. 564—565, April, 1921. *Wireless World*, 9, pp. 25—29, April 2nd, 1921.)

2302. Wireless Navigation Warnings. (*Radioélectricité*, 1, pp. 594—597, May, 1921.)

A table is given of the most important stations of the world which transmit navigation warnings to ships. The call letters, wavelengths and times of signalling are given.

2303. United States Weather Bureau Radio Forecasts. (*Radio Service Bulletin*, No. 48, pp. 14—18, April 1st, 1921.)

Gives particulars of the meteorological messages transmitted by the U.S. Naval radio stations.

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* See RADIO REVIEW, Note No. 1846, p. 42, January, 1921.

2304. **J. W. J. van Haersolte.** Radio Weather Reports. (*Radio Nieuws*, 4, pp. 131—132, May 1st, 1921.)

Particulars are given of the transmission from Vossegat.

2305. A High Speed Radio Service in Western Prussia. (*Annales des Postes, Télégraphes et Téléphones*, 10, p. 183, March, 1921. *Journal Télégraphique*, 45, p. 119, June 25th, 1921—Abstract.)

A short reference to modifications in the radio service between Berlin and Königsberg to permit of duplex working.

2306. **P. Corret.** Transmission Programmes. (*La T.S.F. Moderne*, 2, pp. 23—28, January, 1921.)

A twenty-four hour time table of transmissions from high-power stations.

2307. Regular Transmissions of Wireless Stations. (*Wireless World*, 9, pp. 85—89, April 30th, also Supplement, August 6th, 1921.)

A list of stations giving regular transmission. Times of working, call signs, wavelengths, etc., are given.

2308. Wireless Telephony to Holland. (*Electrical Review*, 88, p. 520, April 22nd, 1921. *Journal Télégraphique*, 45, p. 119, June 25th, 1921—Abstract.)

Refers to recent tests by the Nederlandsche Seintoestellen Fabriek in the distribution of Stock Exchange reports by wireless telephony to a large number of banks throughout Holland. A licence has also been granted to the Marconi Company by the British and Dutch Governments to experiment with wireless telephonic transmission between the two countries.

2309. Wireless Telephony in South Africa. (*Electrical Review*, 88, p. 620, May 13th, 1921.)

The Government of South Africa is said to be experimenting with wireless telephony with a view to linking the chief centres. Communication has successfully been established between Johannesburg and Bloemfontein.

2310. Long Distance Telephony. (*Electrical Review*, 88, p. 485, April 15th, 1921.)

Reference is made to a long distance telephonic communication partly by wire and partly by wireless between Havana and Catalina Island, the total distance being 5,056 miles.

2311. Wireless Transmission of Music. (*Jahrbuch Zeitschrift für drahtlose Telegraphie*, 17, pp. 159—160, February, 1921.)

Refers to experiments in radio transmission of concerts from Königswusterhausen.

2312. Morse Alphabet for Radiotelegraphy. (*Telegraph and Telephone Age*, 39, p. 9, January 1st, 1921.)

A discussion of the relative merits of Continental and American Morse codes for radio working, with a recommendation that American Morse be used for railway wireless and similar traffic not addressed to other countries.

2313. Tuckerton to France Radio Service. (*Wireless Age*, 8, p. 9, March, 1921.)

A new link has been added between America and France by the recent opening of a regular radio service between Tuckerton, N.J., and Lyons, France. The Tuckerton station uses a 200 kW Alexanderson alternator, and the American receiving station is at Belmar, N.J. The receiving station on the French side is located at Ville Juif, near Paris.

2314. The Berlin-London Wireless Service. (*Post Office Electrical Engineers' Journal*, 14, pp. 33—34, April, 1921. *Elektrotechnische Zeitschrift*, 42, p. 232, March 10th, 1921—Abstract. (See pp. 478—479 in this issue.) *Annales des Postes, Télégraphes et Téléphones*, 10, p. 369, June, 1921.)

2315. United States—Indo-China Wireless. (*Electrical Review*, 88, p. 586, May 6th, 1921.)

Refers to the inauguration of a commercial radio service on May 1st between United States and Indo-China *via* Hawaii and Philippines.

(W.) Radio Conventions, Legislation, etc.

2316. Radio America shown to Foreign Experts. (*Wireless Age*, 8, pp. 10—16, December, 1920.)

An account of the visits of the delegates to the International Communication Conference to various places of radio interest in America.

2317. The Radio Congress. (*Scientific American*, 25, p. 3, July 2nd, 1921.)
A short note with regard to the American delegates to the Radio Congress in Paris on June 21st, 1921.

2318. Removal of Wireless Restrictions. (*Sea, Land and Air*, 3, pp. 258—266, July, 1920.)
Particulars are given of revised radio legislation in Australia.

2319. Radio Legislation in France. (*Journal Télégraphique*, 45, pp. 74—77, April 25th, 1921.)
The text is given of the regulations of February, 1917, relating to private radio installations in France, and of a decree of June 2nd, 1920, modifying the earlier regulations.

2320. Japanese Radio Legislation. (*Radioélectricité*, 1, pp. 466—468, February; pp. 515—517, March, 1921.)

2321. Belgian Radio Legislation for the Safety of Ships. (*Radioélectricité*, 1, pp. 465—466, February, 1921.)

2322. Radio Legislation in Greece. (*Radioélectricité*, 1, pp. 559—562, April, 1921.)

2323. Radio Legislation in Iceland. (*Radioélectricité*, 1, pp. 604—605, May, and pp. 642—643, June, 1921. Abstracted from *Journal Télégraphique*.)

2324. Imperial Communication. (*Electrical Industries*, 21, pp. 879—881, July 13th, 1921.)
Some notes with regard to the difficulties of arranging satisfactorily the imperial wireless communications.

(X.) Biographies, Obituary Notices, etc.

2325. **J. Blondin.** (*Revue Générale de l'Électricité*, 9, pp. 347—348, March 12th, 1921.)
Biographical notice. (See RADIO REVIEW, 2, p. 262, May, 1921.)

2326. Who's Who in Radio—**Sir Oliver Lodge.** (*Radio News*, 2, p. 695, April, 1921.)
Biographical notes and portrait.

2327. Who's Who in Radio—**Dr. J. A. Fleming.** (*Radio News*, 2, p. 615, March, 1921.)
Biographical note with portrait.

2328. **G. W. Pickard.** (*Radio News*, 2, p. 784, May, 1921.)
A biographical sketch with portrait.

2329. **E. Branley.** (*Radio News*, 2, p. 867, June, 1921.)
Biographical notes and portrait.

2330. **Dr. Lee de Forest.** (*Radio News*, 2, p. 530, February, 1921.)
Biographical notes with portrait.

2331. **General George O. Squier, K.C.M.G., Ph.D.** (*Radio News*, 3, p. 23, July, 1921.)
Biographical sketch with portrait.

2332. **A. Schuster.** John William Strutt, Baron Rayleigh, 1842—1919. (*Proceedings of the Royal Society*, 98A, pp. 1—50, March 24th, 1921.)
A lengthy obituary notice including many references to his work in various branches of science.

2333. **Dr. Edward Bennett Rosa.** (*Journal of the American Institute of Electrical Engineers*, 40, p. 537, June, 1921. *Electrical World*, 77, p. 1144, May 21st, 1921.)
Obituary notices and biographical sketches with portrait.

(Z.) Miscellaneous Uses of Wireless, and H.F. Currents, Nomenclature, etc.

2334. A New Radio Instructor. (*Radio News*, 2, p. 686, April, 1921.)
An illustration of a special instructional panel designed by the Telefunken Company.

2335. Fused Silica Valves for Wireless Work. (*Electrician*, 86, p. 255, February 25th, 1921.)
A short note with regard to the recent developments of high power valves constructed in

fused silica and designed by H.M. Signal School, Portsmouth. The manufacture of these valves is now in the hands of the **Mullard Radio Valve Co., Ltd.**

2336. **D. W. Horner.** Determination of Longitude. (*Nautical Magazine*, 105, pp. 334—340, April, 1921.

A lengthy abstract of a paper, Professor R. A. Sampson. (See RADIO REVIEW Abstract No. 2348 in this issue.)

2337. **R. L. Atwell.** The application of Wired Wireless, Radio, and Wireless Telephone to Railway Service Communication Systems. (*Telegraph and Telephone Age*, 39, pp. 55—56, February 1st, 1921.)

The importance of radio methods of communication, particularly as regards reliability, is emphasised for railway developments and extensions.

2338. **H. T. Wade.** A Wireless Storm Detector for the Central Lighting Station. (*Monthly Weather Review*, 48, p. 162, March, 1920.)

2339. **P. H. Boucheron.** Transmitting Photographs by Radio. (*Science and Invention* 8, pp. 883, and 932—934, December, 1920.)

An illustrated article giving details of the proposed method adapted to ordinary radio apparatus.

2340. **M. Moye.** The Practical Utilisation of Meteorological Radio Bulletins. (*La T.S.F. Moderne*, 1, pp. 180—184, September, 1920.)

2341. **C. F. Dodwell.** Adelaide Longitude by Wireless. (*Monthly Notices of the Royal Astronomical Society*, 81, p. 101, November, 1920. *Science Abstracts*, 24A, p. 156, Abstract No. 345, March 31st, 1921.)

Rhythmic signals from Lyons were received at Adelaide from June 23rd to July 5th, 1920. Comparing the recorded times with those at Greenwich, and allowing 0·04 seconds for time of transmission, the Adelaide longitude comes out 9 hours 14 minutes 19·95 seconds to compare with adopted value 9 hours 14 minutes 20·07 seconds.

Indirect determinations by means of series of Annapolis signals in July and August gave 9 hours 14 minutes 19·79 seconds and 9 hours 14 minutes 19·78 seconds respectively, but these have not the same weight as the Lyons signals, as the Annapolis signals received at Greenwich are those sent at 17 hours G.C.T., while those received at Adelaide are sent at 3 hours G.C.T.

2342. Vaudeville by Radio Telephony. (*Telegraph and Telephone Age*, 39, p. 179, April 16th, 1921.)

A short note with reference to the transmission of a concert by wireless telephony by **R. F. Gowen,** chief engineer of the de Forest Radio Telephone and Telegraph Company, U.S.A.

2343. **L. de Forest.** Broadcasting News by Radio Telephone. (*Electrical World*, 77, p. 936, April 23rd, 1921.)

Correspondence with regard to the advantages of broadcasting music, news, etc., by radio telephone in isolated districts.

2344. Wireless to Aid Load Dispatching of Southern Interconnection. (*Electrical World*, 77, p. 900, April 16th, 1921. *Technical Review*, 9, p. 158, June 7th, 1921—Abstract.)

Refers to the installation of two wireless stations for inter-communication between different companies interconnected with the power system of the Georgia Railway and Power Company.

2345. **Gesellschaft für drahtlose Telegraphie.** Wireless Signalling in Mines. (*British Patent* 158907, February 9th, 1921. Convention date February 9th, 1920. Patent not yet accepted.)

2346. **T. S. Casner** and **O. L. Badger.** Radio Controlled Clock. (*Journal of the American Institute of Electrical Engineers*, 40, p. 461, June, 1921.)

A short note referring to a master clock at Plainfield, N.J., which is automatically corrected by the radio time signals sent out daily from Washington. The corrective impulses also act on a number of secondary dials connected to the master clock.

2347. **G. Ferrie.** A Note of the Methods Used for the Determination of Longitude by Radiotelegraphy. (*Monthly Notices of the Royal Astronomical Society*, 80, pp. 669—679, May, 1920.)

Gives a detailed description of the apparatus used by the Bureau de Longitude for the longitude determinations between Paris and Annapolis.

2348. **R. A. Sampson.** Determination of Longitude by Wireless Telegraphy. (*Monthly Notices of the Royal Astronomical Society*, 80, pp. 659—669, May, 1920. *Scientific American*, 123, p. 297, September 25th, 1920.)

A short historical *résumé* of longitude determination and of the importance of wireless for such work. Curves are given of the errors of standard clocks and the mapping out of the earth into zones for longitude determination by wireless is dealt with.

2349. Across Arabian Desert. (*The Times*, No. 42778, p. 9, July 21st, 1921.)

Refers to the use of portable wireless apparatus in connection with the survey of the air route between Cairo and Bagdad.

2350. **U. Bianchi.** A New Land Wire and Radio Transmitter of Photographs. (*Radio News*, 2, p. 366, June, 1920.)

Circuit diagrams of the proposed arrangements are given in connection with a short description.

2351. **E. H. Shaughnessy.** Some Recent Wireless Literature. (*Electrician*, 86, pp. 745—746, June 17th, 1921.)

Contains reviews of Van der Bijl's "The Thermionic Vacuum Tube"; B. Leggett's "Wireless Telegraphy with Special Reference to the Quenched Spark System"; and H. Rein's "Radiotelegraphisches Praktikun."

2352. **B. Leggett.** Wireless Telegraphy. (*Engineering*, 111, p. 658, May 27th, 1920.)

Correspondence with regard to a review of his book on wireless telegraphy.

2353. **J. Sayers.** Nomenclature for Wired Wireless. (*Electrician*, 86, p. 133, January 28th, 1921.)

Correspondence with regard to the best term to employ for describing high-frequency telephonic communication along wires.

2354. **G. O. Squier.** A Question of Nomenclature—Wire Radio. (*Electrician*, 85, pp. 716—717, December 17th, 1920.)

Correspondence as to the most suitable term to describe telegraphic and telephonic communication over wire by means of high-frequency currents. The term "wire radio" is suggested as the most comprehensive and useful. (See below.)

2355. **W. H. Eccles.** A Question of Nomenclature and Wire Radio. (*Electrician*, 86, p. 81, January 14th, 1921.)

Further correspondence on the question of nomenclature for high-frequency telegraphy and telephony having wires. The terms "Kumagrophy" or "Cymography" and "Cymoline" derived from the Greek words for a wire and a wave—Kuma and Linon—are suggested. (See RADIO REVIEW Abstracts Nos. 2354 and 2356 in this issue.)

2356. **R. D. Duncans, A. Press, L. Cohen, M. Latour.** A Question of Nomenclature—Wire Radio. (*Electrician*, 86, p. 56, January 7th; p. 305, March 11th; and p. 330, March 18th, 1921.)

Further suggestions for nomenclature. (See RADIO REVIEW Abstracts Nos. 2354 and 2355.) The terms multiple frequency wire telephony or telegraphy, carrier wave Morse system, carrier wave Squier system, line radio telegraphy and telephony and Squier telegraphy are suggested.

2357. Vacuum Tube Nomenclature. (*Radio Nieuws*, 4, pp. 108—109, April, 1921.)

See RADIO REVIEW, 1, p. 437, June, 1920.

2358. Electrolytic Cell Oscillations. (*Wireless Age*, 8, p. 19, January, 1921.)

An arrangement is described in which electrolytic cells containing aluminium electrodes are employed for the direct generation of high-frequency currents, the insulating barrier which is formed on the surface of the electrodes by the electrolytic action is intermittently broken down, and the impulse thus produced sets up high-frequency oscillations which may be coupled directly to the transmitting aerial circuit. Two cells are employed connected up, so that when the barrier in one cell breaks a high potential impulse is impressed on the second cell by means of a transformer to cause the breakdown of the barrier in that cell. A steady series of oscillations is thus produced.

2359. **R. I. Zalkind.** High Frequency Currents. (*French Patent* 504407, September 25th, 1919. Published July 5th, 1920.)

The specification describes an apparatus for the production of high-frequency currents to be employed for physiological purposes. The novel feature consists in collecting the apparatus in a single unit. The transformer secondary is connected to the terminals of the spark gap and with the primary circuit of a solenoid, which circuit is connected to condensers. The secondary of the solenoid is divided into sections and includes a switch permitting regulation of the high-frequency currents.

2360. **S. Loewe.** Röntgen Ray Apparatus. (*British Patent* 149013, July 12th, 1920. Convention date March 5th, 1919. Patent not yet accepted.)

Relates to the use of H.F. currents for exciting X-ray tubes.

2361. **J. Bethenod.** Railway Signals. (*British Patent* 159471, February 23rd, 1921. Convention date February 24th, 1920. Patent not yet accepted.)

Relates to the use of high-frequency currents generated on the train for railway signalling purposes.

2362. **Gesellschaft für drahtlose Telegraphie.** Locating Conductors by Wireless. (*British Patent* 147440, July 7th, 1920. Convention date November 23rd, 1917. Patent not yet accepted.)

For locating hidden conductors such as buried cables a coil with a strong leakage field is associated with an oscillation-generating thermionic valve. A conductor in the vicinity of the coil will then affect the frequency of the oscillations.

2363. **R. T. Lattey.** The Dielectric Constants of Electrolytic Solutions. (*Philosophical Magazine*, 41, pp. 829—848, June, 1921.)

Criticises the methods usually employed, and describes an apparatus and method using H.F. currents for this purpose. A bibliography of literature on the subject is appended to the article.

2364. **E. C. Hanson.** Apparatus for Locating Buried Ore. (*British Patent* 154534, November 23rd, 1920. Convention date May 7th, 1919. Patent not yet accepted.)

2365. **W. L. Carlson** (E. C. Hanson). Electromedical Apparatus. (*British Patent* 154535, November 23rd, 1920. Convention date July 12th, 1919. Patent not yet accepted.)

Deals with the use of valves for generating H.F. currents for electromedical purposes.

(A.) General Descriptive Articles of Installations, etc.

(1) Land Stations.

2366. **H. Thurn.** The Poulsen Arc Plant at Königswusterhausen. (*Radio Nieuws*, 4, pp. 35—45, February 1st, 1921. Also *L'Elettrotecnica*, 8, pp. 228—229, April 5th, 1921—Abstract. *Technical Review*, 7, p. 290, November 30th, 1920—Abstract. *Radioélectricité*, 1, p. 59D, November, 1920—Abstract. *Science Abstracts*, 24B, p. 317, June 30th, 1921—Abstract.)

A translation of the article referred to in Abstract No. 1056, November, 1920.

2367. **H. de la Noë.** The Lafayette (Bordeaux) Station—Construction of Foundations and Calculation of Stresses in Towers. (*Génie Civil*, 79, pp. 32—35, July 9th, 1921, pp. 53—57, July 16th, 1921.)

2368. **S. C. Hooper.** The Lafayette Radio Station. (*Electric Journal*, 28, pp. 112—113, April, 1921.)

An illustrated description.

2369. Wireless Telegraphy at Ushant. (*Radioélectricité*, 1, pp. 425—431, February, 1921.)

An illustrated description of the installations.

2370. The Easthampton Radio Station. (*Technical Review*, 9, p. 79, May 3rd, 1921—Abstract. *Q.S.T.*, 4, p. 25, January, 1921—Abstract.)
See RADIO REVIEW, 2, pp. 66—68, February, 1921.

2371. The Nauen High Power Radio Station. (*Schweizerische Bauzeitung*, 76, p. 174, October 9th, 1920. *Revue Générale de l'Électricité*, 9, p. 37D, January 29th, 1921—Abstract.)
An account of the station and of its official opening last year.

2372. The High Power Radio Stations of the World. (*Schweizerische Bauzeitung*, 76, p. 174, October 9th, 1920. *Revue Générale de l'Électricité*, 9, p. 37D, January 29th, 1921—Abstract.)
Gives a list with particulars of twenty-four of the largest radio stations in the world.

2373. The Lafayette Radio Station at Croix d'Hin near Bordeaux. (*Revue Générale de l'Électricité*, 9, pp. 430—433, March 26th, 1921.)
An illustrated description of the station extracted from previously published articles.*

2374. **A. Gradenwitz.** Inauguration of the Extended Nauen Wireless Station. (*Electrician*, 85, p. 714, December 17th, 1920. *Revue Générale de l'Électricité*, 9, p. 207D, June 25th, 1921—Abstract. *Radioélectricité*, 1, p. 119D, April, 1921—Abstract.)
A short account of the Nauen station with illustrations of the mast base and anchorages. (See also RADIO REVIEW Abstract No. 1549, March, 1921.)

2375. A Few Ideas for Amateur C. W. (*Q.S.T.*, 4, pp. 5—9, September, 1920.)
A description is given of the valve transmitting equipment installed at the N.S.F. radio station of the Naval Air Service Radio Laboratory at Anacostia.

2376. **H. Sauve.** The High Power Radio Station at Kamina. (*Radioélectricité*, 1, pp. 493—496, March, 1921.)
An illustrated description of the construction of the station.

2377. **H. MacCallum.** Recent Commercial Developments in Wireless. (*Radio Review*, 1, pp. 685—694, November, 1920. *Radioélectricité*, 1, p. 91D, February, 1921. *Technical Review*, 9, p. 158, June 7th, 1921—Abstract.)

2378. **G. E. Hyde.** Commercial Radio Telephony at Avalon, Santa Catalina Island. (*Radio News*, 2, pp. 598 and 638, March, 1921.)
An illustrated description of the equipment and arrangements used for this radio telephone link between Santa Catalina Island and the mainland. Elevated aerials are used for transmission and loop aerials for reception in each case.

2379. **H. Thurn.** The Poulsen Arc Equipment at Königswusterhausen. (*Jahrbuch Zeitschrift für drahtlose Telegraphie*, 17, p. 194—217, March, 1921.)
A descriptive account with photographs containing nothing beyond what has already been described. (See RADIO REVIEW Abstract No. 1056, November, 1920.)

2380. **E. F. Huth.** High-frequency Electric Signalling. (*British Patent* 149011, July 12th, 1920. Convention date December 31st, 1917. Patent not yet accepted.)
Describes a radio telephone apparatus adapted for intercommunication between the different rooms of a large building, using the plate circuit inductance of the oscillating valve as the frame aerial, and having a different wavelength allotted to each room. A push button selector may be used for varying the wavelength and so selecting the desired room. The whole apparatus is fed from the supply mains, for both L.T. and H.T. circuits, and the large resistance for the filament circuit may be included inside the bulb of the valve. The microphone is shown joined in the grid circuit of the valve, and the receiving telephones in the plate circuit.

2381. **J. Mayer** and **L. Hogelsberger.** The High Power Station of Deutsch-Altenburg. (*Electrotechnik und Maschinenbau*, 39, pp. 2—9, January 2nd, 1921.) *Electrical World*, 77, p. 724, March 26th, 1921—Abstract.)
A descriptive article with photographs and diagrams of the antenna arrangement and transmitting circuits.

2382. **E. C. Hanson.** Wireless Distribution of Music. (*British Patent* 156769, January 7th, 1921. Convention date June 3rd, 1918. Patent not yet accepted.)
Relates to an "electrostatic" type of transmitter.

* See RADIO REVIEW Abstracts Nos. 1423 and 1425, February, 1921.

2383. **A. Bidault des Chaumes.** Arc *versus* Alternator for High Power Work. (*Radio Review*, 2, pp. 199—201, April, 1921. *Bulletin de la Société Belge des Électriciens*, 35, pp. 124—125, May-June, 1921.)

2384. **E. H. Shaughnessy.** Imperial Wireless Station at Leafield, Oxfordshire. (*Post Office Electrical Engineers' Journal*, 14, pp. 79—89, July, 1921.)
An illustrated description of the station buildings, plant and apparatus.

2385. The Californian Theatre Radio Station. (*Radio News*, 2, p. 857, June, 1921.)
An illustrated description.

2386. **S. R. Winters.** The Washington Air Mail Radio Station. (*Radio News*, 2, p. 860, June, 1921.)
A short illustrated description of the installation.

2387. Carnarvon. (*Aire, Mar y Tierra*, 2, pp. 75—80, February, 1920.)

2388. The Spanish Central Meteorological Office. (*Aire, Mar y Tierra*, 2, pp. 451—457, August, 1920.)
An illustrated description of the wireless equipment.

2389. **M. Verdier.** The Radio Stations of the French Postal Telegraph Administration. (*Annales des Postes, Télégraphes et Téléphones*, 10, pp. 303—315, June, 1921.)
An historical *résumé* of the development of the various French coast stations and of the changes in the apparatus used therein. The high power and transatlantic stations are also considered.

2390. Radio Service between Rotterdam and Germany. (*Radio Nieuws*, 4, pp. 167—170, June 1st, 1921.)
A short account with photographs of the installation at the Central Telegraph Office in Rotterdam. Valve transmitters are employed.

2391. **Dr. Verch.** The Telefunken Valve Transmitter at Königswusterhausen. (*Radio Nieuws*, 4, pp. 179—182, June, 1921.)
A short account of the 10 kW set consisting of six valves in parallel supplied with anode current at 4,800 volts. This set is employed for the high-speed communication with Stonehaven.

2392. The Radio Station at Eilvese (Hanover). (*L'Elettrotecnica*, 8, pp. 137—139, February 25th, 1921.)
An illustrated description.

2393. **R. W. Goddard.** New Mexico State College Radio Station. (*Radio News*, 2, p. 292, November, 1920.)
A short illustrated description.

2394. The Eiffel Tower Radio Station. (*Radio News*, 2, pp. 350—352, December, 1920.)
An illustrated description of the equipment including the time signalling apparatus.

2395. The Lafayette Radio Station. (*Radio News*, 2, pp. 510—512, February, 1921.)
An illustrated description. (See also Radio Review Abstracts Nos. 1425, February, 1921, and 2373.

(2) Ship Installations.

2396. **H. R. Rivers-Moore.** Some recent Designs for Ship Radio Installations. (*Radio Review*, 2, pp. 172—179, April, 1921.)

2397. **H. MacCallum.** Wireless in the Mercantile Marine. (*Electrician*, 85, pp. 263—266, September 3rd, 1920; *Revue Générale de l'Électricité*, 9, p. 15D, January 8th, 1921—Abstract.)
An illustrated description of various types of apparatus manufactured by Marconi's Wireless Telegraph Company.

2398. Radio Telephony on Fishing Vessels. (*Radioélectricité*, 1, p. 549, April, 1921.)
An illustrated description.

2399. **de Bouillane.** Wireless and the Mercantile Marine. (*Radioélectricité*, 1, pp. 574—578, May, pp. 623—628, June, 1921.)

A continuation of the description in Abstract No. 1769, May, 1921. The Telefunken apparatus and the installations of the Société Française Radioélectrique are described and illustrated.

2400. Radio Apparatus for the Mercantile Marine. (*Electrician*, 86, pp. 722—725, June 10th, 1921.)

An illustrated description of some of the apparatus manufactured by Messrs. R. M. Radio, Ltd. A new design of triode valve, using a hemispherical grid and anode, is also briefly described and illustrated.

2401. **R. E. Lacault.** The Audio Frequency Amplifier in France. (*Science and Invention*, 8, pp. 1317—1318, April, 1921.)

A short illustrated article giving circuit diagrams of various patterns of French army amplifiers.

2402. Some Modern Improvements in Radio Installations for Ships. (*Electrician*, 86, pp. 49—51, January 7th, 1921; *Radioélectricité*, 1, p. 127D, May, 1921—Abstract.)

An illustrated description of the 1½ and ½ kW ship installations manufactured by the Radio Communication Co., Ltd.

2403. A New 3 kW Panel Transmitter. (*Radio News*, 2, p. 515, February, 1921.)

A short illustrated note describing apparatus manufactured by the **Wireless Speciality Company.**

(3), (4) AND (5) AIRCRAFT AND PORTABLE INSTALLATIONS.

2404. **R. H. Barfield.** Commercial Progress in Aircraft Wireless. (*Radio Review*, 2, pp. 4—14, January, 1921. *Science Abstracts*, 24B, p. 210, Abstract No. 425, April 30th, 1921—Abstract.)

2405. **M. Bernard.** The Present Position of Wireless in Aviation. (*Radioélectricité*, 1, pp. 523—532, April; pp. 579—586, May; and pp. 613—623, June, 1921.)

A detailed description of different types of apparatus used in French aircraft with many illustrations of gear manufactured by the Société Française Radioélectrique.

2406. **E. F. Huth.** Wireless Apparatus for Aeroplanes. (*British Patent* 148804, July 10th, 1920. Convention date September 8th, 1916. Patent not yet accepted.)

In order to reduce the number of operations required to bring an aeroplane or like wireless set into operation a lever is provided so that when moved in one direction the generator is coupled to the engine shaft and a motor is started up to unwind the aerial. On reversing the movement of the lever the generator is disconnected and the aerial reel motor reversed to pull in the aerial wire.

2407. **C. K. Chandler.** Wireless Apparatus on Aircraft. (*British Patent* 160502, November 24th, 1919. Patent accepted March 24th, 1921.)

In receiving apparatus interference from a magneto or other disturbing source is obviated by a corrector circuit containing inductance and capacity, the inductance of which is coupled to the disturbing source so that the energy picked up by the corrector circuit neutralises that picked up by the receiving circuit.

2408. **E. F. Huth.** Aircraft Wireless Apparatus. (*British Patent* 148323, July 9th, 1920. Convention date December 4th, 1914. Patent not yet accepted.)

Relates to a subdivision of aircraft wireless transmitting apparatus into separate units.

2409. A Marconi Wireless Telephone Set for Aircraft. (*Electrical Review*, 88, pp. 832—833, June 24th, 1921.)

A short illustrated description of some aircraft wireless apparatus manufactured by Marconi's Wireless Telegraph Company. (See RADIO REVIEW, 2, pp. 4—14, January, 1921, for description of the same apparatus.)

2410. **Gesellschaft für drahtlose Telegraphie.** Railway Signals. (*British Patent* 147445, July 7th, 1920. Convention date February 4th, 1919. Patent not yet accepted.)

An oscillation generator carried on the train co-operates with a tuned circuit on the track in such a way that when the track circuit draws energy from the train circuit the relay releases its armature and puts the signal apparatus on the train into operation.

2411. **C. A. Oliver.** Handcart for Transporting Wireless Apparatus. (*British Patent* 154637, May 13th, 1919. Patent accepted December 9th, 1920.)

2412. **E. F. Huth.** Portable Wireless Apparatus. (*British Patent* 148317, July 9th, 1920. Convention date October 30th, 1913. Patent not yet accepted.)

Separate carrier frames for portable wireless apparatus may be united together to form a rigid framework for operating the set.

2413. **E. Nesper.** Wireless Stations in Competition with Wire and Cable Telegraphy. (*Jahrbuch Zeitschrift für drahtlose Telegraphie*, 15, pp. 69—72, January, 1920. *Science Abstracts*, 24B, p. 214, Abstract No. 432, April 30th, 1921—Abstract.)

(6) General and Popular Radio Articles.

2414. The Future of Radiotelegraphy. (*Telegraph and Telephone Age*, 39, p. 157, April 1st, 1921.)

2415. **E. T. Fisk.** The Practical Application of the Triode Valve in Radio Communication. (*Sea, Land and Air*, 3, pp. 769—779, March 1st, 1921.)

A paper read before the Australasian Association for the Advancement of Science in January, 1921, and describing recent advances in the applications of valves. Some commercial valve apparatus manufactured by the Marconi and Associated Companies is illustrated.

2416. German Wireless Telegraphy. (*Telegraph and Telephone Age*, 39, p. 179, April 16th, 1921.)

A short note with regard to the leading German radio installations.

2417. Progress of Wireless Telegraph at the Brussels Commercial Fair. (*L'Électricité pour Tous*, 3, p. 117, April 30th, 1921.)

A short account of some of the wireless apparatus on exhibition.

2418. **E. W. Marchant.** Modern Developments in Wireless Telegraphy and Telephony. (*Electrician*, 86, p. 464, April 16th, 1921.)

A short abstract of a lecture delivered at the Municipal College of Technology dealing in particular with the progress in thermionic valve apparatus in wireless telephony and directional wireless.

2419. Radio Telegraphy at the Paris Fair, 1921. (*Radioélectricité*, 1, pp. 608—609, May, 1921.)

Illustrations are given of the exhibits by the Société Française Radioélectrique.

2420. **J. H. Dellinger.** Radio Communication. (*Radio News*, 2, pp. 678—679, April, 1921.)

An elementary explanation of the principles of radiotelegraphy and telephony.

2421. **H. Eales.** Wireless Telephony. (*Zentralzeitung für Optik und Mechanik*, 41, p. 69, 1920.)

2422. **M. Revol.** Wireless Telegraphy. (*L'Électricité pour Tous*, 3, pp. 148—152, May 31st, 1921.)

Paper read before the Association Technique des Électriciens.

2423. **L. H. Rosenberg.** A New Era in Wireless. (*Scientific American*, 124, p. 449, June 4th, 1921.)

A short article describing the uses of radiotelephony for broadcasting news, music and sermons.

2424. Broad Street, New York, as a Cabling Radio Centre. (*Telegraph and Telephone Age*, 39, p. 212, May 1st, 1921.)

A short article dealing with the concentration of cable and radio offices in Broad Street, New York.

2425. **W. H. G. Bullard.** The Application of Radio to Navigation Problems. (*Journal of the Franklin Institute*, 191, pp. 725—766, June, 1921.) *Electrical World*, 78, p. 131, June 16th, 1921—Abstract.)

The full paper to which reference has already been made in Abstract No. 1786, May, 1921. The author briefly described and illustrated the New York Radio Central Control Station, summarised the transmission of time signals from the high-power naval radio stations of the United States, described the weather reports that are issued from various radio stations on the United States coast and then proceeded to detail the application of direction-finding work to navigation problems. The United States radio compass apparatus is described and illustrated, and some interesting comparisons given in the form of charts of positions as determined by the radio compass bearings and the actual positions and courses of vessels. The application of pilot cables to guiding ships into harbours is described and the acoustic methods of determining the depth of water under the vessel. A chart is given of the International Meteorological Service detailing the weather reports issued by various wireless stations in the world. Some samples of records obtained with high-speed transatlantic reception are also included.

2426. Chicago Police use Radiophone. (*Science and Invention*, 9, p. 246, July, 1921.)

2427. **J. Slepian.** Why High Frequency for Radiation? (*Electric Journal*, 28, pp. 129—131, April, 1921. *Electrical World*, 77, p. 1175, May 21st, 1921—Abstract.)

The author attempts to show in a qualitative way how the introduction of Maxwell's displacement currents combined with the previously held laws of electromagnetism explain the fact that electric and magnetic fields are propagated with a finite velocity.

2428. **E. F. W. Alexanderson.** Notes on Wireless. (*Annales des Postes, Télégraphes et Téléphones*, 10, pp. 364—367, June, 1921.)

A report of an address delivered to the French delegates visiting the Radio Corporation of America in October, 1920.

2429. **W. Lebrenz.** The Berne Directory of Wireless Stations (*Telefunken Zeitung*, 4, pp. 26—31, March, 1921). The author describes his feelings on turning over the pages of the 6th edition and looking for the names of ship and land stations which were once German and Austrian. He says "Sic transit gloria mundi," but calls upon his colleagues to see that the next edition shows Germany again taking her old place.

2. Books.

WIRELESS DESIGN AND PRACTICE. Part I.: TRANSMITTERS AND RECEIVERS. Part II.: PRACTICAL CIRCUITS. By M. B. Sleeper. (London: *Henry Frowde and Messrs. Hodder and Stoughton*. 1920. Pp. 246. $7\frac{1}{2}'' \times 5''$. Price 7*s.* 6*d.* net.)

This work differs from most books on wireless subjects in that it is not a general text-book of the usual type, nor is it a text-book simplified for the amateur, but it is a book devoted entirely to the practical design of wireless apparatus, setting out in the simplest manner the principles of design of the various pieces of wireless apparatus required by the amateur or experimental wireless station. Very little mathematics is used—not more than required for the numerical calculation of dimensions from simple formulæ and tables of factors.

The first part of the book deals with the following items: Oscillating Circuits—Aerials—Design of Receiving Inductances—Design of Receiving Condensers—Valve Detecting Circuits—Oscillating Valve Circuits and Undamped Wave Receivers—Damped Wave Transmitters—and Vacuum Tube Transmitters.

The methods of calculation are set out quite clearly with as little as possible of descriptive padding—and it is assumed throughout that the reader is familiar with at least the general features of the apparatus dealt with. A few useful plates are inserted giving the general appearance of complete instruments and parts.

The second part of the book contains 86 circuit diagrams, each accompanied by a few explanatory notes and dimensions, of various simple arrangements for transmitting and receiving.

A few minor blemishes have been noted but in other respects the book is well prepared. The most serious defect from the point of view of the English reader is the use throughout of "B & S" gauge sizes for wires, without the inclusion of any table of comparison with S.W.G. In some cases in the text B & S gauge is apparently assumed, but is not so labelled. This omission might lead to confusion in the construction of apparatus.

PHILIP R. COURSEY.

THE "PRACTICAL ENGINEER" ELECTRICAL POCKET BOOK AND DIARY FOR 1921. (London: *The Technical Publishing Co., Ltd.* 1921. Pp. ciii + 610 + 48. $5\frac{1}{4}'' \times 3\frac{1}{4}''$. Price 2s. 6d. net. Post free 3s. Abroad 3s.)

As compared with the previous edition of this useful pocket book, the wireless notes in the current issue have been considerably revised and improved, and in particular those relating to the Marconi Company's apparatus have been augmented. The three-electrode valve and its uses is now given more adequate treatment, but for other apparatus—arc and quenched spark transmitters, etc.—the reader is referred to text-books. The list of Wireless Text-books that was previously issued has apparently not been revised, but has been omitted entirely, and its place filled with a short section on Wireless Telephony containing a description of the arrangements for use in aircraft.

P. R. C.

Books Received.

PRINCIPLES OF RADIO COMMUNICATION. By J. H. Morecroft (Assistant Professor of Electrical Engineering, Columbia University), assisted by A. Pinto and W. A. Curry. (New York: *John Wiley & Sons, Inc.* London: *Chapman & Hall, Ltd.* 1921. Pp. x + 935. $9'' \times 6''$. Price 45s. net.)

THERMIONIC TUBES IN RADIO TELEGRAPHY AND TELEPHONY. By John Scott-Taggart, A.M.Am.I.E.E. (London: *The Wireless Press, Ltd.* 1921. Pp. xxiii + 424. $8\frac{1}{2}'' \times 5\frac{1}{4}''$. Price 25s. net.)

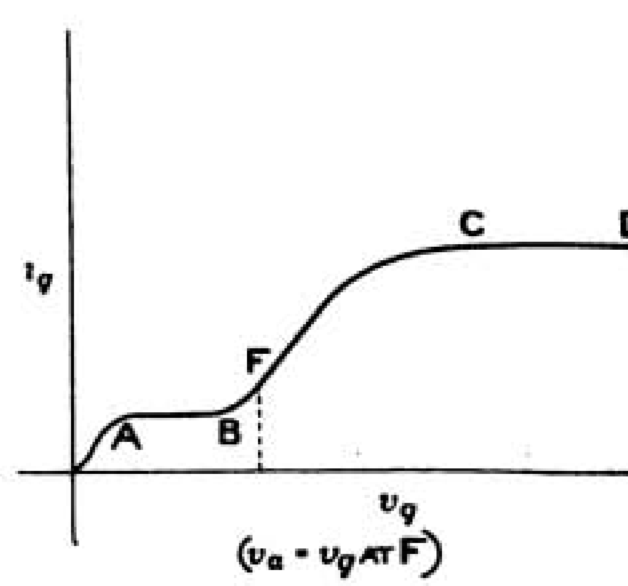
THE ALEXANDERSON SYSTEM FOR RADIO TELEGRAPH AND RADIO TELEPHONE TRANSMISSION. By Elmer E. Bucher. (New York: *Wireless Press, Inc.* 1920. Pp. 55. $10\frac{3}{4}'' \times 8''$. Price 10s. 6d. net.)

Correspondence.

TRIODE CHARACTERISTICS WITH HIGH GRID POTENTIAL.

TO THE EDITOR OF THE "RADIO REVIEW."

SIR,—It is clear from the communications of Dr. van der Pol and Mr. Bartlett that secondary electronic emission from both the grid and the anode of a triode tube occurs at high potentials and plays an important part in the action of high voltage triode generators. It can, however, be shown that secondary electrons from the anode are produced in low voltage circuits (*e.g.* with anode potentials of 10 volts) and can be detected whenever the grid potential approaches that of the anode. It seems that the usual explanations of the form of low voltage triode characteristics in the region where the grid potential v_g is greater than the anode potential v_a are erroneous and that the portion BC of the grid characteristic shown in the diagram is really the characteristic of a diode consisting of the anode as source of electrons and the grid as collecting electrode. The usual explanation is that the sudden increase in grid current is due to the deviation of electrons from the primary stream to the anode, but the difficulty with such an interpretation is to explain the constancy of the grid current in the regions AB and CD. If we adopt the new interpretation these difficulties disappear.



E. V. APPLETON.

Cambridge.
July 16th, 1921.