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Editorial

The Inductor with Air-gapped Magnetic Circuit

A PAPER with the above title was to have been read before the Engineering Section of the British Association at the Dundee meeting which was interrupted by the outbreak of war. Although it was published in *Engineering** it naturally received less attention than it would have done under normal circumstances. In *The Physical Review* in 1925 Spooner published a theoretical and experimental investigation of incremental permeability and referred to a Japanese paper on the same subject, but it was Hanna who in 1927 first calculated the effect of introducing an air-gap and showed how to determine the optimum length of gap; he stated, however, that it was a well-known fact that the incremental permeability could be increased by the introduction of an air-gap. Our editorial for February, 1928, was based on the work of Spooner and Hanna. The method given by Hanna was briefly as follows. From the curves of ordinary and incremental permeability one calculates, for an assumed air-gap ratio, the inductance to superposed alternating current for several values of the d.c. ampere-turns per cm. and plots a curve. By repeating this for other values of air-gap ratio one obtains a series of curves to which an envelope curve can be drawn, giving the optimum air-gap and the necessary number of turns in order to obtain the best a.c. inductance from a given iron core and a given direct current. With 4 per cent. silicon steel the ratio of the length of air-gap to the length of iron was found to vary from 0.2/1000 to 2/1000, the higher value being for larger direct currents or for larger desired inductances which necessitate a larger number of turns and thus increase the effect of the direct current.

The Effect of Fringing

In *The Wireless Engineer* of September, 1928, Mr. A. A. Symonds gave a number of experimental results confirming Hanna's method of determining the optimum gap, but drawing attention to the fact that there will be considerable magnetic fringing at the air-gap, causing its reluctance to be appreciably less than that assumed in the calculations. In a certain case this caused the optimum length of gap to be increased from 0.7 to 1.0 mm., an increase of 40 per cent. In this example the presence of an air-gap increased the inductance to superposed a.c. from 6.8 to 31 henrys.

The next contributor to the subject was Dr. F. W. Lanchester, who published a paper in *The Journal of the Institution of Electrical Engineers* in October, 1933, the most striking

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* *Engineering*, Oct. 13, 1939, p. 406. Attention may be drawn to a misprint in Fig. 1 in which the slope of the line XY should be μ_Δ and not μ_a.

feature of which was the entire absence of any reference whatever to previous papers on the subject. It added nothing to what had already been done, but from the method of approach it was fairly obvious that the author was quite unaware of the work that had been done on the subject.

In *The Wireless Engineer* of February, 1934, Dr. Beatty described an ingenious geometrical construction by which the labour involved in Hanna's method is considerably reduced. It may be as well to warn anyone referring to Beatty's paper that the current-turns per cm. are referred to as c.g.s. units and mixed up with H and B.

In *The Wireless Engineer* of April, 1934, T. Tanasescu described another graphical construction for finding the optimum gap-ratio. Before any of these methods can be used, one must, of course, know the value of the incremental permeability over the range of magnetic inductions likely to be involved.

In the *Journal of the American I.E.E.* for February 1934, R. F. Edgar published curves showing the result of superposing a.c. on the d.c. excitation of ring specimens of low and high silicon steels without any air-gaps. They showed that under certain conditions the mean flux density was increased, but in the absence of an air-gap the flux densities employed were generally very high. He explained that data for low flux densities were lacking. [Why do some people make life more difficult by expressing flux density in kilolines per *square inch ?*].

In the *Journal of the I.E.E.* for January 1939, T. A. Ledward also gave some very interesting results showing the distorted BH loops obtained when a.c. magnetisation is superposed on remanent or d.c. magnetisation. He draws special attention to the increased mean flux density due to superposed a.c. but the peculiar curves that he obtained are only possible with completely closed magnetic circuits. As he points out, the unavoidable air-gap in a core built up of stampings in the usual way is sufficient to modify the results very considerably.

Mr. Glazier's paper, which was prepared for the Dundee meeting, follows on from the work of Hanna, Beatty and Tanasescu, the first part of it being devoted to a description of that work. The graphical construction employed is that of Tanasescu and the calculated results are compared with the measured values obtained in a number of tests on cores of 4 per cent. and 0.2 per cent. silicon steels with various air-gaps.

An Interesting Anomaly

The measured incremental permeabilities were always considerably higher than the calculated values but the measured optimum air-gap agreed very closely with the calculated value. The author then investigates the causes of the discrepancy and shows that, although it is due to some extent to the iron losses causing a phase displacement between δB and δH, by far the most important cause is the increase in the mean magnetic induction when an alternating current is superposed upon the direct current. As this causes an increase in the mean value of H in the air-gap, it must be accompanied by a decrease in the mean value of H in the iron, since the mean value of the total m.m.f. is unchanged by the superposition of the alternating current. We thus have an increased mean B and a decreased mean H in the iron—a rather surprising result—so that we are not working about a point on the original BH curve but on a new BH curve for which the incremental permeability is considerably greater. The magnitude of this effect will obviously depend on the amplitude of the superposed alternating current; for small values there can only be a small movement of the mean point, but for large superposed currents the effect is quite considerable. In some cases the a.c. inductance was found to be over 50 per cent. greater than the value obtained from the uncorrected Tanasescu construction. By applying a correction for the displacement of the mean BH point the author obtained results in close agreement with experiments, except when the air-gap was so small that it could not be determined with any accuracy. The published work on this subject is now sufficient to enable one to calculate the optimum gap-ratio and the effective a.c. permeability with an accuracy more than sufficient for all practical purposes.

G. W. O. H.

Input Conductance*

Measurement in High-Slope H.F. Amplifier Valves

By F. Preisach and I. Zakariás

SUMMARY.—The input conductance of high-slope valves was measured at a frequency of 37 Mc/s. Special valves with multiple cathode leads have been investigated† in order to study the influence of lead inductance. The results of measurements could be explained in agreement with simple formulae taking into account self-inductance of the electrode leads. Using multiple cathode leads, input conductance can be reduced to any desired value, owing to compensating effects.

Introduction

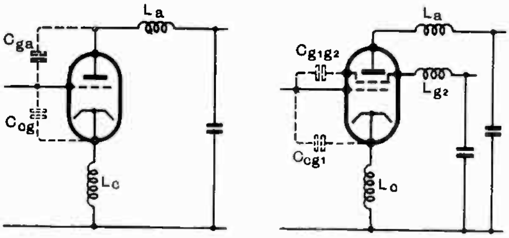
THE input conductance of valves is measured by observing the increase of damping on the grid circuit when the anode and all the auxiliary grids are short circuited for high frequency. There are two known causes of input conductance at high frequencies: 1, the transit time of electrons; 2, the inductance of the electrode leads. The effect of transit time has been investigated thoroughly by D. O. North and W. R. Ferris,[1] who found that the measured values of input resistance were smaller than the computed values though the valves have been used without base. M. J. O. Strutt and A. Van der Ziel[2] stated that the values of input conductance measured on ordinary valves exceed appreciably the values given by electron loading effects. They found that the anode current (and eventually also the screen grid current) has a reaction on the grid circuit, even when the anode and screen grid are short circuited for high frequency. This damping effect is due to the inductance of the electrode leads.

The electron loading effect due to the finite transit time of the electrons is given by a formula valid for screen grid valves:

$$y = \frac{1}{20} S_c \omega^2 \tau^2 q \quad \ldots \quad \ldots \quad \ldots \quad (1)$$

In this formula y is the grid conductance, $\omega = 2\pi f$, S_c the slope of the cathode current, $\tau = \frac{3d_1}{5{\cdot}95 \times 10^7} \frac{1}{\sqrt{U_{eff}}}$ the transit time in the cathode grid space, U_{eff} measured in volts being the effective value of potential in the control grid plane, d_1 the distance between cathode and signal grid, q a factor depending on the transit time from control grid to screen-grid.[3]

In order to estimate the effect of electrode leads, assuming a screen grid valve with a screen grid current negligible compared with the anode current, we have to take into account the drop of H.F. voltage across the cathode lead, and have to calculate the grid current, driven by this voltage drop. The corresponding apparent grid conductance is given by the formula:



(a) (b)

Fig. 1.

$$y = \omega^2 S_c C_{cg1} L_c \quad \ldots \quad \ldots \quad \ldots \quad (2)$$

C_{cg1} being the capacitance of cathode to signal grid, L_c the inductance of the cathode lead.

Both formulae 1 and 2 contain ω^2 and S_c,

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*MS. accepted by the Editor, January, 1940.

†The investigations were carried out in the Tungsram Research Laboratory.

[1] *Proc. Inst. Rad. Eng.*, 1936, Vol. 24, pp. 106–136, and pp. 82–106.

[2] *E.N.T.*, 1937, Vol. 14, p. 281.

[3] A graphical representation of the value q is given by H. Rothe, *Die Telefunken-Röhre*, 1, April, 1937, p. 47.

thus the input conductances increase rapidly with frequency and also with the value of the mutual conductance. As in constructing high slope valves the capacitance of cathode to grid must be increased together with the slope S_c, in practice formula 2 gives a more rapid increase with S_c than the formula 1.

In the case of triodes the grid to anode capacitance causes a further reaction due to the H.F. voltage on the anode lead inductance L_a, therefore a second member in formula 2 must be taken into account (Fig. 1a).

$$y = \omega^2 S(C_{cg}L_c - C_{ga}L_a) \quad .. \quad (2a)$$

B. J. Thompson[1] emphasised the possibility of reducing grid damping of triodes by balancing the effects of the lead inductances of cathode and anode as suggested by formula 2a.

In the case of a screen grid valve with a finite value of screen current, the voltage on the screen grid lead has a similar influence to the voltage on the anode lead of a triode. If this is taken into account (see Fig. 1b) formula 2 must be corrected to :[2]

$$y = \omega^2[S_c C_{cg1} L_c - S_{g2} L_{g2} C_{g1g2}] \quad (2b)$$

S_c,S_a, and S_{g2} being the slopes for the cathode, anode and screen grid currents respectively.

Comparing formulae 2a and 2b it is obvious that in the case of the triode, the condition of balance $C_{cg}\,L_c - C_{ga}\,L_a = 0$ may be easily fulfilled, as the inductances and capacitances in question are nearly equal. In the case of screen grid valves, however, the condition of balance given by $S_c C_{cg1}\,L_c - S_{g2}\,L_{g2}\,C_{g1g2} = 0$ cannot be fulfilled easily, S_{g2} being much smaller than S_c (in ordinary valves $S_c = 4\text{-}5\ S_{g2}$). It is obvious that an artificial increase of L_{g2} or C_{g1g2} for the sake of balance is not feasible. On the contrary, an attempt to reduce capacitances and inductances must be made, in order to increase the resonant frequency of the electrode leads. This idea was carried out with the construction of acorn valves in which through the reduction of size all the detrimental lead effects could be improved.

Use of Several Leads for the Same Electrode

Another way to decrease lead effects is to use several leads for the same electrode. The different leads may be connected either in parallel in order to reduce the resulting inductance or they may be used for different connections. This second possibility must be considered in detail.

It has been suggested that two cathode leads should be used, one for the grid circuit, the other for the anode circuit. The input conductance for the arrangement to the same approximation as in formula 2 (see Fig. 2) can be shown to be

$$y = -\,\omega^2 S(L_{ca} + L_a)\,C_{ga} \quad .. \quad (3)$$

The damping effect caused by the current across the cathode grid capacitance is eliminated here, the reaction of high frequency voltage on the anode, however, increases, resulting in a regenerative effect.

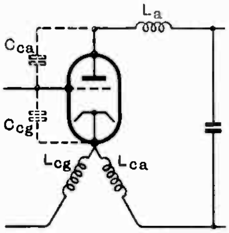

Fig. 2.

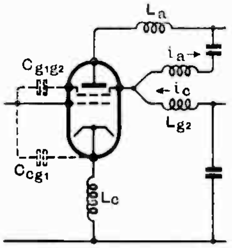

Fig. 3.

Another suggestion pointed out in a patent specification relates to a screen grid valve and proposes the use of two leads for the screen grid (Fig. 3). The input conductance for this arrangement is given by

$$y = \omega^2 S_c(C_{cg1}L_c - C_{g1g2}L_{g2}) \quad .. \quad (4)$$

The balance is here made possible by artificially increasing the high frequency voltage on the screen grid in comparison with the case of Fig. 1b.

We found that a more efficient balance can be attained by using the arrangement of Fig. 4a for screen grid valves. Here the screen grid is connected for high frequency with the cathode lead of the grid circuit. The input conductance is given by

$$y = \omega^2 S_{g2}(C_{cg1}L_{cg} - C_{g1g2}L_{g2}) \quad (5)$$

Comparing with formula 4 we see that in the

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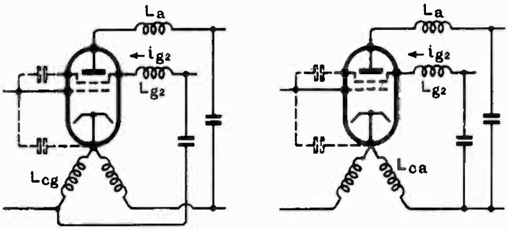
[1] *RCA Review*, 1938, Vol. III, p. 151.

[2] Throughout the considerations of screen grid valves and pentodes we assume the anode to grid capacitance to be small compared with the other interelectrode capacitances.

latter arrangement the resulting value of conductance being proportional to S_{g2}, is only about $\frac{1}{4}$ of the value attainable by the arrangement in Fig. 3.

The damping effect of the electron loading may also be balanced by making use of the negative member of formula (5) introduced by the screen grid voltage. If the screen grid is connected for high frequency with the cathode lead used for the anode circuit (Fig. 4b) we have only a regenerative member analogous to the arrangement of Fig. 2.



(a) (b)

Fig. 4.

$$y = -\omega^2(S_c L_{ca} + S_{g2} L_{g2})C_{g1g2} \qquad (6)$$

This arrangement mostly resulting in an overbalance with regard to the electron damping effect was not found to be practicable.

An arrangement using 3 cathode leads (Fig. 5) makes it possible to obtain a regenerative member of a useful magnitude for the purpose of balancing input circuit losses and electron loading. For this case the input conductance is given by

$$y = -\omega^2 S_{g2}(L_c + L_{g2})C_{g1g2} \quad .. \quad (7)$$

This arrangement seemed to be advantageous for reducing parasitic oscillations with frequencies approaching the resonant frequency of the leads.

Certain considerations concerning feedback and oscillations suggest the use of a valve and an arrangement according to Fig. 6. An additional screening grid g_s reduces the capacitance C_{g1g2} to about $\frac{1}{4}$ of the value in ordinary valves.

The influence of mutual inductance between the electrode leads is of certain importance when balancing conditions are fulfilled. These effects will be dealt with when discussing the results of measurements.

Measuring Equipment

The measuring equipment was designed not only for the measurement of the input conductance but also for investigating the valve when working as a one-stage amplifier for a frequency of 37 Mc/s. For this purpose it was possible to connect a tuned circuit to the anode. The voltage impressed on the grid circuit was of the order of 0.1 volt and was indicated by a triode voltmeter using anode bend rectification with compensated initial current. The output H.F. voltage could be measured with a diode voltmeter. The valves for both diode and triode voltmeters were of the acorn type and the length of the connecting leads was kept as short as possible. In order to investigate valves with multiple cathode leads, separate screening boxes were found necessary for the input and output circuits. Each screening box was connected to the cathode by a separate cathode lead. The capacitance of these boxes to the common housing plays a certain role concerning questions of amplification and feed-back. For the actual measurements of grid conductance the grid screening box was connected to the common housing and the anode screening box was disconnected, the anode circuit being replaced by a condenser of 2,000 $\mu\mu$F in order to by-pass high frequency current. It was found expedient to use a resistance of 50Ω in series in order to eliminate parasitic oscillations. The ultra high frequency generator was connected to the input circuit by means of a capacitive coupling made variable by a movable shielding plate between the electrodes of the coupling condenser C_c (see Fig. 7 where the measuring circuit is shown).

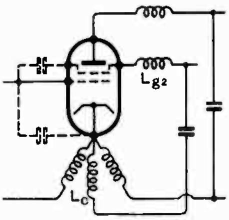


Fig. 5.

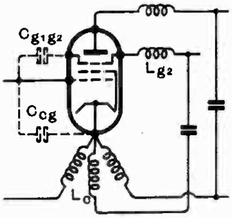


Fig. 6.

The grid conductance was measured by detuning the grid circuit by means of a variable condenser C_v. The resistance of a tuned circuit in resonance is given by $R = 1/2\pi f \delta C$

where f is the resonant frequency and δC the amount of detuning of the condenser necessary to halve the mean square value of voltage. A square law triode voltmeter being used, δC was easily obtained by noting the change in capacitance necessary to reduce the indication of the microammeter to half the resonance value.

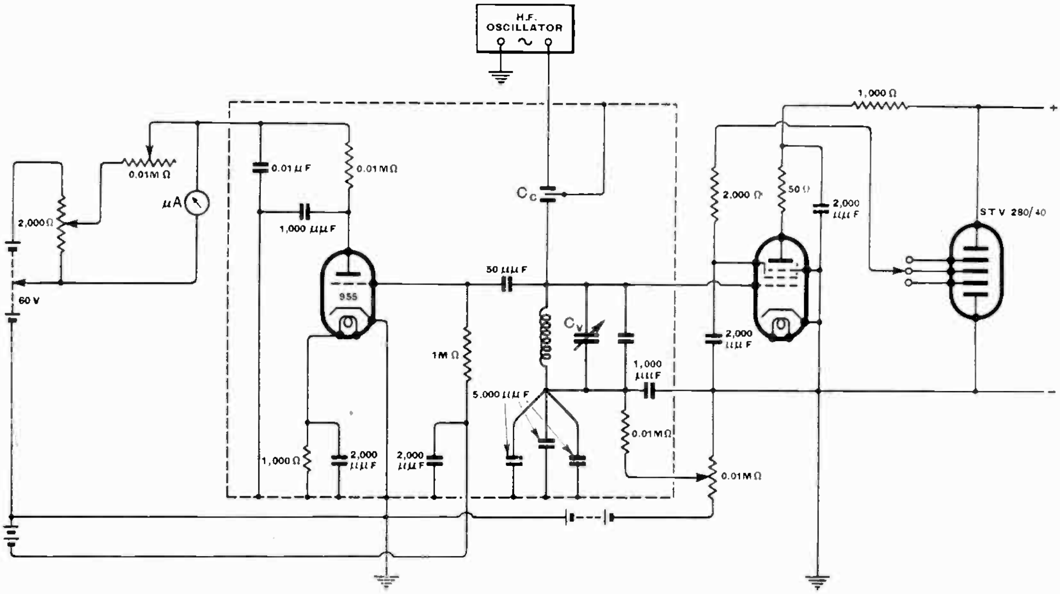


Fig. 7.—*Circuit of the measuring equipment.*

It is known that in U.H.F. measurements lead inductances change the values of the connected impedances. Fig. 8 shows the inductances L_1 and L_2 arising from the connection of the variable condenser C_v and the inductances L_3 and L_4 of the valve input C_i. The points A-B representing the plugs of the coil L_0 of the resonant circuit may be regarded as reference points to which the value of the two connected impedances must be reduced. The described method of measurement will be correct only if the lead inductances are adjusted so as to produce the same reduction factor for the input capacitance C_i of the valve as for the variable capacitance C_v. This adjustment was made with the aid of a test condenser of $C_p = 3$ $\mu\mu$F connected first to the valve input and then to the variable condenser. The lead inductance L_1 was increased until the same amount of detuning of the variable condenser was found necessary in either of the test condenser positions. With this method both the capacitance change and the input resistance of the valve are referred to the pins of the valve. The values determined in this way contain therefore the effect of the internal leads of the valve.

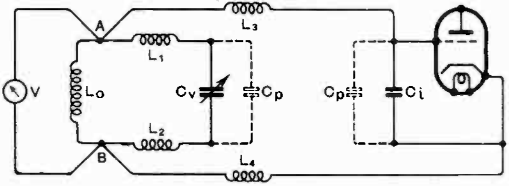


Fig. 8.

The input conductance of the valves was measured for different values of grid bias and constant voltages on anode and screen grid. In a series of measurements taken with the same valve, it was found convenient to determine by the above method the input conductance for one point of the range (for example the cut-off value) and to compute the change in conductance for further points by observing the change of the high frequency voltage indicated by the triode voltmeter. The value of input conductance is given by $y = 2\pi f \delta C$ for the first point ; the conductance values of further points are given by the voltage ratio indicated by the triode voltmeter $y/y_0 = \sqrt{\frac{\alpha}{\alpha_0}}$, α being the deflection of the microammeter. Thus a determination of frequency and the calibration of the variable condenser were necessitated. Further the square law of the triode voltmeter was checked by plotting the resonance curve.

The frequency was 37 Mc/s and the variable condenser with a dial of 100 deg. had a capacitance change of 0.22 $\mu\mu$F per degree. The sensitivity of the triode voltmeter was 12 degrees for 0.1 volt r.m.s. The voltages for the investigated valve were supplied by the A.C. mains ; the anode and screen grid voltages were stabilised (see Fig. 7). The triode voltmeter was fed by batteries. The U.H.F. generator was a mains-driven 15-W triode oscillator with stabilised anode voltage.

Results

Input conductance was measured for different values of anode current, the curves were, however, plotted against the slope of the anode current, obtained by a separate audio-frequency measurement. The change of input capacitance was measured at the same time.

Besides commercial types of high slope valves, measurements were made on high slope valves with multiple cathode leads specially constructed for these investigations. The results obtained on the commercial valves are shown in Fig. 9. Curves 1–4 refer to valves of conventional glass construction, valve 4 being an improved type of valve 2, manufactured by the same firm. Valve 5 is a metal valve (1851) superior both in respect of electron loading and of lead effects. In all curves (Figs. 9–16) the total conductance is plotted against slope, the conductance of the tuned circuit being $65.10^{-6}\Omega^{-1}$.

The laboratory types are numbered I, II, III, IV. Valve No. I is similar in quality to the commercial valve No. 1, having cathode area and electrode spacing corresponding to high slope output valves used in radio sets. Valves No. II, III and IV are indentical in respect of cathode and control grid construction and have reduced spacings corresponding to valve No. 5. Valves II and III are pentodes similar in inner construction but different in base construction and lead arrangement. Valve IV has a similar lead arrangement to valve II but an auxiliary grid is used between screen grid and control grid.

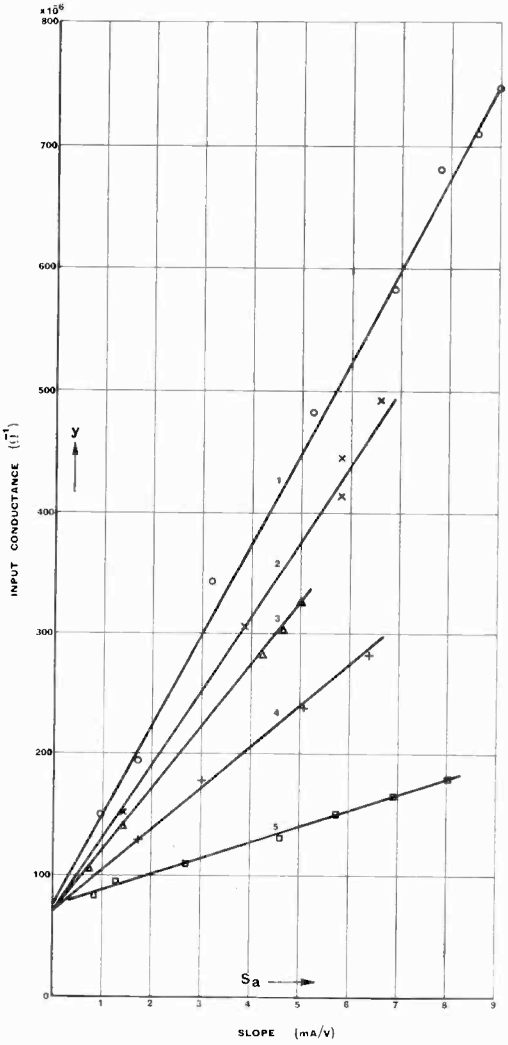


Fig. 9.—*Input conductance plotted against slope, for different commercial high slope valves at a frequency of 37 Mc/s.*

All the valves in question were provided with two pins on the top of the metallised glass bulb. To one of them, the control grid was connected ; to the other, one of the cathode leads. Two or more additional cathode leads were brought out on the base. The simplest way of applying the multilead arrangement is to use these cathode leads connected in parallel. Therefore the result of measurements obtained by using this arrangement will be given for all the valves in question.

Measurements on valve I (large electrode spacings) are shown in Figs. 10, 11 and 12. Curves of Fig. 10 show the reduction of the value of grid conductance due to the use of several cathode leads connected in parallel. There were two cathode leads brought out on the base, and another one on the top of the valve. Curve 1 refers to an arrangement where only one cathode lead of the base was used in the usual manner. Curve 2 shows the improvement due to the use of both leads of the base. The cathode lead of he top being shorter, curve 3, where one of the leads of the base and that of the top were used shows a further improvement. The use of the third cathode lead of the base (curve 4) does not improve the conductance considerably. Fig. 11 shows the results obtained by different arrangements of the cathode leads. Curves 1 and 2 refer to the arrangement of Fig. 4a (formula 5), where one of the

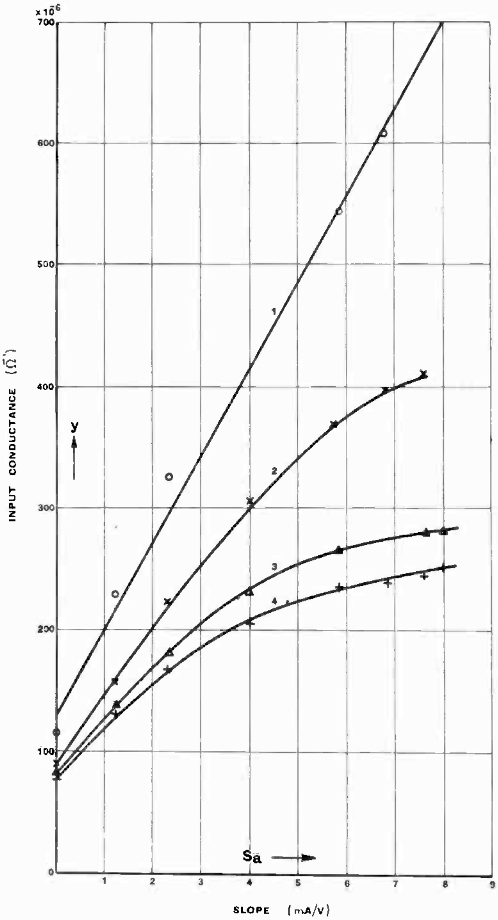


Fig. 10.—*Input conductance of valve I with three cathode leads, using different parallel connections. Frequency 37 Mc/s (1) one base lead; (2) two base leads; (3) one base lead and one top lead; (4) two base leads and one top lead in use.*

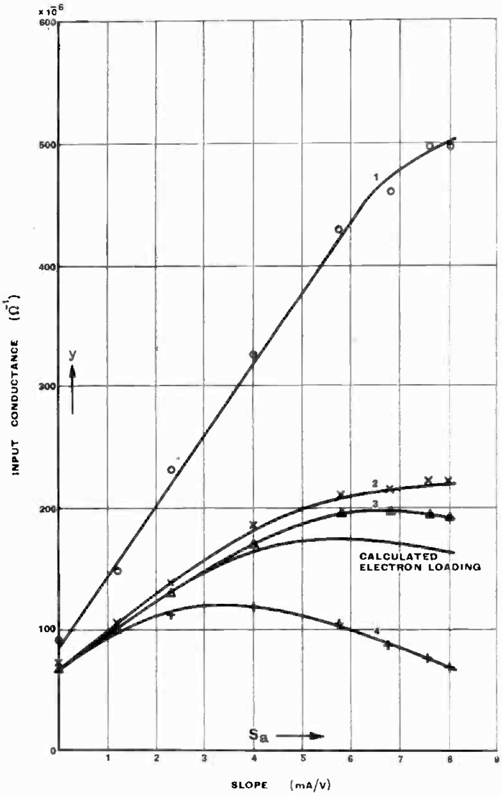


Fig. 11.—*Different use of multiple cathode leads of valve I. (1) one base lead connected to the control grid and screen grid, another base lead to the anode, top lead not used; (2) one base lead and one top lead to the grids, the other base lead to the anode; (3) top lead to the control grid, two base leads to anode and to screen grid separately; (4) one top lead and one base lead to the control grid, the second base lead to the screen grid and anode. For comparison: calculated curve for electron loading effect.*

cathode leads is used for the high frequency connection of the anode. Using one base lead for the grid connection, curve 1 was obtained; connecting the top lead in parallel gave curve 2. This considerable difference is due partly to effects of mutual conductance of the base leads which are minimised when using the top connection. Curve 3 refers to a connection according to Fig. 5 (formula 7). Curve 4 refers to Fig. 4b (formula 6). This curve clearly shows a condition of over-correction. Could the effect of mutual inductance be fully neglected the curve due to electron loading would be expected to lie between curves 2 and 3. According to the formula of North and using the method of determination of transit time of Ferris the conductance due to electron loading was also plotted against slope and lies below curve 3. The general shape of a grid conductance-slope curve due to transit time always increases linearly at the beginning, showing further on a bend as if reaching saturation. The explanation is given by transforming the formula of Ferris and North. Putting $y = KS\tau^2$ the transit time being $\tau = \dfrac{\text{const}}{\sqrt{U_{eff}}}$ and $U_{eff} = \dfrac{3}{2} \cdot \dfrac{i}{S}$ it follows that the conductance is proportional to S^2/i. In the region of cut-off S/i is approximately constant, giving a linear relation between y and S. In the region of space charge limited conditions (closely approximated if fine meshed grids are used) S^3 is proportional to the anode current i. In a medium range S^2 will be approximately proportional to i, consequently the curve will show a trend to saturation, and further on a decrease with S.

Curves of Fig. 12 show the influence of mutual inductance between base leads, in the arrangement to which curves 1 and 2 of Fig. 11 refer. Here the lead inductances taken into account in formula 5 carry only the screen grid current, consequently we must expect the coupling with leads carrying the whole cathode current, to influence the results appreciably. Curves 1 and 2 of Fig. 12 refer to connections not using the top lead, curves 3 and 4 refer to the same connection with the top lead connected parallel to the base leads. The difference between 1 and 2 and 3 and 4 respectively arises from the different ways of using the two base leads for the cathode. In the case of 2 and 4, leads situated near to each other have been connected for high frequency: c_1 to the anode lead a, c_2 to the screen grid g_2 (the arrangement of the leads in the pinch is shown on the right of Fig. 12). This connection gives rise to a small coupling with the circuit carrying the total cathode current, hence the smaller values of grid conductance. Interchanging the use of the cathode leads

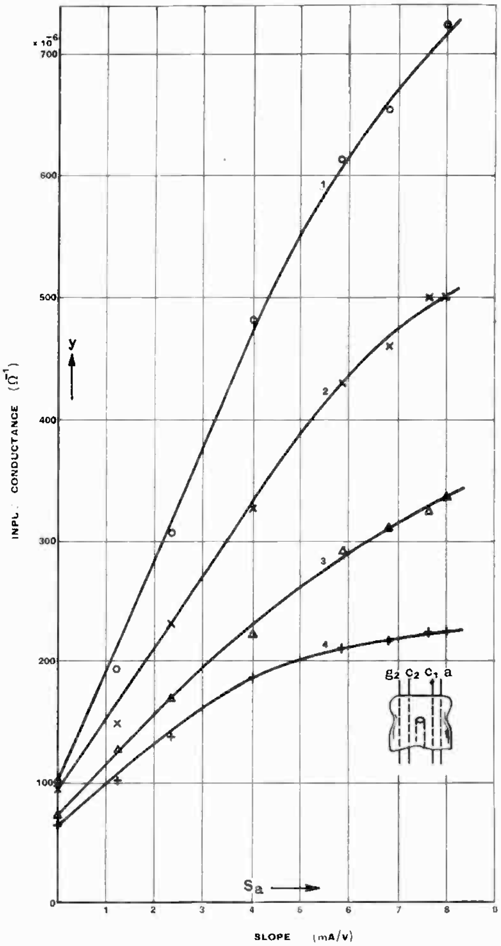


Fig. 12.—*Influence of mutual inductance of electrode leads in valve I. Different use of cathode leads c_1 and c_2 for connecting anode and screen grid and control grid respectively.* (2) *and* (4) *c_1 connected to a, c_2 to g_2;* (1) *and* (3) *c_1 connected to g_2 c_2 to a. The arrangement of the leads c_1, c_2, g_2 and a in the pinch is sketched.* [(2) *is identical with* (1) *of Fig.* 11 *and* (4) *identical with* (2) *of Fig.* 11.]

c_1 and c_2, the coupling increases and results in higher values of grid conductance (curves 1 and 3).

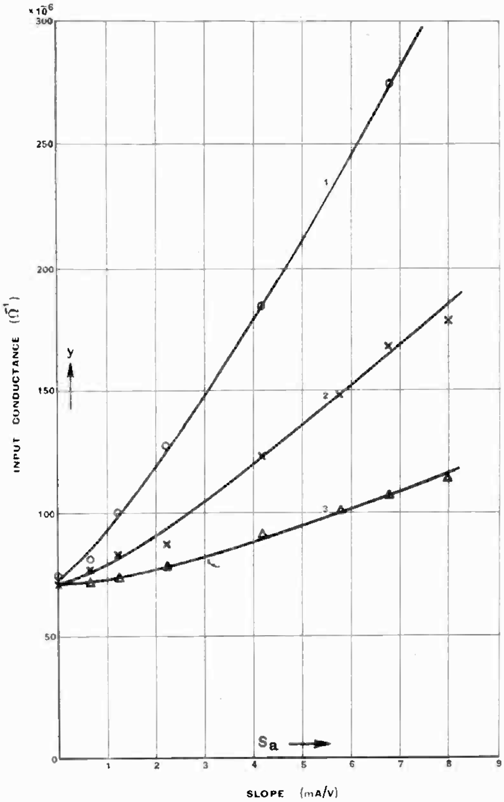


Fig. 13.—*Input conductance of valve II with three cathode leads, using different parallel connections.* (1) *one base lead* ; (2) *two base leads* ; (3) *two base leads and one top lead in use.*

Measurements on valve II are shown in Figs. 13 and 14. This valve has also two base leads and one top lead for the cathode. Fig. 13 shows the result of parallel connections: (Curve 1 one base lead, curve 2, two base leads, curve 3, two base leads and one top lead in use). The reduction of input conductance in comparison with valve I (note the different scales) is due to the reduction of valve size without a change of electric data; interelectrode spacings as well as the length of electrode leads have been reduced. The different shapes of the curves compared with those of the analogous curves of valve I (Fig. 10), are due to the fact that electron loading which gives rise to a downward bend has been considerably reduced in this valve (compare Table I). The change of grid to cathode capacitance with slope, however, takes place also in valves with reduced spacings, this change of capacitance being approximately equal to $1/3\ C_{cg}$. Formulae 2–5 show immediately that the increase of the capacitance C_{cg1} with increased slope gives rise to conductance curves with a bend that is mainly upward if a balanced condition is approximated. (A balance suggested by formula 5 can only be attained for one certain value of the slope.) On the other hand, near a balanced condition electron loading cannot be neglected in comparison with the effect of electrode leads. Hence the curves obtained are likely to be a superposition of a curve with an upward bend due to lead effects and of a curve with a downward bend due to electron loading. The theoretical curve of electron loading has not been plotted, the effective distance between cathode and signal grid being very small and not accurately available. The value of grid conductance calculated is

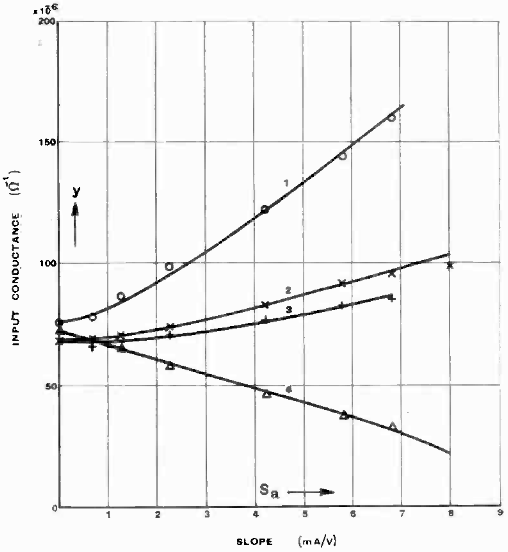


Fig. 14.—*Different use of the three cathode leads of valve II.* (1) *One base lead connected to the control grid and screen grid, the other base lead to the anode, top lead not used* ; (2) *top lead used in parallel with the base lead connecting signal grid and screen grid* ; (3) *similar to* (2) *but external leads to signal grid arranged differently* ; (4) *one top lead and one base lead connected to the signal grid, another base lead to the screen grid and anode.*

approximately $15 \times 10^{-6}\ \Omega^{-1}$ for a slope of 8 mA/V.

Fig. 14 shows several curves for the same valve, with different use of the cathode leads. Curves 1 and 2 are analogous to curves 1 and 2 in Fig. 11, one separate cathode lead being used for earthing the anode. Curve 3 differs from curve 2 in using the top lead of the cathode directly for connecting the cold point of the grid circuit, whereas in curve 2 the cold point was joined to the common connection of a base lead with the top lead. The difference is due to the inductance of the external connection. Curve 4 is analogous to curve 4 of Fig. 11 and shows the state of over-correction treated in formula 6 (compare Fig. 4b).

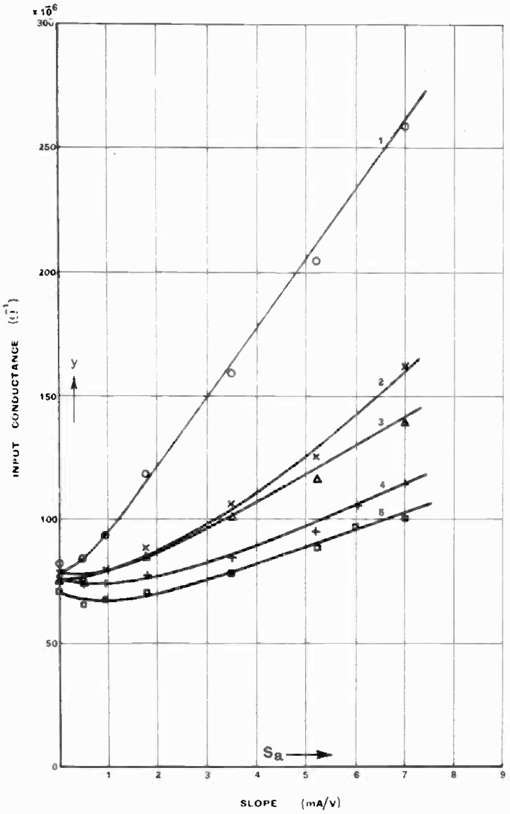


Fig. 15.—*Input conductance of valve III with four cathode leads, using different parallel connections.* (1) *one base lead ;* (2) *two base leads ;* (3) *three base leads ;* (4) *one base lead and one top lead ;* (5) *three bare leads and one top lead in use.*

The results obtained on valve III are shown in Figs. 15 and 16. This valve has the same internal structure as valve II, but has shorter electrode leads, being constructed with a base without pinch. Three base leads and one top lead for the cathode have been used. Fig. 15 shows the result of parallel connections of the cathode leads in a manner analogous to Figs. 10 and 13 (see explanations below the figure). The conductances are smaller than those of valve II, due to a further reduction of the length of leads.

Fig. 16 represents the possibilities, due to different use of the cathode leads of valve III. Curves 1, 2 and 3 refer to arrangements of a separate cathode lead for earthing the anode circuit (Fig. 4a). In the arrangement of curve 1 only one base lead, in that of curve 2 two base leads and in that of curve 3 two base leads and one top lead are connected in parallel in order to connect the signal grid circuit and the screen grid bypass

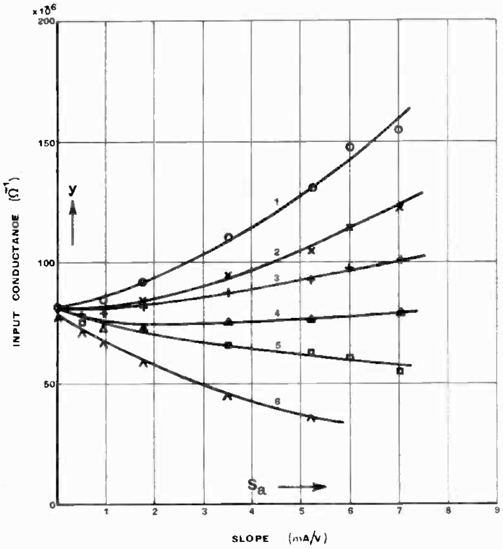


Fig. 16.—*Different use of the four cathode leads of valve III.* (1) *one base lead connected to the control grid and screen grid, the other base lead to the anode, top lead not used ;* (2) *a second base lead connected parallel to the first base lead for grid connection ;* (3) *the top lead added for the same connection ;* (4) *separate leads for control grid, screen grid and anode respectively ;* (6) *common lead for anode and screen grid, control grid connected separately, using one base lead and one top lead ;* (5) *the same arrangement as that of* (6) *but using two parallel base leads for anode and screen grid.*

condenser. The gradual decrease of input conductance is due partly to the reduction of the influence of a coupling with the anode circuit through mutual inductance of the base leads, partly to a gradual decrease of the positive member in formula 5. In the case of curve 4 the connection of Fig. 5 (compare formula 7) was adopted. Curves 5 and 6 refer to the " overcorrected state " (compare Fig. 4b and formula 6). In the case of curve 5 two parallel cathode leads were used for the high frequency connection of the anode and screen grid, hence a smaller decrease of input conductance compared with curve 6, which referred to an arrangement where only one cathode lead was used for this purpose. Curves of Fig. 16 show clearly that with a suitable variation of the use of cathode leads, very different values of grid conductance—positive as well as negative—may be attained.

In Fig. 17 the measurements on valve IV are shown. In this valve an auxiliary grid has been introduced in order to reduce the control grid—screen grid capacitance C_{g1g2} (compare Fig. 6). This valve has also two base leads and one top lead for the cathode. Curves 1, 3 and 4 are analogous to curves 1, 3 and 4 of valve II (Fig. 14). Curve 2 shows the result when all the three cathode leads are used in parallel as in curve 3 Fig. 13 of valve II. In accordance with the reduction of the negative member in formulae 2–6 all the curves are situated higher than those of valve II. (For comparison, the important data of the valves are given in Table I). The connection for over-correction gives rise in this case to positive conductances (curve 4). The positive values are, however, partly due to mutual inductance owing to the fact that the coupling between the leads carrying the screen-grid current and those, carrying the total cathode current is closer in this valve than in valves II and III.

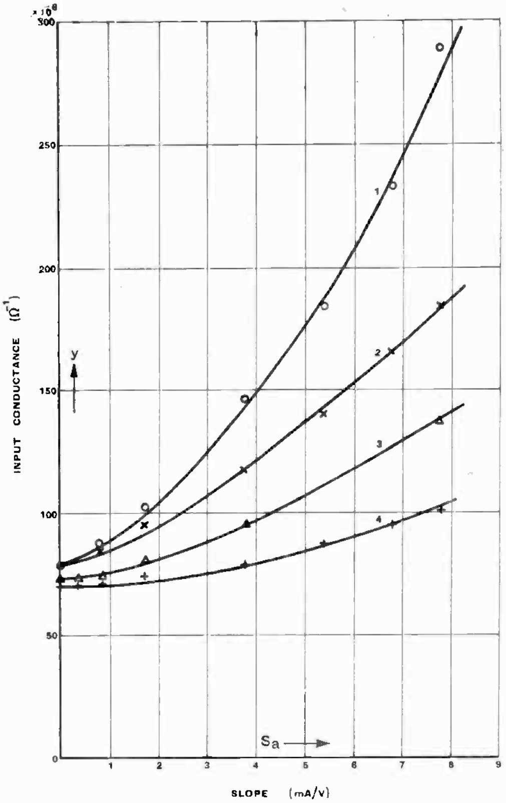


Fig. 17.—*Input conductance of valve IV with reduced capacitance of control grid to screen grid. (1), (3), and (4) analogous to (1), (3) and (4) of valve II, Fig. 14; (2) all the three cathode leads used in parallel.*

Formulae 2b, 5, 6 and 7 can be used—with the aid of the experimental results—

TABLE I

Valve No.	Capacitances $\mu\mu F$		Screen-grid current S_{g2}/S_c	Spacings mm		Lead inductances 10^{-9} *Hy*		Electron-loading for $S = 8mA/V$ $10^{-6}\Omega^{-1}$
	C_{cg1}	C_{g1g2}		$d1$	$d2$	L_{base}	L_{top}	
I	9.1	3.3	0.26	0.3	1.3	83	23	116
II	6.0	4.0	0.20	0.1	0.28	52	11	25
III	6.0	4.0	0.20	0.1	0.28	44	11	25
IV	9.0	1.0	0.27	0.1	0.28	52	11	about 40

to calculate the values of lead inductances. Owing to the number of variations made in the arrangement of the lead connections we are able to calculate the average value of the inductance of a base lead, and of the top lead as well as the value of the grid conductance due to electron loading, which may be considered an additional conductance. We have found that in the case of parallel connections the disturbing influence of mutual inductance can be neglected, whereas in the balanced condition their effect is not negligible but somewhat affects the measurement. The values determined for the different valves in question are to be found in Table I. The values of inductance are in reasonable agreement with calculations on the basis of the geometric dimensions of the leads. In the same Table further data are given, necessary for the computations. The change of the capacitance between cathode and control grid has been taken into account; its change is plotted against slope in Fig. 18 for the different valves.

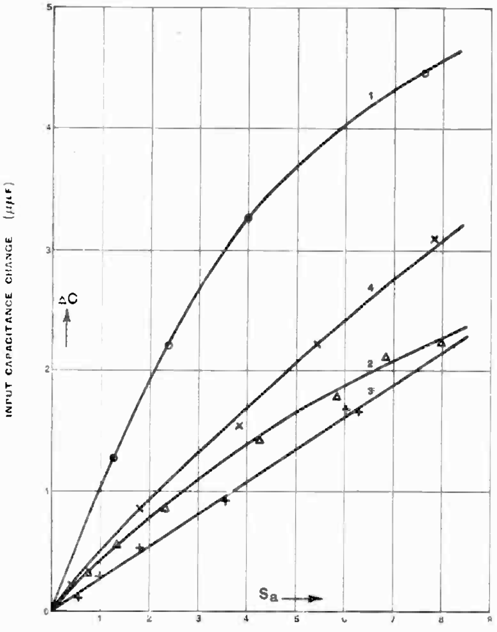


Fig. 18.—*Change of input capacitance of the valves investigated, plotted against slope, measured as in Figs.* 10 *to* 17, *at a frequency of* 37 *Mc/s.*

It should be mentioned that in the "over-corrected" state the calculated decrease of input conductance always exceeds the measured values. The influence of the mutual inductance does not seem to account sufficiently for this discrepancy.

From these measurements we may conclude that in the case of high-slope valves electrode-lead effects are the predominant factor of input conductance. Their influence cannot be easily reduced to a negligible degree compared with the conductance due to electron loading. The measured values are very dependent on the manner in which the connections to the valve are made as every tenth of an inch of lead length has an appreciable influence on input conductance.

TELEVISION RELAY SYSTEM

Success of American Experiments

ENGINEERS of the Radio Corporation of America have successfully carried out experimental tests with a wireless-link television relay system between the National Broadcasting Company's television transmitter W2XBS in New York and the Corporation's laboratories at River Head, Long Island. In the experiments the transmission from W2XBS, on a frequency of 42.5 Mc/s, was received at a station 45 miles away, where it was converted into a frequency of about 500 Mc/s and again broadcast. At this frequency the signals were received and re-transmitted at each succeeding 10-watt relay station, which were approximately 15 miles apart. At the end of the chain of stations, the frequency was lowered to its original 42.5 Mc/s for rebroadcasting.

At each of the 10-watt relay stations, the transmitting and receiving apparatus was mounted on the 100ft. steel mast which carried the parabolic aerials.

VALVE DATA

AN annual feature of our sister journal *The Wireless World* has been the publication of a valve data supplement giving a list of receiving valves with details of their characteristics and base connections.

This data will be published in the May issue of *The Wireless World*—on sale on April 20th, which will also include a number of articles on recent valve developments.

As an unusually heavy demand is expected for this issue, readers would be well advised to place an order with a newsagent to ensure obtaining a copy.

Magneto Striction Oscillators[*]

By D. C. Stenning, B.A., B.Sc.

(Scophony Research Laboratories)

General

IT is known that certain materials undergo a mechanical deformation when placed in a magnetic field, and that, conversely, their state of magnetisation undergoes a change when a mechanical stress is applied. If, therefore, a rod of magneto-strictive material is used to couple two coils, through one of which a current is passing, then any small change in this current will produce a small change of length in the rod in its vicinity. This deformation will be propagated along the rod and on arrival at the other coil will produce a change in field there, thus causing an e.m.f. to appear across the coil terminals. If the current through the first coil is an alternating one whose periodicity is equal to the resonant period of the rod, then the rod will resonate mechanically and produce an e.m.f. of this frequency across the second coil. This fact has been used by Pierce and others to control the frequency of a valve oscillator.[†]

A rod of magneto-strictive material is arranged so that its vibrations provide coupling between the components of an oscillatory circuit. In order to maintain oscillation of the rod a magnetising field in the direction of the length of the rod is generally required, although it is possible to make the rod oscillate at double the applied frequency with no field. This field may either be obtained by a permanent magnet or, more conveniently, by a direct current passed through the coils of the coupling circuit surrounding the rod.

Effect of External Fields

By suitable arrangement of the circuit constants it has been found possible to make the instrument extremely sensitive to external magnetic fields, such as that of the earth. Rotating the rod and the coils in the earth's field, from the position in which this opposes the standing field to that in which it assists the latter, will give an increase in amplitude of oscillations of many times. To appreciate this effect we must consider the way in which the oscillations are produced. The basic circuit used in these experiments is shown in Fig. 1, the rod being No. 9 S.W.G. annealed Calomic Wire (65% Ni, 15% Fe, 20% Cr.).

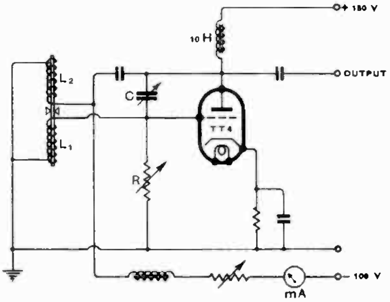


Fig. 1.—*The basic circuit.* $C = 0.002\,\mu F + 0.002\,\mu F$ *variable ;* $R = 2000\ \Omega + 2000\ \Omega$ *variable.*

In order to give a series of different standing field strengths the anode coil was "para-fed" and a separate source used to pass D.C. through it.

There are here three types of feed-back in operation simultaneously :

(a) Capacitive feed-back due to condenser C and the inter-electrode capacitances—regenerative.

(b) Inductive feed-back due to the coupling of L_1 and L_2—degenerative, since the coils are arranged to be in opposition.

(c) Regenerative feed-back due to the magneto-strictive oscillation of the rod.

If the circuit is set up with zero D.C. through L_2, without the rod and with no damping on L_1, it will oscillate due to feed-back (a). At the frequency concerned (of the order of 13 kc/s) there is no appreciable coupling between the coils L_1 and L_2 in air. The damping on L_1 may be considerably increased by reducing R and the oscillations will still be maintained. Now if the rod is inserted without the rod itself oscillating, e.g., by holding the rod or by using a rod of inappropriate length, the increase of de-

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[*] MS. accepted by the Editor, January, 1940.

[†] Proc. American Acad. (Boston), Vol. 63 (1929), p.1.

generative coupling (b) will stop oscillation. R must then be increased to overcome this, and the amplitude of oscillation depends on the effective Q of the circuit, i.e., on the regenerative feed-back. By now passing D.C. through L_2 the degeneration is reduced and the amplitude of the oscillation increases. The rod is then acting purely as an iron core. The hysteresis curve for the iron is shown in Fig. 2, and by differentiating this curve the change in degenerative coupling is obtained (Fig. 3).

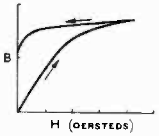

Fig. 2.

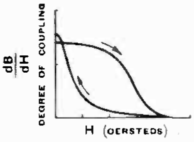

Fig. 3.

For a value of R such that oscillation was just not maintained with zero D.C. the curve shown in Fig. 4 was obtained experimentally. The amplitude of oscillation is on an arbitrary scale, being in fact inches of deflection on an oscilloscope.

If the rod is now cut to a suitable length and clamped accurately at its centre with the ends free, and D.C. passed through the coil, then the condenser can be adjusted so that on reducing R still further beyond the point at which oscillation ceases, the rod itself will start to oscillate and provide sufficient feed-back (c) to maintain oscillation, which is then controlled in frequency by the rod. Holding the rod will stop oscillation completely, which will restart on releasing it. The field as produced by the D.C. governs this type of feed-back also. The relation between the change in dimension of a magneto-strictive material and the applied field is shown in Fig. 5. Again a differentiation gives the amplitude of oscillation of the rod which provides this feed-back (Fig. 6). The dotted region is unstable.

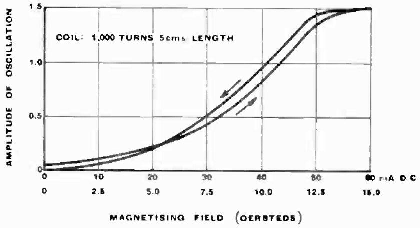

Fig. 4.

Both these feed-back effects are present when the rod is in oscillation and the resulting amplitude is due to the combination of Figs. 4 and 6, viz., Fig. 7.

At low values of H, holding the rod completely stops the oscillation, as when this feed-back is removed the remaining energy transfer is not sufficient to maintain it. At higher values the same thing merely reduces the amplitude, since the feed-back illustrated in Fig. 4 is now sufficient by itself.

The above adjustment of the condenser makes it a little greater than that required to tune the circuit to the resonant frequency of the rod. Owing to the damping the tuning is sufficiently flat to enable the rod to pull it in. If the capacitance is reduced the amplitude is increased and the two settings of R for uncontrolled oscillation ceasing and rod oscillations commencing merge into one as the circuit comes more into tune with the rod. Holding the rod then again only reduces the oscillations to that caused by the other feed-backs.

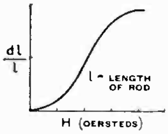

Fig. 5.

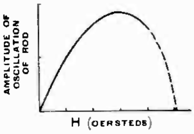

Fig. 6.

On the other hand if the capacitance is increased, the amplitude falls as the circuit becomes more off tune and a greater magneto-strictive effect is required before oscillations commence. In addition there are secondary effects caused by the changes of self-inductance of the coils by the field strength.

A series of curves for different capacitances obtained experimentally is shown in Fig. 8. In each case the value of R was adjusted for maximum amplitude of controlled oscillation. The rod and coil were mounted horizontally in an East–West direction to eliminate effects of the earth's field.

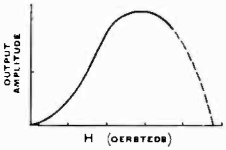

Fig. 7.

Examination of these curves shows the derivation of the extreme sensitivity to external fields. If conditions are made, for example, such that, when the rod is pointing so that the D.C. field is in opposition to the resultant of the earth's field, we are working at a point *A*; then a change of field of 0.93 oersted caused by rotating the assembly through 180 deg. in the plane of the field will cause the working point to move to *B*, thus increasing the amplitude some seven times.

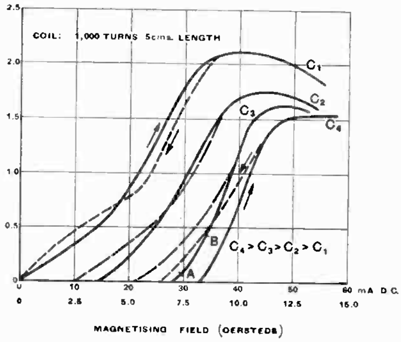

Fig. 8.

This change may be amplified up to any amount since the "zero" level can be made very small.

Frequency Stability

When controlled by the rod at a constant temperature the stability of the oscillator for variations of tuning of the electrical circuit is at the most ± 2 c/s in 13 kc/s, or less than 0.03 per cent. The effect of change of supply voltage is negligible over a large range and the maximum rate of change of frequency of the whole apparatus is less than 1/1000 cycle per second per second.

Change of magnetising field affects the frequency to a small amount, an increase of approximately 4 oersted corresponding to an increase of frequency of 2 c/s.

Rise in temperature of the rod lowers the frequency at a rate of about 1 c/s per degree centigrade.

Finally the frequency is controlled over a range of about ± 5 c/s by the exact centring of the clamping knife-edges and by the pressure applied there. Increasing this pressure raises the frequency. As a frequency standard it is better to mount the centre of the rod in sorbo rubber and allow it to oscillate freely.

There is apparently no difference in the stability of the apparatus when the magnetostrictive effect is entirely controlling the oscillation or when the rod is only controlling existing oscillations caused by the other feed-back effects.

Materials of different composition can be found which have an even greater stabilising effect and different temperature coefficients, but in general these requirements are conflicting. A table of these coefficients for a large number of alloys is given in the work referred to at the beginning. It is suggested there that for more accurate temperature control, a tube of material with a negative coefficient may be fitted with a concentric tight-fitting cylinder of a material with a positive coefficient.

WIRE BROADCASTING

ALL the principal methods of re-distributing broadcast programmes by means of metallic conductors were dealt with by Dr. T. Walmsley, of the G.P.O., in a paper entitled "Wire Broadcasting Investigations at Audio and Carrier Frequencies," read before the Wireless Section of the I.E.E. on March 6th. With regard to radio-frequency methods, the use of telephone lines was discussed exhaustively; distribution over the electric supply mains was dealt with more briefly. The discussion that followed was chiefly on the relative advantages of these two methods.

APRIL MEETINGS

TWO papers published by the Institution of Electrical Engineers during the period when there were no meetings are to be read at the request of members at the Wireless Section meeting at Savoy Place, Victoria Embankment, London, W.C.2, on Wednesday, April 3rd, at 6.0 p.m. The papers are "Reflection Curves and Propagation Characteristics of Radio Waves Along the Earth's Surface," by Dr. J. S. McPetrie and Miss A. C. Stickland, and "An Experimental Investigation of the Propagation of Radiation having Wavelengths of Two and Three Metres," by Dr. McPetrie and Mr. J. A. Saxton. A paper by Dr. R. L. Smith-Rose and Mr. H. G. Hopkins on "Radio-Direction-Finding on Wavelengths Between 2 and 3 Metres (100–150 Mc/s)" will also be read.

At the Section's informal meeting to be held at 6 p.m. on Wednesday, April 23rd, Mr. P. R. Coursey will open the discussion on "Wartime Standardisation."

Mr. P. G. A. H. Voigt will open the discussion on "Electro-Acoustics in Practice" at the I.E.E. informal meeting at 6.0 p.m. on Monday, April 1st.

Professor D. R. Hartree, of the University of Manchester, will give a lecture on "Wave Mechanics" at a meeting of the Institution of Electronics to be held at 6.0 p.m. on Thursday, April 4th, at the Royal Society of Arts, John Street, Adelphi, London, W.C.2. Tickets of admission are obtainable from the secretary, Mr. Alexander H. Hayes, 27, Fetter Lane, London, E.C.4.

Single-Valve Time-Base Circuit*

Adaptable for Saw-Tooth or Rectangular Waveforms

By B. C. Fleming-Williams

(Queen Mary College, University of London)

Introduction

A GREAT many forms of oscillator are known which will produce a saw-toothed waveform, such as is required for the time-base of a cathode-ray oscillograph, but all of them suffer from certain disadvantages. In choosing one for any particular purpose the various defects have to be considered in the light of one's requirements. Thus the Thyratron circuit, though basically simple, will not operate at high frequencies, this is particularly true where large amplitudes are required, and there is often difficulty in synchronisation especially as the Thyratron grid loads the associated circuit quite appreciably. Various forms of " Kipp " circuit often require a separate synchronising valve, and even without this they will not operate at high frequencies unless extreme care is taken with the wiring ; they sometimes burst into spurious oscillation, and because of their complexity they are bulky, expensive, and apt to fail in service.

The circuit to be described here is a simple one, only employing one hard valve, it will operate at high frequencies and is extremely easy to synchronise. Furthermore, as a time-base the velocity of both the forward and return strokes may be controlled, and without modification the circuit may be used to produce either saw-tooth or rectangular waveforms.

The Basic Circuit

The normal type of H.F. pentode has been found the most satisfactory for use in this circuit (valves of the multi-grid " mixer " type have been used but are not so good for the purpose).

Let us consider the circuit shown in Fig. 1. For simplicity suppose that the valve is already oscillating, and let us break into the cycle of operations at some convenient point, and then follow it through.

Suppose that initially there is no voltage across C_1, and that G_3 (the third grid from the cathode, i.e. the suppressor) is biased negative, so that all the current is passing from the cathode to G_2. Under these circumstances C_1 will charge up through R_1 carrying the anode up positive. Simultaneously C_2 will start to discharge through R_3, so that G_3 will also go positive. We will call this the charging portion of the cycle.

As a result of this a time will come when the anode will draw electrons through G_3, and thus take current. In doing so the anode will " rob " G_2 of some of the current flowing to it from the cathode, so that the potential of G_2 will rise, and as this grid is coupled to G_3 through a condenser, G_3 will also go positive thus further increasing the proportion of the cathode current taken by the anode. This action is cumulative, and in an extremely short time a new equilibrium is reached in which C_1 is being discharged through the valve, and G_3 is becoming less positive due to grid-current. The voltage on G_2 is again constant but at a new equilibrium value. This may be called the discharge portion of the cycle.

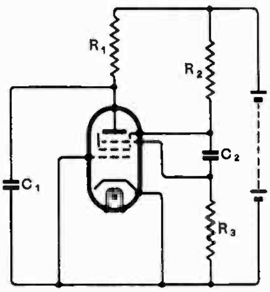

Fig. 1.

Once C_1 is nearly discharged, current to the anode must become reduced, and a greater proportion of the electron current pass to G_2 which in consequence becomes less positive, and in doing so drives G_3 negative, which in turn reduces the anode current further, and so on. This cumulative

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* MS. accepted by the Editor, February, 1940.

action continues until in a very short time anode current ceases, and the circuit reaches the condition in which we broke in to the cycle.

Thus we have a valve circuit in which the anode voltage alternately increases and decreases (in a linear manner if R_1 is a constant current device) and at the same time the voltage on the screening grid jumps between two equilibrium values.

It might be thought that the anode current during the discharge time would be slightly less than the current to G_2 during the remainder of the cycle, but that is not so. When the anode current starts the potential of G_2 rises, and this increases the electron current leaving the cathode, and thus the discharge time is decreased. If the H.T. voltage is large with respect to the 15 or 20 volts required on G_2, R_2 can be considered as a constant current device. Then when anode current starts, the potential of G_2 will rise by that amount necessary to keep the electron current to the second grid constant. With a Cossor MS Pen used by the author, under certain conditions the cathode current rose from 3 mA during the charging time, to a total of 14 mA during discharge.

The Circuit in Practice

A typical set of circuit values is shown in Fig. 2, these are suitable for frequencies of the order of 100 c/s.

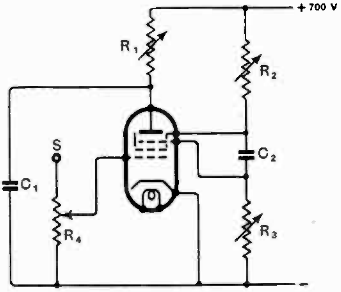

Fig. 2.—*Circuit values for frequencies of the order of* 100 *c/s.* R_1, 0.2 *to* 2 *megohms*: R_2, 0.05 *to* 0.5 *megohm*; R_3, 0 *to* 0.25 *megohm*; R_4, 0.05 *megohm*; C_1, 0.1 μF; C_2, 1.0 μF.

It will be seen that G_1 is tapped from a potential divider, if a negative pulse is applied to the point *S* in the circuit just before the valve is in a condition to discharge C_1 (i.e. near the end of the charging time), the current to G_2 will be momentarily reduced, sending G_2 and G_3 positive. This will start anode current and initiate discharge conditions. In this way the oscillator may be synchronised to a signal applied to *S*. It will be found in practice that there are definite advantages in having a separate electrode to which synchronising signals may be applied. Because of the high mutual conductance of the modern H.F. Pentode, very small synchronising potentials are required, and synchronisation is very easy to attain.

It may be seen from the circuit diagram that R_1, R_3, C_1, and C_2 together determine the amplitude and frequency of oscillation, while R_2 mainly determines the ratio of charging to discharging time, and thus in a normal time-base equipment may have a fixed value.

An examination of the operating voltages of the circuit by means of a cathode-ray oscillograph showed the following typical set of results.

Mean value of current in the anode resistor R_1 = 0.5 mA

Mean value of current to G_2 = 1.5 mA

Ratio charge/discharge time = 8.3

Voltage on anode = 0 to 52 volts saw-tooth waveform

Voltage on G_2 = 21 to 43 volts rectangular waveform

Voltage on G_3 = − 6 during the charging time; + 17.5 during the discharging time.

These conditions are illustrated in Fig. 3(a).

When the values of R_1 and R_2 were modified until the anode current was 2 mA and the G_2 current 1.25 mA, the charging and discharging times became equal, so that the voltage on G_2 was of square waveform as may be seen in Fig. 3(b).

A full analysis of this circuit has not been made, either practically or theoretically, but the full details of its operation appear to be very complex. It is immediately obvious that the voltage of G_3 must drift towards zero during the charging portion of the cycle. The extent of this drift may be calculated. The frequency of oscillation may be found from the above data to be 100 c/s and since R_3 was about a tenth of a megohm, we find that the voltage of G_3 must have drifted about 0.5 per cycle. During the discharge time the voltage on G_3 is about 17.5 volts positive, so that the current flow in R_3 must then be reversed. Calculation shows that nearly half the charge necessary to maintain the negative bias on G_3 is obtained from this current reversal in R_3, the remainder presumably being supplied by the grid current in the valve. Experiment has shown that in a pentode of this type, electron current to G_3 is quite small unless the positive voltage on this grid is nearly equal to, or greater than, the anode voltage. Thus it seems probable that any grid current there is only flows at the end of the discharge period, when the anode voltage approaches zero.

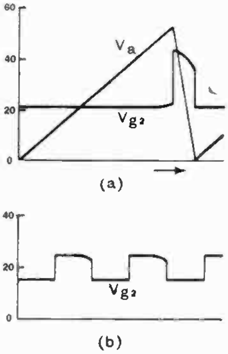

Fig. 3.

A possible disadvantage of this circuit is that if large frequency changes are to be made, then both C_1 and C_2 must be altered, but with the modern wafer-type switch this is not a very difficult matter.

By reducing C_1 and C_2, this circuit was without difficulty made to operate at a frequency of 100 kc/s, and at this frequency the oscillator was still found to be easy to synchronise. No attempt was made to exceed this frequency, but if care were to be taken with the wiring, very high frequencies could no doubt be attained.

Conclusion

We have here a single-valve time-base circuit which is very nearly as simple as the conventional Thyratron circuit, but which has all the advantages of a hard valve circuit. It is very readily synchronised, and has an easily controlled fly-back time.

By making connection to the second grid of the valve instead of to the anode, a voltage of rectangular waveform may be obtained.

Note Added to Proof

It has been pointed out to the author that a potential having a better rectangular waveform may be obtained across a resistance in the cathode circuit.

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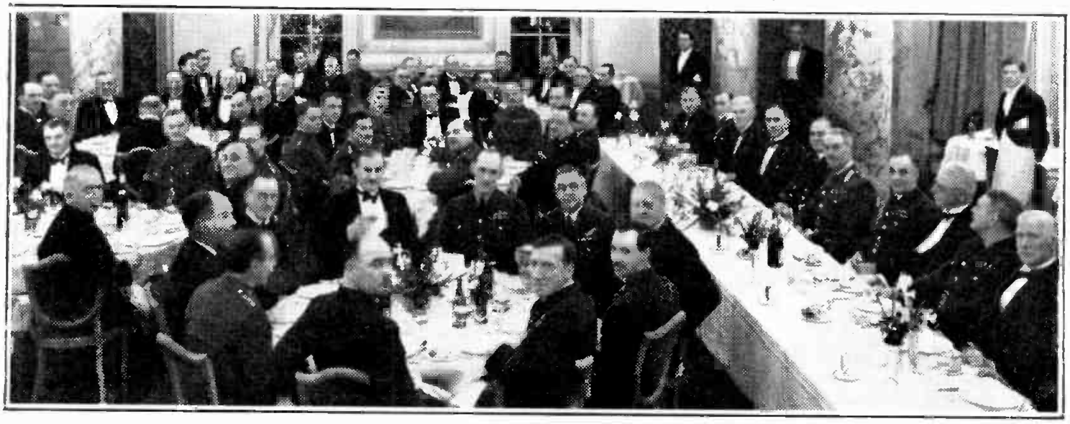

At the Waldorf Hotel, London, on February 17th, the eighteenth annual dinner of the British Wireless Dinner Club was held, and this picture shows part of the company. Membership of the club is open to past and present wireless officers of the Services and civilian wireless personnel holding responsible positions. The attendance was fully up to the peace-time average.

Correspondence

Letters of technical interest are always welcome. In publishing such communications the Editors do not necessarily endorse any technical or general statements which they may contain

Two-way Radio-Telephony

To the Editor, The Wireless Engineer

SIR,—In my article, under the above heading, in the March issue of this journal, it was shown that the voltage amplitude, at F and H, of the self-oscillation which may arise in the new terminal circuit, is given by $V'_F = \frac{\delta_C}{\alpha_C \beta 2h}$, and by $V'_H = \frac{\delta_D}{\alpha_D \beta 2h}$ (see eq. 26). It was also shown that if "singing" occurs, it disappears as soon as super-audible voltages are impressed upon the system at E and G, provided the amplitudes of these voltages are at least equal to $\frac{\delta_D k_{HE}}{\alpha_D \beta 2h}$, and to $\frac{\delta_C k_{FG}}{\alpha_C \beta 2h}$, respectively (see eq. 27, and the end of Section IV). Any "singing" may also be suppressed, in a simple manner, by introducing amplitude filters into the links FG and HE of the transmission system, suppressing voltages of amplitude less or equal to V'_F and V'_H, and allowing the passage of voltages of amplitude greater than the above voltage limits.

Such amplitude filters may be constructed, most simply, by using two Westectors arranged as for full-wave rectification.

The current-voltage characteristic curve of an ideal amplitude-filter is shown in Fig. 1.

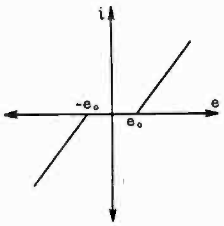

Fig. 1.

If E is the amplitude of the voltage impressed upon such a filter system, and if $e_o/E \ll 1$, the harmonic distortion coefficient of the resulting current is given by $k_h = \left(2 - \frac{16}{\pi^2}\right)^{1/2} \frac{e_o}{E} \sim \frac{1}{2}\frac{e_o}{E}$, as may easily be shown. Fig. 2 shows the position of the amplitude filters (AF) in the transmission system.

Supposing an e.m.f. e_D is impressed at D, and let e_{1D} and e_{2D} be the lower and upper values of this e.m.f., corresponding to the minimum and maximum intensities of sound in the subscriber's voice, the voltage at H (input to amplitude filter) will be $E = V_H = \alpha_2 e_D$ (see eq. 23). If k_h is the maximum harmonic distortion coefficient which we can tolerate during transmission, we must have

$$k_h = \frac{1}{2}\frac{e_{oD}}{\alpha_2 e_{1D}} \quad \ldots \quad \ldots \quad \ldots \quad (1)$$

e_{oD} being the lower voltage limit of the filter at terminal T_D. But, for suppressing of "singing," we must also have:

$$e_{oD} = V'_H = \frac{\delta_D}{\alpha_D \beta 2h} = \frac{\delta_D \alpha_2}{\alpha_D \beta h_D} \quad \ldots \quad \ldots \quad (2)$$

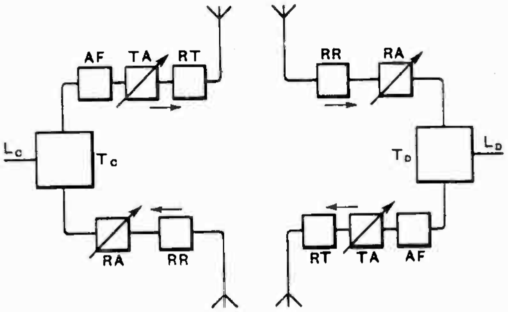

Fig. 2.

Eliminating e_{oD} between (1) and (2):

$$k_h = \frac{1}{2}\frac{\delta_D}{\alpha_D \beta h_D e_{1D}} \quad \ldots \quad \ldots \quad \ldots \quad (3)$$

Further, at the reception point C, there will be amplitude distortion, due to the feed-back network, the value of which is $h_c V_c$ (see Section III(d). But $V_C = g_{DC} \cdot e_D$, and if k_a is the maximum amplitude distortion coefficient which we can tolerate during transmission, we may write:

$$h_C V_C = h_C g_{DC} \cdot e_{2D} = k_a \quad \ldots \quad \ldots \quad (4)$$

If $h_C = h_D$, the elimination of h_C in (3) and (4) gives:

$$g_{DC} = 2\alpha_D \beta k_h k_a \frac{e_{1D}}{e_{2D}} \cdot \frac{1}{\delta_D} \quad \ldots \quad \ldots \quad (5)$$

Comparing this with the gain g' given by the conventional systems (hybrid-coil balancing-network), where:

$$\lambda = \delta_C \delta_D g'_{DC} g'_{CD} < 1 \text{ (see end of Section III)}$$

if:

$$\delta_C \sim \delta_D = \delta, \; g'_{DC} = g'_{CD} = g':$$

$$g' < \frac{1}{\delta}; \; \therefore g' = \frac{\epsilon}{\delta}. \; (\epsilon < 1)$$

we obtain

$$\frac{g}{g'} = 2\alpha\beta \frac{k_h k_a}{\epsilon} \cdot \frac{e_{1D}}{e_{2D}}.$$

Finally, let

$$k_h = 5\%; \; k_a = 10\%; \; e_{1D}/e_{2D} = 10^{-1};$$

$$\alpha\beta = 10^5; \; \epsilon = 1/2 \; \therefore \frac{g}{g'} = 2.10^2$$

This means that with the new "terminal," and in the particular case taken as an example, we can increase the gain 23 db. beyond the gain obtained with conventional systems, without impairing the transmission quality.

M. G. Marinesco.

Bucharest, Rumania.

Valve Circuit Conventions

To the Editor, The Wireless Engineer

Sir,—Although I have for a good many years used the standard valve equations (such as you quote from Mallett's "Telegraphy and Telephony") I do not feel guilty of any disloyalty to Ohm's law; for the use of these forms can be logically and consistently based on the following premises :—

(1) It is an accepted convention that, in the absence of any specific statement, the cathode of a valve is considered to be at zero potential, and the potentials of other points are measured from it.

(2) In order to line up A.C. and D.C. working, vectors shall be so arranged that a positive instantaneous value of anode- or grid-voltage vector shall actually mean that the relevant potential is then positive with respect to the cathode.

If one takes the circuit of Fig. 1 for a diode there is no difficulty in writing

$$V_a = E_a - ZI_a = R_aI_a \quad \ldots \quad \ldots \quad (1)$$

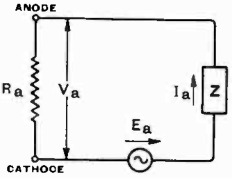

Fig. 1.

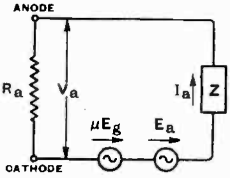

Fig. 2.

But by definition of amplification factor, μ, a triode behaves as though an additional voltage μE_g were added in series with the anode voltage, as shown in Fig. 2. (The relative sense of E_a and μE_g is determined by clause (2) above, μ being a positive quantity.) We then have

$$R_aI_a = E_a + \mu E_g - ZI_a \quad \ldots \quad \ldots \quad (2)$$

or in the particular case when $E_a = 0$,

$$R_aI_a - \mu E_g = V_a = -ZI_a \quad \ldots \quad \ldots \quad (3)$$

The difficulty seems to arise in deciding whereabouts in the circuit to place the fictitious generator μE_g; one's instinct is to place it between R_a and either the anode or cathode terminal, but I do not think the definition of μ demands this.

Future generations may work in terms of anode and mutual conductances, and will then debate whether the current flows through valve and load in series or in parallel; but while we use resistance and amplification factor, the generally-used conventions can be presented in consistent form, and do not demand the sacrifice which you seem prepared to make, of giving D.C. components the opposite sign to that of instantaneous values of A.C. vectors of similar polarity.

D. A. Bell.

Great Baddow, Chelmsford.

We emphasised that it is a matter of convention. As our correspondent says, one's instinct is to place the source of the alternating e.m.f. inside the valve, and as we said in the Editorial, one cannot pretend that the source of the A.C. power is inside the valve without paying the penalty somewhere. If one turns a deaf ear to the voice of instinct, one can assume that the p.d. E_g applied to the grid causes an e.m.f. μE_g to be induced somewhere in the external circuit, as our correspondent says. This is not, however, what is done in Terman's "Fundamentals of Radio" which I quoted, for he says "by postulating that the plate circuit can be replaced by an equivalent generator of voltage $-\mu e_s$ acting from cathode towards the plate and having an internal resistance equal to the plate resistance *Rp*." He thus follows instinct and pays the penalty by "cooking" the signs. Our correspondent's equation (3) shows signs of "disloyalty to Ohm's law."

His equation (1) is correct, viz.

$$V_a = E_a - ZI_a = R_aI_a$$

If one replaces E_a by μE_g as he does, one obtains

$$V_a = \mu E_g - ZI_a = R_aI_a$$

$$\text{or} \quad R_aI_a - \mu E_g = -ZI_a$$

$= V_a - \mu E_g$ and not V_a, unless in Fig. 2 he makes V_a include both R_a and the generator of μE_g.

The Editors.

The Industry

STANDARD TELEPHONES AND CABLES, LTD., Oakleigh Road, New Southgate, London, N.11, have issued a leaflet describing their Type R.502 wavemeter. This is a workshop and laboratory instrument of the absorption type with a diode rectifier as indicator. The range covered is 6.5 to 3,000 metres and the accuracy is better than 0.15 per cent. A single dry cell supplies the filament current.

An inexpensive beat frequency oscillator (Type TF602) has been developed by Marconi Ekco Instruments, Ltd., Knoll Cottage, Gills Hill, Radlett, Herts. The frequency range is 50–12,000 c/s and the power output 300 mW into 600 or 5,000 ohms. Another recent product is the Type TF620 A.F. Microvolter which is essentially an attenuator monitored by a rectifier type voltmeter. The range is 1 μV to 1 V and the voltage ratios are accurate to ± 2 per cent. above 10 μV.

A number of new receiving valves have been added to the Osram and Marconiphone lists. These include a range of 1.4 valves for "all-dry" battery sets comprising the X14 heptode frequency charger, Z14 R.F. pentode, HD14 double-diode-triode and N14 pentode output valves.

For A.C./D.C. sets a new tetrode valve, the KT35, has been introduced. The anode dissipation has been limited to 10 watts and the available output is 4.3 watts. The heater is centre tapped and may be used in 13- or 25-volt circuits.

An improved mercury vapour rectifier, the GU50, now replaces the Osram GU5. The characteristics are similar to those of the latter valve, i.e. max. current with delayed switching 250 mA and permissible input 1,500 volts R.M.S., but greater reliability is claimed at the maximum rating.

Abstracts and References

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For the information of new readers it is pointed out that the length of an abstract is generally no indication of the importance of the work concerned. An important paper in English, in a journal likely to be readily accessible, may be dealt with by a square-bracketed addition to the title, while a paper of similar importance in German or Russian may be given a long abstract. In addition to these factors of difficulty of language and accessibility, the nature of the work has, of course, a great influence on the useful length of its abstract.

PROPAGATION OF WAVES

1301. ULTRA-SHORT WAVES IN CONCENTRIC CABLES, AND THE "HOLLOW-SPACE" RESONATORS IN THE FORM OF A CYLINDER WITH PERFORATED-DISC ENDS.—H. Buchholz. (*Hochf:tech. u. Elek:akus.*, Nov. 1939, Vol. 54, No. 5, pp. 161–173.)

For previous work *see* 2629 of 1939. The wave-guide research of Barrow & others has been limited to truly "hollow" guides without any central conductor, but it is a mistake to assume from this that similar phenomena cannot occur in the ordinary type of concentric cable. In the present paper the laws governing the radiation from axially-symmetrical emitters ("ring emitters") of electromagnetic waves along the hollow space within a concentric cable are derived from first principles and discussed in §§ I–IV. Fig. 1 shows the position of the ring emitter and the concentric cable. The three fundamental forms of ring emitter, comprising (1) tangential, (2) radial, (3) axially-directed dipoles, are described mathematically in § II. Hyper-frequency waves with a transverse magnetic vector (§ III) may be produced by a ring emitter of tangential magnetic dipoles or of radial or axially-directed electric dipoles. The waves produced by these various types are worked out; a quantitative connection between their excitation intensities is derived (§ III, 4). It is found that "with a single exception, the principal wave of a concentric cable is included in the radiation field of this group of emitters, along with the ultra-short waves properly so-called. The concentric cable thus has the character of an all-pass filter for this wave type." The greatest critical wavelength for the occurrence of a typical ultra-short wave is shown in Fig. 4 as a function of the ratio of the radii of the internal and external conductors. The production of ultra-short waves with a transverse electric vector (§ IV) is discussed in a similar way; the fundamental form of the emitter is a circular ring of electrical dipoles. In this case it is found that "a principal wave [of the concentric cable] is never found in the radiation field of these emitters. The losses sustained by these waves in the case of finite conductivity of the internal and external conductors have for each of the overtones the property that they decrease to zero as $\omega^{-3/2}$ with varying frequency."

The wave field in a hollow resonator in the form of a squat cylinder with perforated ends is worked out in § V. The analytical expression for the wave field and the relations for the various resonant frequencies are derived for the transverse magnetic and electric fields respectively.

1302. CONCENTRIC CABLES WITH LONGITUDINALLY STRATIFIED DIELECTRIC AS BAND-STOP FILTERS IN THE *m* WAVE RANGE AND BELOW.—H. Buchholz. (*E.N.T.*, Oct. 1939, Vol. 16, No. 10, pp. 258–273.)

The cables considered are shown schematically in Fig. 1; the longitudinal stratification occurs in practice in cases where ring-shaped discs at equal intervals are used to hold the internal conductor in place mechanically. Their effect on transmission becomes noticeable at the short television wavelengths. The conductivity of the two metallic conductors is here regarded as perfect. As the wavelength decreases, it is possible for other wave-types besides the principal wave here considered to occur (*see* above abstract); there is however no practical error in neglecting them with the present dimensions of concentric cables and principal wavelength. The general solution is given in § 2; in § 3 this is specialised to the case of a cable with given initial voltage, terminated by a known impedance. The physical meaning of the auxiliary parameters introduced in the solution is discussed in § 4, the special case of the cable with greatest attenuation in the stop region in § 5, the behaviour of the voltage in § 6, that of the input impedance in § 7, and the effect of attenuation in § 8. It is found that "the cable has an infinite series of frequency bands in which it behaves as a filter in the stop region. The position and width of these stop bands in the frequency scale, and their attenuation properties, can be altered considerably.

"By choosing a suitable terminal impedance, a cable with longitudinally stratified dielectric can be made to behave, within the separate pass bands, like a homogeneous cable. Thus the reflected wave can be suppressed and the input impedance made equal to the terminal impedance. The magnitudes typical of a longitudinally stratified cable are the transmission equivalent and the two principal wave impedances. All three quantities depend on the geometrical and electrical constants of a single element of the cable. Their frequency variation is shown in numerous diagrams. The phase and group velocities and the attenuation due to dielectric losses in the material of the disc are also investigated."

1303. The Scattering of Radio Waves in the Lower and Middle Atmosphere [B- & C-Region Reflections Very Weak, and due to Scattering Patches rather than Reflecting Strata: etc.].—J. H. Piddington. (*Proc. Inst. Rad. Eng.*, Dec. 1939, Vol. 27, No. 12, pp. 753–757.)

For previous papers *see* Appleton & Piddington, 1745 of 1938, and Piddington, 2638 of 1939. All B-region echoes probably originate within troposphere, even when semi-paths as great as 20–25 km are indicated: water vapour molecules the agency rather than electrons or heavy ions. C region (ionisation perhaps due to same agency as sudden E-region patches) may coincide with lower slope of temperature maximum of middle atmosphere.

1304. Analysis of the Effect of Scattering in Radio Transmissions [Later Investigations by Pulses from High-Power Stations establish Scattering as Major Factor in Practically All Transmissions: Short E, 1F & 2F Types: Structure of E Layer: etc.].—T. L. Eckersley. (*Electrician*, 9th Feb. 1940, Vol. 124, p. 106.) Summary of I.E.E. paper.

1305. Wave Reflections from Diffuse Boundaries [where Dielectric Constant inside Reflection Layer varies as Some Power of Distance: Fresnel's Equations applicable to Layers of Considerable Thickness if Refractive Index is Very Close to Unity: Theory].—C. D. Thomas & R. C. Colwell. (*Phys. Review*, 15th Dec. 1939, Series 2, Vol. 56, No. 12, pp. 1214–1216.)

1306. A Table of Fresnel Reflection [applicable to Many Problems, including Scattering of Light by Fog].—P. Moon. (*Journ. of Math. & Phys. of M.I.T.*, Jan. 1940, Vol. 19, No. 1, pp. 1–33.)

1307. Application of Abelian Finite Group Theory to Electromagnetic Refraction [Definition of Abelian Group: Use of Double Subscripts: Refraction at Plane Surface: in Kennelly-Heaviside Layer (Point of Total Reflection Not Necessarily at Region of Max. Electron Density): Electronic Refraction (Comparison of Properties of Thin Electrostatic and Thin Glass Lenses): Simple Equation determines Applicability].—R. A. Whiteman. (*RCA Review*, Jan. 1940, Vol. 4, No. 3, pp. 372–380.)

1308. Reciprocity and the Generalised Concept of the Transducer in Radio Links.—G. Latmiral. (*Alta Frequenza*, Dec. 1939, Vol. 8, No. 12, pp. 755–788.)

Author's summary:—"The generalised concept of the transducer is little used in the study of wireless links; this situation is to a large degree due to the belief that the theorem of reciprocity has narrow limits of application, and to the doubt whether, even when these limits are respected, at any rate apparently, it may not often fail—belief and doubt which are in reality unfounded.

"It is shown that the reciprocity theorem is strictly valid not only if ϵ, μ, and γ are scalar quantities but also if they are symmetrical homographs (dilatations); this extenson may be of some interest in the optical field. In the case of links depending on ionospheric propagation, the reciprocity theorem is not strictly valid. But when applied to values averaged over a period of time (thus taking into account the instability of the ionosphere) it must still be valid, provided that ϵ, μ, and γ are [linear] homographs and that the wavelengths considered are well below 214 m. Experiments carried out between Rome and Italian East Africa confirm this thesis.

"Applying the generalised concept of the transducer, it is shown finally that it does not necessarily follow from reciprocity that the efficiency of a wireless link should remain unaltered on interchanging transmitter and receiver. An imperfect realisation of this fact has perhaps sometimes led to the view that experimental results have been inconsistent with reciprocity, whereas in reality they have agreed with it."

1309. The Ionosphere [Comprehensive Survey of Researches, up to the URSI Venice Assembly of 1938].—Q. Majorana. (*Nuovo Cimento*, Nov. 1939, Year 16, No. 9, pp. 459–487.)

1310. Report on the Activity of the "G. Marconi" Radioelectric Centre during the Year 1938 [particularly the Researches on Ionosphere and Aerials].—A. Bottini. (*Boll. del Centro Volpi di Elett.*, English Edition, April/May/June 1939, Year 2, No. 2, Abstracts p. 209d.)

1311. Symmetrical Electromagnetic Propagation in Relation to an Axis [in Medium where Electric & Magnetic Properties are expressed by Constant Elements: Problem reduced to Integration of Three Differential Equations of Second Order: etc.].—C. Agostinelli. (*Boll. del Centro Volpi di Elett.*, English Edition, April/May/June 1939, Year 2, No. 2, Abstracts p. 219d.) For previous work *see* 3460 & 3474 of 1939. *Cf.* also Manarini, 1312, below.

1312. On the Motion of an Electrified Corpuscle in the Presence of a Magnetic Dipole [Maupertuis Mass constant during Motion, so Classical-Mechanics Results are maintained Qualitatively in Relativity: Prime Integral of Agostinelli's Equations].—M. Manarini. (*Boll. del Centro Volpi di Elett.*, English Edition, April/May/June 1939. Year 2, No. 2, Abstracts p. 219d.) *See* Agostinelli, 3460 of 1939: *also* Baños & others, 1340, below.

1313. On the Spreading of Auroral Disturbance in the Ionosphere and the Resulting Latitude Effect.—Beckmann, Menzel, & Vilbig. (*T.F.T.*, Dec. 1939, Vol. 28, No. 12, pp. 425–427.)

It was mentioned in the newspapers at the time that the submarine attack of 13th October on the British warships in Scapa Flow occurred by the light of a strong auroral display. This was invisible in Germany, but in accordance with previous observations (*e.g.* 400 of 1938) the resulting ionospheric disturbance had its effect on the ionosphere over Legefeld, near Weimar (50° 56′ N compared with the 58° N of Scapa Flow). The record strip of Fig. 2 shows that till 19.45 on the evening of the 13th the run was normal; at that moment a spontaneous rise of the F layer occurred, to nearly twice its previous height. At 20.10 the "auroral layer" (arrow) became visible above the F layer and remained till about 1.00, while the normal F layer died away at about 21.30. In the course of the night hardly any reflections occurred. Sunrise on 14th Oct. was at 6.22, but Fig. 3 shows that the daylight layer first appeared much later, at about 7.30, and at a far higher level than usual. "This also is a frequent after-effect of an auroral disturbance." Short-wave reception at Beelitz was strongly disturbed on the evening of the 13th and the following night. The magnetic record at Potsdam showed a medium-strength magnetic storm (Fig. 4).

These ionospheric disturbances at latitudes where the aurora is not visible are due either to an ionising radiation reaching such latitudes as well, or else to a migration to lower latitudes of space charges (ion clouds) originating in discharge processes in the polar regions. In this way a latitude effect is produced, as illustrated in Fig. 5, where a Legefeld record is undisturbed while that of Kühlungsborn (more northerly) is highly disturbed. The latter record also illustrates the fact that these auroral disturbances affect chiefly the F_2 layer (whose origin is still not fully explained) while the E and F_1 layers, due to ultra-violet radiation, remain undisturbed and apparently screen the earth from the effects of the alteration of charges, since the simultaneous magnetic disturbance is comparatively slight: it seems also to occur only (or chiefly) at the time of formation of the "auroral layer." The effect of the asymmetrical spreading of the disturbances from the polar regions, in producing different local conditions in the ionosphere and consequent fadings, d.f. errors through lateral deviation, etc., is mentioned.

1314. Excitation of the Green Auroral Line of Oxygen [with Discharge Tubes containing Mixtures of Argon and Oxygen: Consideration of Collision Processes].—Emeleus, Sloane, & Cathcart. (*Proc. Phys. Soc.*, 1st Nov. 1939, Vol. 51, Part 6, No. 288, pp. 978–988.)

1315. Photometric Study of the Ultra-Violet Absorption Spectrum of Gaseous Nitrogen Protoxide between the Temperatures + 20°C and − 90°C.—J. Nicolle & B. Vodar. (*Comptes Rendus*, 22nd Jan. 1940, Vol. 210, No. 4, pp. 142–144.)

1316. The Light of the Night Sky [Survey, with 88 Literature References].—G. Frongia. (*Nuovo Cimento*, July 1939, Vol. 16, No. 7, pp. 360–387.)

1317. Absorption of Hydrogen Lyman Radiation [Line 1215.7 A.U.] by Atmospheric Gases [Results of Measurements: if this Emission is responsible for Short-Wave Radio Fade-Outs, It will Penetrate to about 80 km before It is Absorbed in producing Ionisation].—S. E. Williams. (*Nature*, 13th Jan. 1940, Vol. 145, p. 68.)

1318. The Origin of Terrestrial Magnetism [Two Fields, One due to Ferromagnetism of Rocks and the Other to Rotation of Earth in External Field with Lines of Force sensibly Normal to Ecliptic Plane, due fundamentally to Solar Activity].—A. Dauvillier. (*Comptes Rendus*, 29th Jan. 1940, Vol. 210, No. 5, pp. 177–179.)

1319. Big Sunspots [observed during Early January].—(*Nature*, 13th Jan. 1940, Vol. 145, p. 66.)

1320. Photogrammetric Measurements of the Height of Nacreous Clouds.—C. Störmer. (*Comptes Rendus*, 29th Jan. 1940, Vol. 210, No. 5, pp. 179–181.)

1321. Solar Radiation and the Weather [Abbot's Deductions freed from Accusation of being based on Statistical Errors].—T. E. Sterne: Abbot. (*Science*, 8th Dec. 1939, Vol. 90, Supp. p. 10.) *See* also 482 of February.

1322. Electromagnetic Waves and Meteorological Phenomena [and the Usefulness of Propagation Observations for Weather Forecasting].—R. Basili. (*Boll. del Centro Volpi di Elett.*, English Edition, April/May/June 1939, Year 2, No. 2, Abstracts p. 221d.)

1323. Does a Surface Wave exist? A Question of Nomenclature: Suggestions to prevent Confusion.—P. David. (*Rev. Gén. de l'Élec.*, 9th/16th Dec. 1939, Vol. 46, No. 23/24, p. 510.)

In his survey (2251 of 1939) David mentioned a divergence of views between Sommerfeld and Norton & Burrows on the existence of a surface wave. Burrows writes to point out that the divergence is due chiefly to the fact that what Norton calls "surface wave" is exactly what Sommerfeld calls "space wave." Burrows's results support the view that Sommerfeld's "surface wave" was due to an error in sign in his calculations, and has no actual existence: moreover, "an unpublished work of Schelkunoff has shown that a single surface separating two media, such as earth and air, cannot act as a support for a guided wave." But Norton proposes to keep the term to represent the component introduced by diffraction round the earth. David now suggests a nomenclature, to avoid this and other sources of confusion, using the following terms, each of which he defines: direct wave, ground-reflected wave, diffracted wave (Norton's "surface wave"), tropospheric wave, and ionospheric wave. For papers by Norton *see* 834 of 1938 and back references.

1324. THE INFLUENCE OF THE RADIO-GEOLOGICAL PROPERTIES OF THE SUBSOIL ON THE PROPAGATION OF ELECTROMAGNETIC WAVES.—V. Fritsch. (*T.F.T.*, Dec. 1939, Vol. 28, No. 12, pp. 427–433.)

Based on the writer's own investigations (430 of January) and those of Doborzynski (4311 of 1938). Author's summary :—" The investigation of the electrical properties of the subsoil as regards the flow of high-frequency currents and the passage of a Hertzian field is one of the tasks of radio-geology. The radio-geological properties of the subsoil are of the greatest importance for the propagation of a Hertzian field at the earth's surface, and must therefore be taken into account without fail when radio links are planned and new stations erected. Wireless communication below ground, even over great distances, is possible. It is of course largely dependent on the radio-geological properties of the hills passed through and on the wavelength, and also on the weather [with its effects on the water conditions]. The radio-geological properties of the subsoil may lead to bearing errors in d.f. working. The direction of field is largely dependent on these properties. Conversely, deductions on the electrical properties can be made from such directional variations ; this fact is made use of in radio-prospecting."

As regards the above sentence on the use of wireless communication below ground, the writer considers that although little has been done so far the subject is likely to develop. The most obvious application is " mine " wireless, particularly for emergency use ; but more than once the writer mentions the possibility of other employment. " In the layers below the deepest subterranean-water horizon the propagation conditions are by no means unfavourable."

1325. ELECTRICAL WAVE SHOWN IN SLOW MOTION [by Mechanical Model of Transmission Line : Reproduction of Effects of Lightning Arrester, etc.].—C. F. Wagner : Westinghouse Company. (*Journ. of Applied Phys.*, Oct. 1939, Vol. 10, No. 10, p. x : short note only.)

1326. VELOCITY OF PROPAGATION AND TRANSIENT PHENOMENA ALONG SMOOTH LINES AND PUPINISED CABLES.—Possenti. (*See* 1355.)

1327. NOTES AND ABACS ON THE PENETRATION OF MEDIUM-FREQUENCY [around 5 kc/s] ELECTROMAGNETIC WAVES IN FERROMAGNETIC MATERIALS [for example, in Induction Furnaces].—van Lancker : Ribaud. (*Bull. de la Soc. franç. des Élec.*, Dec. 1939, Series 5, Vol. 9, No. 108, pp. 969–980.)

1328. THE APPLICATION OF A NEW PHOTOELECTRIC METHOD TO THE DETERMINATION OF THE OPTICAL CONSTANTS OF SOME PURE METALS *and* THE OPTICAL CONSTANTS OF COPPER/NICKEL ALLOYS.—Bor, Hobson, & Wood. (*See* 1521.)

ATMOSPHERICS AND ATMOSPHERIC ELECTRICITY

1329. ATMOSPHERICS IN RADIO BROADCAST RECEPTION AT CALCUTTA [in Medium & Short Wave Bands : Measurements of Direction, Number, & Strength : Approx. Formulae : Suggested Broadcast Transmission Standards for India].—S. P. Chakravarti, P. B. Ghosh, & H. Ghosh. (*Proc. Inst. Rad. Eng.*, Dec. 1939, Vol. 27, No. 12, pp. 780–783.) *See* also 2265 & 3064 of 1939.

1330. THE RECEPTION OF BROADCAST SIGNALS SUBJECT TO DISTURBANCE BY ATMOSPHERICS.—Moore. (*See* 1391.)

1331. RECORDING TRANSIENT DISTURBANCES [Automatic Recording Oscillographs], *and* AUTOMATIC CATHODE-RAY OSCILLOGRAPH.—Grismore : Gaines. (*Bell Lab. Record*, Jan. 1940, Vol. 18, No. 5, pp. 140–144.)

1332. PROPAGATION VELOCITY OF LIGHTNING WAVES IN TRANSFORMER WINDINGS.—Ohkohchi & Yui. (*Electrot. Journ.*, Tokyo, Jan. 1940, Vol. 4, No. 1, pp. 11–13.)

1333. REMARKS ON " DIRECT-LIGHTNING STROKES . . . AND EXPERIMENTS WITH HAZEL-TWIG DIVINING."—Baumeister. (*E.T.Z.*, 14th Dec. 1939, Vol. 60, No. 50, p. 1444.) *See* 897 of February.

1334. ARGUMENT ON " THE PROTECTION ZONE OF LIGHTNING CONDUCTORS AND ITS DETERMINATION BY TESTS ON MODELS."—Matthias & Burkhardtsmaier : Schwaiger. (*E.T.Z.*, 14th Dec. 1939, Vol. 60, No. 50, pp. 1443–1444.) *See* 3487 of 1939. For a review of Schwaiger's book *see* 3479 of 1938.

1335. A LABORATORY STUDY OF SPARK DISCHARGE BETWEEN CONDUCTING CLOUDS.—L. B. Snoddy & J. W. Beams. (*Phys. Review*, 1st Jan. 1940, Series 2, Vol. 57, No. 1, p. 63.)

1336. IONISATION BY POSITIVE IONS IN ATMOSPHERIC SPARKS [Calculations of Energy required and Chance of Ionisation show Invalidity of Townsend Theory of Spark Breakdown by Ionisation by Positive Ions].—R. N. Varney. (*Phys. Review*, 1st Jan. 1940, Series 2, Vol. 57, No. 1, pp. 72–73 : abstract only.)

1337. THE INTERPRETATION OF IONISATION MEASUREMENTS IN GASES AT HIGH PRESSURES [Predictions of Cluster Recombination Theory for Ionisation by Gamma-Radiation agree with Experimental Data].—E. Kara-Michailova & D. E. Lea. (*Proc. Camb. Phil. Soc.*, Jan. 1940, Vol. 36, Part 1, pp. 101–126.)

1338. THE INTERMEDIATE IONS OF THE ATMOSPHERE [Smaller Nucleated Ions in City Air exist in Separate Groups with Distinct Mobilities, are composed of Sulphuric Acid Droplets].—A. R. Hogg. (*Proc. Phys. Soc.*, 1st Nov. 1939, Vol. 51, Part 6, No. 288, pp. 1014–1026 : Discussion pp. 1026–1027.)

1339. ON ASYMPTOTIC ORBITS IN THE THEORY OF PRIMARY COSMIC RADIATION.—A. Baños, Jr. (*Journ. of Math. & Phys. of M.I.T.*, July 1939, Vol. 18, No. 3, pp. 211–238.) For a previous paper *see* 3498 of 1939. *Cf.* also 1340, below.

1340. STABLE PERIODIC ORBITS IN THEORY OF PRIMARY COSMIC RADIATION [a Phase of General Dynamical Problem of Motion of Charged Particle in Field of Magnetic Dipole].—Baños, Uribe, & Lifshitz. (*Rev. of Mod. Phys.*, July/Oct. 1939, Vol. 11, Nos. 3/4, pp. 137–148.) *See* also Manarini, 1312, above, and 1339.

1341. THE SIGNIFICANCE OF VARIATIONS IN COSMIC-RAY INTENSITY AND THEIR RELATION TO SOLAR, EARTHMAGNETIC AND ATMOSPHERIC PHENOMENA.—V. F. Hess. (*Rev. of Mod. Phys.*, July/Oct. 1939, Vol. 11, Nos. 3/4, pp. 153–157.)

1342. A THEORY OF WORLD-WIDE PERIODIC VARIATIONS OF THE INTENSITY OF COSMIC RADIATION [which are largely accounted for by Hypothesis of Permanent Solar Field together with Known Behaviour of Ionospheric Ionisation].—Vallarta & Godart: Gill: Forbush. (*Rev. of Mod. Phys.*, July/Oct. 1939, Vol. 11, Nos. 3/4, pp. 180–189: Discussion pp. 189–190.)

1343. IMPROVEMENTS IN RADIO SONDE.—Nat. Bureau of Standards. (*Journ. Franklin Inst.*, Jan. 1940, Vol. 229, No. 1, pp. 102–103: notes from *Technical News Bulletin* No. 263, March 1939.)

1344. AN IMPROVED ELECTRIC HYGROMETER [for Radio Sondes].—F. W. Dunmore. (*Journ. of Res. of Nat. Bur. of Stds.*, Dec. 1939, Vol. 23, No. 6, pp. 701–714.)

1345. AUTOMATIC RADIOMETEORIC STATIONS [for Investigations with Sounding Balloons].—F. Francini. (*Boll. del Centro Volpi di Elett.*, English Edition, April/May/June 1939, Year 2, No. 2, Abstracts p. 221d.)

PROPERTIES OF CIRCUITS

1346. INVESTIGATION OF ELECTROMAGNETIC HOLLOW SPACES.—Müller. (*See* 1379.)

1347. ULTRA-SHORT WAVES IN CONCENTRIC CABLES AND THE "HOLLOW-SPACE" RESONATORS WITH PERFORATED DISC ENDS, *and* CONCENTRIC CABLES WITH LONGITUDINALLY STRATIFIED DIELECTRIC AS BAND-STOP FILTERS IN THE *m* WAVE RANGE AND BELOW.—Buchholz. (*See* 1301 & 1302.)

1348. AN OSCILLATING SYSTEM WITH SMALL LOSSES [for Micro-Wave Frequency-Stabilisation].—Bunimovich. (*See* 1380.)

1349. RECIPROCITY AND THE GENERALISED CONCEPT OF THE TRANSDUCER IN RADIO LINKS.—Latmiral. (*See* 1308.)

1350. ON THE FOUNDATION AND IMPORT OF THE HEAVISIDE OPERATIONAL CALCULUS.—Wagner. (*See* 1665.)

1351. AN OUTLINE OF THE THEORY OF ALGEBRAIC COMPLEX OPERATORS, WITH APPLICATIONS TO ELECTRIC CIRCUIT THEORY.—G. W. C. Hirst. (*Journ. Inst. Eng. Australia*, Nov. 1939, Vol. 11, No. 11, pp. 391–395.)

1352. FUNDAMENTALS OF FREQUENCY CORRECTION [without Use of Filters].—H. C. Likel. (*Communications*, Nov. 1939, Vol. 19, No. 11, pp. 14–15 and 29, 30.)

1353. ON SOME PARTICULAR RELATIONSHIPS BETWEEN THE FREQUENCY CHARACTERISTIC AND THE TRANSIENT FUNCTION.—Kharkevich. (*See* 1442.)

1354. TRANSIENT PHENOMENA DUE TO STARTING AND STOPPING OF CURRENTS IN ELECTRIC CIRCUITS [and the Use of Abridged Methods of Calculation].—G. Giorgi. (*Boll. del Centro Volpi di Elett.*, English Edition, April/May/June 1939, Year 2, No. 2, Abstracts p. 213d.) For previous work *see* 4327 of 1939.

1355. VELOCITY OF PROPAGATION AND TRANSIENT PHENOMENA ALONG SMOOTH LINES AND PUPINISED CABLES.—R. Possenti. (*Boll. del Centro Volpi di Elett.*, English Edition, April/May/June 1939, Year 2, No. 2, pp. 11–22: in English.) A summary of the original Italian version was referred to in 499 of February. An appendix deals with Poincelot's treatment of a similar problem (2229 of 1938).

1356. GENERAL THEORY OF THE OSCILLATORY PHENOMENA IN THE WINDINGS OF TRANSFORMERS.—J. Pirenne. (*Rev. Gén. de l'Élec.*, 6th/13th & 20th/27th Jan. 1940, Vol. 47, Nos. 1/2 & 3/4, pp. 19–29 & 53–64.)

1357. AN ESSAY IN THE SYSTEMATIC TREATMENT OF DIPOLE CIRCUITS WITH DIFFERENTIAL NEGATIVE RESISTANCE.—N. Carrara. (*Alta Frequenza*, Nov. 1939, Vol. 8, No. 11, pp. 683–695.)

Author's summary:—"Starting from the hypothesis that every dipole with differential negative resistance presents a capacitance and an inductance associated together, a theory is given which represents the working of electrical circuits containing such dipoles. The conditions for stability and instability of these circuits are derived; as regards the instability conditions both sinusoidal oscillations and relaxation oscillations (complex and real) are investigated. The behaviour of dipoles with 'N' and 'S' characteristics are studied as regards external oscillatory circuits, and the reason is given why 'N' dipoles are unsuitable for feeding oscillatory circuits with current resonance [series oscillatory circuits] and why 'S' dipoles are unsuitable for feeding oscillatory circuits with voltage resonance" [parallel oscillatory circuits]. The classification into "N" and "S" types is based on the shapes of the static characteristic: *see* also 64 of 1939. The "N" type includes tetrodes & dynatrons, the "S" type arcs, gas-filled tubes, etc. For an experimental investigation *see* 1358, below.

1358. Experimental Researches on Circuits containing Type N Dipoles with Differential Negative Resistance.—P. Budini. (*Alta Frequenza*, Nov. 1939, Vol. 8, No. 11, pp. 696–706.)

Confirmation of Carrara's theoretical conclusions (1357, above). From the author's summary :—" Seeking confirmation of the existence, demanded by the theory, of an ideal capacity in parallel with the type ' N ' dipole, we succeeded in measuring its value by various methods which gave results sufficiently consistent among themselves [and independent of the circuit constants. An analogous method would no doubt show the presence of the inductance in series with a type ' S ' dipole].

" The behaviour of the ' N ' dipole as a generator of real or complex oscillations was also examined experimentally. Finally, a satisfactory physical explanation was found for the already known fact that an ' N ' dipole is unsuitable for maintaining, in a stable régime, complex oscillations in a current-resonance circuit connected to it."

1359. The Coupling of Dipole and Quadripole Circuits and the Matching of Impedances.—A. Ferrari-Toniolo. (*Alta Frequenza*, Nov. 1939, Vol. 8, No. 11, pp. 707–734.)

Author's summary :—" The paper develops, in shortened form, the theory of the coupling of an active dipole (generator) to a passive dipole (load), with and without the interposition of a passive linear quadripole. The problems relating to ' impedance matching ' are also discussed.

" In the simplest case of the active dipole directly coupled to the passive dipole, eight different conditions of maximum are dealt with. Besides ' power matching,' ' uniformity matching ' is considered, and departing from the usual treatment of the problem it is shown that ' uniformity matching ' is prompted not so much by considerations of so-called ' reflection losses ' as by the necessity of having a uniform transmission over a wide frequency range. Some curves and a numerical example illustrate the value, the method of calculation, and the relations of the various coefficients (of non-uniformity, reflection, etc.) in use in telecommunication technique.

" A second part is devoted to the study of the coupling of a generator to its load by way of a quadripole. It deals systematically with the various coefficients which are used to evaluate the transmission efficiency from the point of view of current (insertion loss factor), of real power (transducer loss factor), and of apparent power (composite loss factor). It is shown how, from the general treatment, the usual ' transmission equivalent ' [over-all attenuation] can be deduced and how the considerations of efficiency are related to it. Throughout the treatment care is taken to observe symmetry of definition and uniformity of terminology, according to certain general rules."

1360. Impedance Matching.—A. Preisman. (*Communications*, Dec. 1939, Vol. 19, No. 12, pp. 5–9 and 12.)

1361. Synthesis of Reactance 4-Poles which produce Prescribed Insertion Loss Characteristics : including Special Applications to Filter Design.—S. Darlington. (*Journ. of Math. & Phys. of M.I.T.*, Sept. 1939, Vol. 18, pp. 257–353 : *Bell Tel. System Tech. Pub.*, Monograph B-1186, 97 pp.)

1362. Intermediate-Frequency Selectivity in Receivers for Commercial Radio Services [Description of Composite Band-Pass Filter containing Combined " M-Derived " and " Tuned-Transformer " Sections].—J. B. Moore & H. A. Moore. (*RCA Review*, Jan. 1940, Vol. 4, No. 3, pp. 319–323.)

1363. Bridged-T and Parallel-T Null Circuits for Measurements at Radio Frequencies.—Tuttle. (*See* 1549.)

1364. Simple Band-Pass X-Circuits [and Comparison with Their Equivalent Bridge-Type Circuits].—R. Rabe. (*T.F.T.*, Dec. 1939, Vol. 28, No. 12, pp. 449–457 : to be concluded.)

1365. The Energy Cycles in Auto-Oscillating Systems of the Thomson Type.—K. F. Teodorchik. (*Journ. of Tech. Phys.* [in Russian], No. 11, Vol. 9, 1939, pp. 1005–1007.)

From a general equation (1) of an auto-oscillatory system methods are derived for plotting the energy-balance curve of the system for one period of oscillation. Curves are plotted for systems operating under the soft (Fig. 1) and hard (Fig. 2) régimes. It is suggested that the appearance of self-oscillations in the system can be best realised from a consideration of these energy cycles. An equation is also derived for calculating the energy balance of the system for one cycle. From this the well-known van der Pol equation is derived for determining the building up of the amplitude of oscillations in a self-excited oscillator operating under the hard régime.

1366. On the Synchronisation of Self-Excited Valve Transmitters, with Special Attention to Frequency Division [Theoretical & Experimental Investigation of the Synchronising Conditions necessary for Frequency Division : the Phenomena near the " Mitnahme " (" Pull-In ") Region].—H. Schlicke. (*E.T.Z.*, 30th Nov. 1939, Vol. 60, No. 48, p. 1383.) Summary of a Dresden Dissertation.

1367. Some Quantitative Relations governing the Working of the Ferromagnetic Frequency Demultiplier.—R. Dehors & E. Rouelle. (*Comptes Rendus*, 3rd Jan. 1940, Vol. 210, No. 1, pp. 44–47.)

1368. Electronic Valves as Controlled Switching Devices.—Vecchiacchi. (*See* 1541.)

1369. A Stabilised Bridge Circuit [primarily for Photometer for Very Small Light Values, but applicable to Other Measurements: Highly Efficient Method without Stabilisation of Power Supply].—H. P. Kalmus. (*Electronics*, Dec. 1939, Vol 12, No. 12, pp. 30–31 and 72.)

1370. Analysis of a Class C Radio-Frequency Power Amplifier.—Simon, Bell, & others. (*Phys. Review*, 1st Jan. 1940, Series 2, Vol. 57, No. 1, p. 72: abstract only.)

1371. The Push-Pull and Class AB Connection [Determination of Dynamic Characteristic, and Its Ideal Form].—L. Boë. (*L'Onde Élec.*, Nov./Dec. 1939, Vol. 18, No. 215/216, pp. 361–374.)

TRANSMISSION

1372. Considerations of the Effect of Space-Charge in the Magnetron [Theory for Plane and Cylindrical Electrodes: Problem of Radius of Electron Cloud after Anode Current has ceased in Idealised Diode].—E. B. Moullin. (*Proc. Camb. Phil. Soc.*, Jan. 1940, Vol. 36, Part 1, pp. 94–100.)

"It does not appear that the presence of space-charge can do anything to increase the chance of an electron reaching the anode when H exceeds the critical value."

1373. Action of a Magnetic Field on the Electrons of Oscillating Triodes [and particularly the Improvement in the Efficiency of Ultra-Short-Wave (2 m) Oscillators with Cylindrical Electrodes, produced by a Field of 700 Oersted between Pole-Pieces (of Cross Section equal to That of Anode) coaxial with Filament: No Accurate Value of Field required].—H. Copin. (*Rev. Gén. de l'Élec.*, 23rd/30th Dec. 1939, Vol. 46, No. 25/26, p. 568.)

"In the best conditions the action of the field results in an increase of about 20% in the intensity of the current in the oscillating circuit. The best conditions are realised when the secondary emission from the plate is negligible and the filament emission slightly above the normal value. In these conditions the field produces an increase in the d.c. grid current and a decrease in the d.c. plate current . . . ." For other observations of the effect of a magnetic field *see* 3894 & 3895 of 1938 (McPetrie: Biguenet) and 1410 of 1939 (Jonescu).

1374. The Retarding-Field Generator [for Decimetric & Centimetric Waves: Elementary Survey of Theory & Experiment].—W. Kleinsteuber. (*E.T.Z.*, 28th Dec. 1939, Vol. 60, No. 52, pp. 1479–1482.) For the writer's own recent work *see* 3925 of 1939.

1375. Experimental Researches on the Pierret Oscillator [Retarding-Field Type: Determination of Variation of Wavelength with Filament and Feed Voltages: Comparison with Pierret's Formula].—A. Bullini. (*Boll. del Centro Volpi di Elett.*, English Edition, April/May/June 1939, Year 2, No. 2, Abstracts p. 197d.)

1376. The Energy Turn-Over in the Transverse Control of a Cathode Ray in a Ballistic Model.—H. E. Hollmann. (*Zeitschr. f. tech. Phys.*, No. 12, Vol. 20, 1939, pp. 340–343.)

A previous paper (1659 of 1939) described a stretched-rubber-membrane ballistic model for studying the electron paths for an ultra-high-frequency transverse field. The equally interesting problem of the retroactive action which the electrons, by induction, exert on the transverse field and consequently on the deflecting-plate potentials (or in other words, the coupling and energy-exchange between the ray electrons and the field) also presents difficulties when treated electrically: thus, owing to the looseness of the coupling, ray currents would be required much stronger than those usually available, to produce measurable effects in u.s.w. circuits with their natural damping. The writers therefore developed the special ballistic model shown in Fig. 2. Here a stream of metal balls is delivered onto a see-sawing flat plate whose movements are recorded optically on a film.

"The theory of the ballistic model leads to the same 'inversion' formula for the average real power as in the electrical case [correspondence between eqn. 7 for the model and eqn. 1, derived by Hollmann & Thoma (2914 of 1937 & 1353 of 1938) to replace the condemned formula given by Benner]. The records of the see-saw swings show, in agreement with the theory, both damping and regeneration, according to the transit-time angle." The principle of the model, here applied to a transverse deflection, can equally well be applied to examine the energy turnover in longitudinal modulation. "The possibility is thus offered of representing by models a whole number of transit-time devices, above all the latest devices with velocity modulation, and of obtaining in this way not only an insight into the complicated starting processes but also reliable conclusions as to the optimum dimensions and working conditions. According to their design, such models will function either as ballistic amplifiers, frequency multipliers, or (through their 'negative internal resistance' or with the assistance of a mechanical back-coupling) as transit-time oscillators. A later paper will deal with this further development of the transverse-control model here described."

1377. The Electronic Valve with Velocity Modulation.—Bethenod. (*See* 1416.)

1378. The Electronic-Wave Theory of Velocity Modulation Tubes.—S. Ramo. (*Proc. Inst. Rad. Eng.*, Dec. 1939, Vol. 27, No. 12, pp. 757–763.) The full paper, a summary of which was dealt with in 69 of January (where by a misprint in the title "wave" appeared as "curve.").

1379. Investigation of Electromagnetic Hollow Spaces [bounded by Well-Conducting Metallic Surfaces: as used for Frequency Stabilisation, Screening, etc., in Ultra-Short-Wave Oscillators: General Theory, and Determination of Internal Field].—J. Müller. (*Hochf:tech. u. Elek:akus.*, Nov. 1939, Vol. 54, No. 5, pp. 157–161.)

This general theory starts from Maxwell's equations, using the complex Poynting vector, and derives (§ II) a relation between two neighbouring states. An extension of Zobel's theorem to hollow spaces is given in § III; the connection between the loss factor and the relative half-value breadth of the resonance curve is derived in § IV. The change in the natural frequency due to disturbances in the medium filling the space and in that surrounding it is calculated in § V. A method for determining the distribution of electric and magnetic fields within and on the surfaces of hollow spaces of arbitrary form is worked out in § VI.

1380. An Oscillating System with Small Losses.—V. I. Bunimovich. (*Journ. of Tech. Phys.* [in Russian], No. 11, Vol. 9, 1939, pp. 984–1004.)

It is important that the "Q-value" of a system used for stabilisation purposes, especially on decimetric and centimetric waves, should be made as high as possible. It is therefore necessary to reduce radiation losses from such a system, and in this respect hollow geometric bodies constructed of sheet metal are particularly suitable. In the present paper oscillating systems have the shape of a right cylinder (Fig. 2) and a rectangular parallelepiped (Fig. 3) are discussed, and it is assumed that oscillations taking place in the system are of the "flat" type, *i.e.* the electromagnetic field within the system is uniform along the *OZ* axis. For each of the above cases equations are derived for determining *Q*, natural wavelength, standing waves within the system, and distribution of currents on the walls of the systems. Forced oscillations in a parallelepiped are then considered when this is galvanically coupled to an oscillating circuit, *i.e.* when the transmission line passes inside the parallelepiped and the two conductors are connected to the opposite walls of the body (Fig. 5c). The input impedance of this system is also determined. In an appendix, *Q* is found for a parallelepiped and a sphere when oscillations are of the general type.

1381. New Ultra-High-Frequency Transmitters [Frequency-Modulation and Television].—General Electric. (*Communications*, Dec. 1939, Vol. 19, No. 12, pp. 10–12.)

1382. The Nature and Use of Amplitude, Phase-Angle, and Frequency Modulation.—E. C. Metschl. (*E.T.Z.*, 30th Nov. & 7th Dec. 1939, Vol. 60, Nos. 48 & 49, pp. 1357–1361 & 1395–1401.)

Analytical and graphical treatment. "In pure frequency modulation the frequency is directly made to fluctuate by the rhythmic change of a frequency-determining element of the master-oscillator, whereas in phase-angle modulation the phase angle of the oscillation is altered in a later amplifying stage (the master-oscillator being stable in frequency) by some means such as a periodic detuning of a circuit. That this latter process also produces a frequency modulation is shown in the following simple analysis, which also reveals that in the transmission of a range of tones, as for music or speech, there is an important difference between frequency and phase-angle modulation. . . ." In the transmission of a single tone no difference can be detected. *Cf.* 545 of February; *also* 2303 of 1939.

1383. Frequency Modulation [Survey].—C. H. Yocum. (*Communications*, Nov. & Dec. 1939, Vol. 19, Nos. 11 & 12, pp. 5–8 & 14–16 and 27, 30.)

1384. The Service Range of Frequency Modulation.—Crosby. (*See* 1644.)

1385. Wide-Band Frequency Modulation in Amateur Communication: Its Application and Advantages for U.H.F. Work.—Grammer & Goodman. (*QST*, Jan. 1940, Vol. 24, No. 1, pp. 11–19 & 92, 94.)

1386. Electronic Valves as Controlled Switching Devices [Applications include Production of Very Deep Distortionless Modulation].—Vecchiacchi. (*See* 1541.)

1387. A One-Kilowatt Broadcast Transmitter [with Stabilised Feedback, Doherty Circuit, etc: Type 443-A-1: Fuses replaced by New Type of Circuit Breakers].—H. A. Reise. (*Bell Lab. Record*, Sept. 1939, Vol. 18, No. 1, pp. 17–20.)

1388. "Der Kurzwellensender" [the (Low-Power) Short-Wave Transmitter: Theoretical & Practical Foundations: Book Review].—Behn & Monn. (*E.T.Z.*, 14th Dec. 1939, Vol. 60, No. 50, p. 1444.)

RECEPTION

1389. Superheterodyne Converter System Considerations in Television Receivers.—Herold. (*See* 1491.)

1390. The Service Range of Frequency Modulation.—Crosby. (*See* 1644.)

1391. The Reception of Broadcast Signals subject to Disturbance by Atmospherics.—R. L. Moore. (*Proc. Phys. Soc.*, 1st Nov. 1939, Vol. 51, Part 6, No. 288, pp. 972–977.)

From the author's abstract:—The paper describes a machine which produces pulses similar to atmospherics, and records speech-intelligibility tests carried out with it with a view to finding how intelligibility varies with atmospheric noise. It is suggested that a signal/atmospheric ratio equal to 20 db, corresponding to a voltage ratio of 10 : 1, should be a sufficiently high standard for districts where atmospheric disturbance is severe. The atmospheric level has been measured with a special peak voltmeter which integrates the value over several seconds.

1392. An Experimental Investigation of the Characteristics of Certain Types of Noise [Thermal Agitation, Atmospherics, Buzzer, Voltage-Pulse, & Ignition: Relations between Band Width and Peak, Average, & Effective Voltages: Dependence on Shape, Width, & Overlapping of Pulses: etc.].—K. G. Jansky. (*Proc. Inst. Rad. Eng.*, Dec. 1939, Vol. 27, No. 12, pp. 763–768.)

"It should be mentioned that the relationship found for this limited band-width range [up to 112 kc/s] may not hold for much wider band widths such as will be used for television purposes. . . ."

1393. On the Legal Control of Radioelectric Interference [in France: Obligations of Makers, Installers, & Users of Electrical Apparatus: of the Broadcast Listener: Need for Revision: etc.].—J. Isoré. (*Rev. Gén. de l'Élec.*, 23rd/30th Dec. 1939, Vol. 46, No. 25/26, pp. 569–576.)

1394. Researches at the Central Electricity Laboratory on the Conditions of the Deposit of Dew on the Insulators of Overhead Lines.—J. Cuilhé. (*Rev. Gén. de l'Élec.*, 28th Oct./4th Nov. 1939, Vol. 46, No. 17/18, pp. 427–428.)

1395. The Subjective Effect of Disturbing Signals in Telephone Circuits.—von Susani & Schöbel. (*See* 1474.)

1396. Regeneration in the Pre-Selector: Theoretical Investigation of the Possibilities of Image Rejection and Gain [and Measurements of the Signal/Noise Ratio].—G. H. Browning. (*QST*, Jan. 1940, Vol. 24, No. 1, pp. 28–31 and 58.)

1397. Intermediate-Frequency Selectivity in Receivers for Commercial Radio Services.—Moore & Moore. (*See* 1362.)

1398. Single-Sideband Short-Wave Receiver [for Two Speech Channels, One in Band below Carrier & the Other in Band above].—J. C. Gabriel. (*Bell Lab. Record*, Nov. 1939, Vol. 18, No. 3, pp. 84–87.)

1399. A Remotely Controlled Radio Receiver.—McKennie. (*See* 1651.)

1400. More on the Combined Beat Oscillator and I.F. Amplifier [Improved Method of adding C.W. Reception to a Receiver not provided with a Beat-Frequency Oscillator].—R. A. McConnell. (*QST*, Jan. 1940, Vol. 24, No. 1, pp. 22–23.)

1401. Standardisation of [Tests on] Receivers.—(*L'Onde Élec.*, Nov./Dec. 1939, Vol. 18, No. 215/216, pp. 392–397.) Continued from 4416 of 1939.

1402. Die Castings in Parts Production.—H. Chase. (*Communications*, Nov. 1939, Vol. 19, No. 11, pp. 16–17 and 19.)

1403. New Electrothermic Joining Method for the Fixing of Metal Parts to Ceramic Bodies.—W. Osenberg. (*E.T.Z.*, 7th Dec. 1939, Vol. 60, No. 49, pp. 1401–1402: summary only.)

AERIALS AND AERIAL SYSTEMS

1404. Biconical Electromagnetic Horns [Analysis & Experimental Tests (on 8.3 cm) of Horn for All-Round Horizontal Radiation, or (in "Septate" Version) for Special Patterns].—Barrow, Chu, & Jansen. (*Proc. Inst. Rad. Eng.*, Dec. 1939, Vol. 27, No. 12, pp. 769–779.) For similar treatment of the sectoral horn *see* 1446 & 3944 of 1939.

1405. An Investigation of [the Phase Structure of] the Electromagnetic Field in the Vicinity of a Transmitting Antenna [Theoretical & Experimental Work (with the "Radio Interferometer") on Wavelengths 120–600 m: in connection with Radio-Interference Distance-Meters, etc.].—J. L. Alpert, V. V. Migulin, & P. A. Rjazin [Riasin]. (*Journ. of Phys.* [of USSR], No. 5/6, Vol. 1, 1939, pp. 381–387: in English.)

Continuation of Riasin's work (4089 of 1937). The interferometer was previously used in dispersion investigations (3103 of 1938) over sea and land. The present results are in excellent agreement with the phase calculations of the vertical component of the electrical field for a perfectly conducting earth: "in the near zone in the equatorial plane the phase of the electromagnetic field is determined mainly by the phase of the vertical electrical component." For allied papers see *ibid.*, pp. 389–396.

1406. Radiation Efficiency of Aerial Systems.—F. Babin. (*L'Onde Élec.*, Nov./Dec. 1939, Vol. 18, No. 215/216, pp. 375–391.) Concluded from 1016 of March.

1407. The Design and Calculation of Directive Dipole Aerials [with Application to the Fiumicino Array for Communication with Tripoli, on 29.58 m Wave].—G. Barzilai. (*Radio e Televisione*, Nov. 1939, Vol. 4, No. 3, pp. 109–129.)

1408. The Aerials of the Radio-Andorra Station.—Adam. (*See* 1652.)

1409. The Vertical Aerial for Special-Event Broadcasting [on 1.6–2.8 Mc/s: Comparison with Doublet Aerial].—D. Langham. (*Communications*, Jan. 1940, Vol. 20, No. 1, p. 8.)

1410. The Manahawkin Musa [New Jersey, for London Service: Sixteen Rhombic Units].—A. A. Oswald. (*Bell Lab. Record*, Jan. 1940, Vol. 18, No. 5, pp. 130–134.) For various papers on the development of "Musa" aerials *see* 1414, 2318, & 4622 of 1938.

1411. The Triangle Antenna: Selecting Directivity with a Non-Rotatable Aerial.—J. Arnold. (*QST*, Jan. 1940, Vol. 24, No. 1, pp. 20–21 and 53.)

1412. Improved Pi-Section Antenna Coupler: Simpler Alterations for Wider Impedance Range and Better Harmonic Reduction.—R. B. Jeffrey. (*QST*, Jan. 1940, Vol. 24, No. 1, pp. 40–41.)

1413. Curves for Overhead Lines with Suspension Points of Different Heights.—F. Niethammer. (*E.T.Z.*, 14th Dec. 1939, Vol. 60, No. 50, pp. 1419–1421.)

VALVES AND THERMIONICS

1414. Internal Capacity and Resistance of Magnetron [Phenomenon of Sudden Large Increases of Internal Capacity at Magnetic-Field Values giving Anode-Current Cut-Off and Oscillation Onset: etc.].—G. Hara. (*Electrot. Journ.*, Tokyo, Jan. 1940, Vol. 4, No. 1, p. 24.)

1415. ACTION OF A MAGNETIC FIELD ON THE ELECTRONS OF OSCILLATING TRIODES [at Ultra-Short Wavelengths].—Copin. (*See* 1373.)

1416. THE ELECTRONIC VALVE WITH VELOCITY MODULATION [Approximate Expressions giving Electron Velocity, Current, & Amplifying Action of Space traversed by Electron].—J. Bethenod. (*Comptes Rendus*, 15th Jan. 1940, Vol. 210, No. 3, pp. 103–104.)

"Various researches have been made into the theory of the velocity-modulated valve; the object of the present Note is to complete these on certain points." The approximations made allow the avoidance of the solution of an implicit equation of complicated form.

1417. THE ELECTRONIC-WAVE THEORY OF VELOCITY MODULATION TUBES.—Ramo. (*See* 1378.)

1418. THE USE OF BALLISTIC MODELS FOR THE STUDY OF ENERGY EXCHANGE CONDITIONS IN VELOCITY-MODULATED & OTHER DEVICES.—Hollmann. (*See* 1376.)

1419. LIMITING CURRENT DENSITIES IN ELECTRON BEAMS [Limiting Effect of Thermal Velocities: Expressions based on Liouville's Theorem: Current Densities in Perfectly Focused Beams: Curves showing Nearness of Approach to Maximum Attainable Current Density: Application to Cathode-Ray Tubes and Electron Multipliers].—J. R. Pierce. (*Journ. of Applied Phys.*, Oct. 1939, Vol. 10, No. 10, pp. 715–724.) *See* also Langmuir, 3803 of 1937.

1420. DISTRIBUTION OF [Steady-State] POTENTIAL IN CYLINDRICAL THERMIONIC VALVES [Solution of Potential Equation: Use of Graphs and Differential Analyser: Numerical Examples of Applications of Results to Thermionic Valve Problems].—Crank, Hartree, Ingham, & Sloane. (*Proc. Phys. Soc.*, 1st Nov. 1939, Vol. 51, Part 6, No. 288, pp. 952–971.)

1421. FLUCTUATIONS IN SPACE-CHARGE-LIMITED CURRENTS AT MODERATELY HIGH FREQUENCIES: PART I—GENERAL SURVEY [Theoretical & Historical Backgrounds for Succeeding Papers by R.C.A. Workers].—B. J. Thompson. (*RCA Review*, Jan. 1940, Vol. 4, No. 3, pp. 269–285.)

1422. GENERAL CONSIDERATIONS ON PENTODE VALVES FOR WIRELESS TRANSMITTERS.—R. Warnecke. (*Rev. Gén. de l'Élec.*, 9th/16th and 23rd/30th Dec. 1939, Vol. 46, Nos. 23/24 & 25/26, pp. 527–539 & 557–566.)

Comparison between triodes, tetrodes, & pentodes (efficiency & useful power: stability, and the control-grid/anode capacity). Characteristics of the voltage as a function of current, and the specification of a pentode (characteristic of the ideal pentode: secondary emission: elimination of the secondary electrons, including Jonker's analysis—4459 of 1939: distinction between the two methods of elimination: the action of the primary space charge: suppression of secondary emission by the primary space charge: valves with large anode/screen-grid space and "beam" valves: electron trajectories and division of current: current division and space charge: valves with real suppressor grids: current division as an electron-optical problem). Technical considerations on special transmitting pentodes (cathodes: temperatures of the electrodes, and their cooling). Use of pentodes in transmitters (telegraphy: telephony, in class B régime: modulation). Description of some S.F.R. pentodes.

1423. APPLICATIONS OF THE VOLTAGE-DOUBLER RECTIFIER [Extended Use of Double-Diode (*e.g.* Type 6H6): Advantages as Voltage-Doubler Detector and in Valve Voltmeters].—M. A. Honnell. (*Communications*, Jan. 1940, Vol. 20, No. 1, pp. 14 and 35.)

1424. ON THE NATURE OF THE SECONDARY EMISSION FROM COMPOSITE CATHODES, *and* SECONDARY EMISSION FROM THIN DIELECTRIC LAYERS.—Morgulis: Korshunova & Khlebnikov. (*See* 1504 & 1505.)

1425. SECONDARY ELECTRON EMISSION OF TUNGSTEN, COPPER, AND IRON AT HIGH VOLTAGES.—V. I. Rakov & V. A. Antonov. (*Journ. of Tech. Phys.* [in Russian], No. 10, Vol. 9, 1939, pp. 870–875.)

A report on an experimental study of the secondary emission from certain metals at voltages up to 70 kv. The main conclusions reached are as follows: 1—With an increase in the speed of primary electrons (above 5 kv) the coefficients of secondary emission decrease, reach a minimum (at 50 kv approx.), and then remain substantially constant. 2—Metals of heavier atomic weight possess higher coefficients of secondary emission. 3—When the speed of primary electrons increases the proportion of secondary electrons thrown off at large angles to the bombarded surface is also increased. For tungsten, at voltages from 30 to 50 kv, the quantities of secondary electrons thrown off at various angles to the bombarded surface are approximately proportional to the sines of the angles. 4—The speed of secondary electrons varies from 0 to 95% approx. of the speed of the primary electrons. Certain regularities in the speed distribution of secondary electrons have been observed.

1426. THE SECONDARY EMISSION FROM EVAPORATED NICKEL AND COBALT [Data for Ratio Secondary-Yield/Primary-Energy compared with Theoretical Predictions].—D. E. Wooldridge. (*Phys. Review*, 15th Nov. 1939, Series 2, Vol. 56, No. 10, pp. 1062–1063.) For the theory *see* 147 of January.

1427. ANODE EFFECT AS A FUNCTION OF TEMPERATURE [with Time Studies for Drift of Contact Potential].—P. L. Copeland. (*Phys. Review*, 1st Jan. 1940, Series 2, Vol. 57, No. 1, p. 72: abstract only.) Extension of work dealt with in 3958 of 1939.

1428. THE EXPLANATION OF THE DIRECTIONAL VARIATION OF FIELD EMISSION [from Single-Crystal Metal Points with Spherical "Calotte"] AS A BRAGG INTERFERENCE PHENOMENON IN THE METAL LATTICE.—E. W. Müller. (*Naturwiss.*, 8th Dec. 1939, Vol. 27, No. 49, pp. 820–821.)

1429. FURTHER RESEARCHES ON THE PHOTOELECTRIC EFFECT IN METALS AT HIGH TEMPERATURES.—M. della Corte : Ricca. (*La Ricerca Scient.*, Dec. 1939, Year 10, pp. 1096–1098.)

For a joint paper with Ricca see *Nuovo Cimento*, Aug./Sept./Oct. 1939, Vol. 16, No. 8, pp. 410–416. Author's summary :—" From measurements of the variations of the anode current of a diode when its [tungsten] filament is illuminated, and from a determination of the course of the curve in the passage from the saturated régime to the space-charge régime, it is deduced that such variations are due in part to a photoelectric effect, even if the frequency of the light is below the threshold [of the material of the filament]. Considering that the temperature of the filament is about 2100°, such an effect is in accordance with Fowler's theory." *Cf.* Ranzi & Ricamo, 4218 of 1937 ; Vercelli, 1113 of 1936 ; Marchant, 3163 of 1935.

1430. NEW TRANSMITTING TUBES [HK257 Beam Tetrode (230 W Output on Telegraphy) : RCA 811 & 812 (with Zirconium-Coated Nickel Plates) : HY615 for Frequencies up to 300 Mc/s].—(*QST*, Jan. 1940, Vol. 24, No. 1, pp. 45–46.)

1431. NEW RECEIVING TUBES [RCA Miniature Battery Valves 1R5, 1S4 & 5, and 1T4, for 1.5 V Dry-Cell Operation].—(*QST*, Jan. 1940, Vol. 24, No. 1, pp. 47 and 90.)

1432. VACUUM-TUBE LIFE PROBABILITY *versus* CONSUMER SATISFACTION.—H. W. Parker. (*Proc. Inst. Rad. Eng.*, Jan. 1940, Vol. 28, No. 1, p. 45 : summary only.)

1433. RECENT ADVANCES IN BARIUM GETTER TECHNIQUE [New Form of " Batalum " Getter using Barium Berylliate].—E. A. Lederer. (*RCA Review*, Jan. 1940, Vol. 4, No. 3, pp. 310–318.)

DIRECTIONAL WIRELESS

1434. INSTRUMENT LANDING SYSTEM [C.A.A.-I.T. & T. System].—(*Communications*, Nov. 1939, Vol. 19, No. 11, pp. 9 and 25. .29.)

1435. PAPER ON THE REFLECTING POWER OF GROUND SURFACES, IN CONNECTION WITH ACOUSTIC ALTIMETERS.—Ernsthausen & von Wittern. (*See* 1095 of March.)

1436. RADIO COMPASS FOR SMALL VESSELS [Type 50A].—W. E. Reichle. (*Bell Lab. Record*, Jan. 1940, Vol. 18, No. 5, pp. 151–152.)

1437. A TRUE OMNIDIRECTIONAL RADIO BEACON.—E. N. Dingley, Jr. (*Communications*, Jan. 1940, Vol. 20, No. 1, pp. 5–6 and 35.)

1437 *bis*. RUSSIAN PAPERS ON DISTANCE MEASUREMENT.—(*See* 1405, above.)

ACOUSTICS AND AUDIO-FREQUENCIES

1438. A REVIEW OF CARDIOID-TYPE UNIDIRECTIONAL MICROPHONES.—R. P. Glover. (*Journ. Acoust. Soc. Am.*, Jan. 1940, Vol. 11, No. 3, pp. 296–302.)

1439. THE LARYNGOPHONE [Microphone using Mechanical Vibrations of Throat instead of Air Vibrations : Advantages : Theoretical Considerations, leading to Design of Rochelle-Salt and Carbon Types : Results of Tests].—J. de Boer & K. de Boer. (*Philips Tech. Review*, Jan. 1940, Vol. 5, No. 1, pp. 6–14.)

1440. THE ELASTIC, DIELECTRIC, AND PIEZOELECTRIC CONSTANTS OF HEAVY-WATER ROCHELLE SALT.—Holden & Mason. (*See* 1536.)

1441. AN IMPROVED COMMERCIAL TELEPHONE RECEIVER.—J. S. P. Roberton. (*Revue d'Acoustique*, July/Sept. 1939, Vol. 8, Fasc.4, pp. 147–162.) The English original was referred to in 576 of 1939.

1442. ON SOME PARTICULAR RELATIONSHIPS BETWEEN THE FREQUENCY CHARACTERISTIC AND THE TRANSIENT FUNCTION [of a System].—A. A. Kharkevich. (*Journ. of Tech. Phys.* [in Russian], No. 9, Vol. 9, 1939, pp. 831–838.)

It has been established that the frequency characteristic completely determines the system, and that there is therefore a definite relationship between this characteristic and the transient function of the system. This relationship in its general form is very complicated, and in the present paper the following particular cases are examined, which are of practical interest from the point of view of frequency connections : (a) Systems with an upper frequency limit (*e.g.* moving systems of horn loudspeakers) ; (b) systems consisting of a number of similar sections (*e.g.* resonant connecting circuits) ; and (c) systems whose frequency characteristics have a trough (*e.g.* band-stop filters). For each of the above cases the transient function is determined and the relationship between this and the frequency characteristic is established. In the second part of the paper systems corrected at the lower frequencies (*e.g.* moving-coil microphones) are considered, and the transient phenomena in a h.f. filter are determined.

1443. INTERACTION IMPEDANCE OF A SYSTEM OF CIRCULAR PISTONS.—S. J. Klapman. (*Journ. Acoust. Soc. Am.*, Jan. 1940, Vol. 11, No. 3, pp. 289–295.)

1444. ON THE CORRECTION OF THE DISTORTION DUE TO AN OPTICAL SLIT.—Kharkevich. (*See* 1512.)

1445. AN ARMCHAIR SPECTATOR CONVEYER-GUIDE [to General Motors " Futurama " Exhibit at New York World's Fair : Sound Drum System].—Dunlop & White. (*Elec. Engineering*, Dec. 1939, Vol. 58, No. 12, pp. 509–514.) *Cf.* 4499 of 1939.

1446. SYNCROSOUND SYSTEM [for 8 & 16 mm Motion Pictures].—R. C. Powell. (*Communications*, Nov. 1939, Vol. 19, No. 11, pp. 12–13.)

1447. SOUND IN THE THEATRE [Its Control, and the Effect on the Audience].—H. Burris-Meyer. (*Journ. Acoust. Soc. Am.*, Jan. 1940, Vol. 11, No. 3, pp. 346–351.)

1448. The Development of Sound Equipment [Public Address, etc: including Electrical Production of Air-Raid Warning Signal].—D. T. Bennett. (*Electrician*, 19th Jan. 1940, Vol. 124, pp. 41–42: summary only.)

1449. On Selecting a Circuit for a Limiting Compressor.—B. S. Galperin. (*Journ. of Tech. Phys.* [in Russian], No. 10, Vol. 9, 1939, pp. 914–918.)

For previous work *see* 167 of January. Limiting compressors are used in equipments in which considerable variation of the input level takes place, as for example in systems with a constant modulation coefficient or in automatic recorders of frequency characteristics. The operation of such compressors is discussed and forward-acting as well as backward-acting circuits are considered. It is shown that in the case of a forward-acting circuit the characteristics of the rectifier and the variable-μ amplifier must satisfy definite conditions, and that even a slight deviation from these conditions affects adversely the operation of the circuit. In the case of a backward-acting circuit additional distortion must be introduced in order to maintain a non-linear relationship between the signal and the grid bias of the amplifier. This circuit however is more reliable in operation, possesses a higher stability, and allows for considerable deviations in the characteristics of the valves.

1450. Disc-Cutting Problems [Troubles in Instantaneous Recording, and Precautions in Reproducing to give Increased Life].—C. J. LeBel. (*Electronics*, Dec. 1939, Vol. 12, No. 12, pp. 17–19.)

1451. A Motor Van for Sound Recording by the Philips-Miller System [even while in Motion over Rough Ground].—(*Philips Tech. Review*, March 1939, Vol. 4, No. 3, pp. 73–78.)

1452. Diffraction of Light by Sound Film of the Variable-Width Type [using Philips-Miller Process: Application to Immediate & Exact Fourier Analysis of the Sound: Comparison with Variable-Density Method: etc.].—J. F. Schouten. (*Physica*, Feb. 1940, Vol. 7, No. 2, pp. 101–121: in English.) *See* also 1061 & 1062 of March.

1453. Optical Curve Analysis [of Speech and Music].—H. C. Montgomery. (*Bell Lab. Record*, Sept. 1939, Vol. 18, No. 1, pp. 28–30.) *See* also 4437 of 1938, and *cf.* 1060/1063 of March.

1454. The Analysis of Low Frequencies by the Diffraction of Light at Capillary Waves [Theory applicable to Diffraction at Supersonic Waves: Direction and Intensity of Scattered Light give Frequency and Amplitude of Components: Possibility of Continuous Recording of Constantly Changing Frequency Combinations: Experimental Examples of Analysis of Music and Speech].—H. E. R. Becker. (*Ann. der Physik*, Series 5, No. 7, Vol. 36, 1939, pp. 585–608.)

1455. An Apparatus for Accurate Measurements of Audio-Frequencies [1–15 kc/s, Accuracy within 0.001%: Broadcasting-Station Frequency subdivided to give 100 c/s: Beats between Known Integral Multiples of This and the Unknown Frequency are counted].—Ewell & others. (*Review of Scient. Instr.*, Jan. 1940, Vol. 11, No. 1, pp. 39–40.)

1456. Measurements of the Frequency of the Musical Pitch of Orchestras.—G. B. Madella. (*Boll. del Centro Volpi di Elett.*, English Edition, April/May/June 1939, Year 2, No. 2, pp. 5–9: in English.) The original paper in Italian was dealt with in 3198 of 1939. For a method of high-precision checking *see* 656 of February.

1457. Electronic Musical Instruments and the Development of the Pipeless Organ.—G. T. Winch & A. M. Midgley. (*Electrician*, 5th Jan. 1940, Vol. 124, p. 9.) Summary of an I.E.E. paper (circulated).

1458. A New Electronic Musical Instrument [Organ with Rotating Electrostatic Generators modulating a Supersonic Frequency (corresponding to Variable-Area Recording)].—E. L. Kent. (*Journ. Acoust. Soc. Am.*, Jan. 1940, Vol. 11, No. 3, pp. 352–356.)

1459. A Scientific Search for the Secret of Stradivarius.—F. A. Saunders. (*Journ. Franklin Inst.*, Jan. 1940, Vol. 229, No. 1, pp. 1–20.)

1460. A Theory of the Arrangement of Frets on the Finger Board of Plucked Instruments.—N. Jakovlev. (*Journ. of Tech. Phys.* [in Russian], No. 9, Vol. 9, 1939, pp. 839–842.)

1461. The Influence of the Soundboard on Piano Tone Quality.—Bilhuber & Johnson. (*Journ. Acoust. Soc. Am.*, Jan. 1940, Vol. 11, No. 3, pp. 211–320.)

1462. The Sound of Bells: the Strike Note.—J. Arts. (*Journ. Acoust. Soc. Am.*, Jan. 1940, Vol. 11, No. 3, pp. 321–322.)

1463. A Suggestion for Simplified Musical Notation [which would simplify Reading, Writing, & Design of Typewriter: probably also Transposing].—P. Edwards. (*Journ. Acoust. Soc. Am.*, Jan. 1940, Vol. 11, No. 3, p. 323.)

1464. Synthetic Reverberation.—Goldmark & Hendrick. (*Proc. Inst. Rad. Eng.*, Dec. 1939, Vol. 27, No. 12, pp. 747–752.) The full paper, a summary of which was dealt with in 3211 of 1939.

1465. Simple Apparatus for the Measurement of Reverberation Time [Results only 2% from Those by Elaborate Recording Method].—A. Calza & M. Nuovo. (*La Ricerca Scient.*, Dec. 1939, Year 10, No. 12, pp. 1090–1095.)

On the principle that the microphone voltage reaches a relay across an attenuator, which is automatically cut out when the relay acts: the time is measured between this instant and the moment when the microphone voltage releases the relay. Thus the initial sound pressure need not be known.

1466. The Effective Values of Reverberation.—A. M. Kostzov. (*Journ. of Tech. Phys.* [in Russian], No. 10, Vol. 9, pp. 919–929.)

The standard reverberation time t_R can be regarded as a factor determining the damping of sound only in the case when the measuring microphone is mainly affected by reflected waves. If, on the other hand, both reflected and direct waves impinge on the microphone, it is necessary to use the conception of an effective reverberation time t_R eff. which depends on the ratio of energies in the two types of waves. Formulae 10 to 13 are derived for calculating t_R eff., and also formula 15 for determining the new value of t_R eff. when the threshold of hearing is altered. Curves are plotted showing the effect of the following factors on t_R eff: intensity of reflected sound (Fig. 7), distance between the source of sound and the microphone (Fig. 8), threshold of hearing (Fig. 12), loss of hearing in % (Fig. 14), and frequency of sound (Fig. 15). On the basis of this investigation a number of practical suggestions are made for studio work.

1467. On the Theory of Fluctuations in the Decay of Sound [in a Room].—R. C. Jones. (*Journ. Acoust. Soc. Am.*, Jan. 1940, Vol. 11, No. 3, pp. 324–332.)

These fluctuations perhaps help one to judge the acoustical "goodness" or "badness" of a room, and may be one of the means by which the blind can judge its size and shape with remarkable accuracy.

1468. The Normal Modes of Vibration of Rooms with Non-Planar Walls, and an Investigation of Diffuse Sound Reflection.—E. Skudrzyk. (*Journ. Acoust. Soc. Am.*, Jan. 1940, Vol. 11, No. 3, pp. 364–366.) Long summary of the German paper dealt with in 3620 of 1939.

1469. The Filtration of Sound: II [Filtration in Solid Media: Loaded Rods: High-Pass Compressional-Wave Filters: Filtration of Torsional Waves: Compressional Waves in Stratified Media: Dissipative Structures].—R. B. Lindsay. (*Journ. of Applied Phys.*, Oct. 1939, Vol. 10, No. 10, pp. 680–687.)

1470. Vibratory Characteristics of Vibrafram [formerly Heerwagen Tiles].—Ham & Darracott. (*Journ. Acoust. Soc. Am.*, Jan. 1940, Vol. 11, No. 3, pp. 333–340.)

1471. Noise and Vibration Isolation [and the Determination of the Correct Stiffness Factor, etc: Cases of Immovable and Movable Base].—H. A. Leedy. (*Journ. Acoust. Soc. Am.*, Jan. 1940, Vol. 11, No. 3, pp. 341–345.)

1472. A New Standard Volume Indicator and Reference Level.—Chinn, Gannett, & Morris. (*Proc. Inst. Rad. Eng.*, Jan. 1940, Vol. 28, No. 1, pp. 1–17.) Also in *Bell S. Tech. Journ.* for Jan. 1940. Summaries were referred to in 187 of January.

1473. Loudness Level to Loudness Conversion Chart.—P. H. Geiger. (*Journ. Acoust. Soc. Am.*, Jan. 1940, Vol. 11, No. 3, pp. 308–310.)

1474. The Subjective Effect of Disturbing Signals in Telephone Circuits [Ringing & Dialling Signals: Determination of Tolerable Voltages for Different Frequencies: Noise-Voltage Meter agrees with Subjective Results only below 1 kc/s].—G. von Susani & W. Schöbel. (*T.F.T.*, Dec. 1939, Vol. 28, No. 12, pp. 446–449.)

1475. An Experimental Investigation of the the Characteristics of Certain Types of Noise.—Jansky. (*See* 1392.)

1476. Gas-Tube Noise Generator for Circuit Testing [primarily for Multi-Channel Carrier-Telephone Systems: Uniform Output of Noise over One Megacycle Band: Simpler than "Resistance Noise" Generator].—E. Peterson. (*Bell Lab. Record*, Nov. 1939, Vol. 18, No. 3, pp. 81–83.)

1477. An Artificial Larynx for Speaking and Choral Singing by One Person.—F. A. Firestone. (*Journ. Acoust. Soc. Am.*, Jan. 1940, Vol. 11, No. 3, pp. 357–361.)

"Even a person whose normal voice is raucous and who has very little sense of pitch can sing a very acceptable solo with but a few hours of practice."

1478. An Artificial Mastoid for Audiphone [Bone-Conduction Receiver] Measurements [where Impedance Load equal to That of Head is desired].—M. S. Hawley. (*Bell Lab. Record*, Nov. 1939, Vol. 18, No. 3, pp. 73–75.)

1479. The Ortho-Technic Audiphone [embodying Results of Latest Research: Advantage of Separate Batteries for Transmitter and Receiver], *and* The 710A Bone-Conduction Receiver.—W. L. Tuffnell: M. S. Hawley. (*Bell Lab. Record*, Sept. 1939, Vol. 18, No. 1, pp. 8–11: pp. 12–14.)

1480. On the Auditory Significance of the Term "Hearing Loss" [and the Limitations of the Audiogram].—Steinberg & Gardner. (*Journ. Acoust. Soc. Am.*, Jan. 1940, Vol. 11, No. 3, pp. 270–277.)

1481. Auditory Patterns [Spiral Diagrams representing the Cochlea and Nerve Response at Different Points: Use in Deafness Investigations].—H. Fletcher. (*Reviews of Mod. Physics*, Jan. 1940, Vol. 12, No. 1, pp. 47–65.)

1482. Statistical Measurements on Conversational Speech.—Dunn & White. (*Journ. Acoust. Soc. Am.*, Jan. 1940, Vol. 11, No. 3, pp. 278–288.)

1483. Twenty-Second Meeting of the Acoustical Society of America, at Iowa: Summaries of Papers.—(*Journ. Acoust. Soc. Am.*, Jan. 1940, Vol. 11, No. 3, pp. 373–382.)

Including symposia on speech and vocal music, architectural acoustics, hearing defects, gramophone recording (including application of Buchmann-Meyer effect—1930 Abstracts, p. 458—to the calibration of recording & reproducing equipment, and pre-emphasis, etc., in " ultra-high-quality " disc recording).

1484. Chats on Acoustics [Acoustics of a Hall: Physiology of Hearing: Acoustics & Music: Acoustics & Wireless: the Psychology of Hearing].—L. Brillouin & others. (*Revue d'Acoustique*, July/Sept. 1939, Vol. 8, Fasc. 4, pp. 163–195.)

1485. " Principi fondamentali di Elettroacustica teorica ed applicata " [Book Review].—C. Crescini. (*Alta Frequenza*, Dec. 1939, Vol. 8, No. 12, pp. 817–820.)

1486. Study of a Case of Propagation of Elastic Waves: Thermodynamic Application [Method of Measuring the Ratio of Specific Heats of a Gas].—M. Parodi. (*Revue d'Acoustique*, July/Sept. 1939, Vol. 8, Fasc. 4, pp. 140–146.)

1487. Study of the Velocity of Propagation and of the Absorption of Sound in Liquids under Pressure [up to 1000 kg/cm^2].—P. Biquard. (*Revue d'Acoustique*, July/Sept. 1939, Vol. 8, Fasc. 4, pp. 130–139.)

1488. Physiological Effects of Ultrasonics.—M. Ponzio. (*Boll. del Centro Volpi di Elett.*, English Edition, April/May/June 1939, Year 2, No. 2, Abstracts p. 203d.)

1489. Effects of Double Refraction in Liquids, due to Supersonic Waves.—Lucas. (*See* 1524.)

PHOTOTELEGRAPHY AND TELEVISION

1490. Television Reception in an Airplane [Press Demonstration at Distances up to 200 Miles].—R. S. Holmes. (*RCA Review*, Jan. 1940, Vol. 4, No. 3, pp. 286–289.)

1491. Superheterodyne Converter System Considerations in Television Receivers.—E. W. Herold. (*RCA Review*, Jan. 1940, Vol. 4, No. 3, pp. 324–337.) A summary was dealt with in 139 of January.

1492. Simplified Television Intermediate-Frequency Systems [using Mutual-Inductance Coupling and Capacitance Tuning].—G. Mountjoy. (*RCA Review*, Jan. 1940, Vol. 4, No. 3, pp. 299–309.)

1493. The Reception of Television Images [General Survey].—M. Adam. (*Rev. Gén. de l'Élec.*, 28th Oct./4th Nov. 1939, Vol. 46, No. 17/18, pp. 413–424.)

1494. British Vision Receivers: I.—W. J. Brown. (*Electronics*, Dec. 1939, Vol. 12, No. 12, pp. 26–29.)

1495. Television Economics: Parts X to XII, *and* Some Unusual Features of Our Television System.—A. N. Goldsmith: A. Preisman. (*Communications*, Nov. & Dec. 1939, Vol. 19, Nos. 11 & 12, pp. 23–25 & 17, 21, 22, 30, and Jan. 1940, Vol. 20, No. 1, pp. 20–31 and 35: Jan. 1940, Vol. 20, No. 1, pp. 15–19 and 33 . . 35.)

1496. Products of the F.I.M.M. in the Field of Television.—Magneti Marelli Company. (*Radio e Televisione*, Nov. 1939, Vol. 4, No. 3, pp. 145–152.)

1497. Italian Television by S.A.F.A.R.—A. Castellani. (*Radio e Televisione*, Nov. 1939, Vol. 4, No. 3, pp. 130–144.)

1498. Ultra-Short Waves in Concentric Cables and the Hollow Resonators with Perforated-Disc Ends, *and* Concentric Cables with Longitudinally Stratified Dielectric as Band-Stop Filters in the *m* Wave Range and Below.—Buchholz. (*See* 1301 & 1302.)

1499. The Influence of Impedance Irregularities on the Transmission Properties of Wide-Band Cables.—A. Grün. (*T.F.T.*, Dec. 1939, Vol. 28, No. 12, pp. 433–446.)

" Hitherto the transmission properties of wide-band cables have been estimated from measurements of the input resistance. Since irregularities in local characteristic-impedance values become less and less noticeable, at the measuring point, the further away they are from this, it is desirable, in order to estimate the distortion to be expected, to make use also of measurements of attenuation and transit times, which take in the whole length of cable under investigation."

Author's summary:—" The double reflections in wide-band cables resulting from impedance irregularities produce at the cable end an ' aiding flux ' [Mitfluss, as contrasted with the ' back flux ' due to a single reflection], and its consequent frequency-dependent attenuation variation, which produce a gradual building-up and decay of the signals reaching the end, and thus may lengthen the transient processes. . . . For a 1000 km transmission length the ' aiding flux ' at the beginning of a picture-signal, and its resulting attenuation variation, determined in this way [by the attenuation measurements mentioned above], amounted to 15% for a spiral-insulated cable and to 5% for ' Sicken ' cable. The period of the ' aiding flux ' is probably of the same order as the length of the building-up time which is to be expected for a frequency-band limit of 2 Mc/s, so that for the cable constructions investigated, and the transmission length mentioned, any additional distortions due to the ' aiding flux ' are hardly to be feared.

" The ' ripple ' of the measured attenuation curves [*cf.* Mertz & Pfleger, 596 of 1938] implies the existence of correspondingly fluctuating transit-time curves. These fluctuations may lead to additional distortions. Television transmission tests with a high number of picture-elements must bring out these distortions, so that when once the comparison has been made between the image quality and the corresponding results of the attenuation measurement, the latter can be used as a simple criterion of the transmission condition of the cable."

1500. High-Frequency [Carrier-Current] Telephony and " Visiotelephony " [Two-Way Television over Telephone Lines: Particulars of German Service].—M. Adam. (*Génie Civil*, 3rd Feb. 1940, Vol. 116, No. 5, pp. 82–85.)

1501. TELEVISION TRANSMISSION OVER TELEPHONE CABLES [from Remote Pick-Up Points].—C. L. Weis, Jr. (*Bell Lab. Record*, Oct. 1939, Vol. 18, No. 2, pp. 34–37.) *Cf.* 4038 of 1939 and back references.

1502. R.C.A. TELEVISION FIELD PICK-UP EQUIPMENT [using Iconoscope Cameras, with Provision for Later Use of Orthicon Type].—T. A. Smith. (*RCA Review*, Jan. 1940, Vol. 4, No. 3, pp. 290–298.)

1503. CARRIER INTRODUCTION WITH SECONDARY-ELECTRON MULTIPLIERS.—H. Geest. (*Hochf: tech. u. Elek:akus.*, Nov. 1939, Vol. 54, No. 5, pp. 145–151.)

The type of multiplier considered is that of the German P.O. (*see* Weiss, 1470 of 1937). Author's summary :—" Various methods for electric and magnetic modulation are given. The efficacy of electrical modulation methods is determined by the magnitude of the cross-talk between control electrode and output anode. The most favourable results for secondary-emission multipliers with 9 or 14 gauzes were obtained by modulation of the electron current by superposing an alternating voltage on the d.c. bias of the first gauze. The current modulation reached a figure of 100% with a small ' klirr ' factor, under working conditions determined experimentally. The coupling capacity of the first multiplier gauze to the output could be reduced to 10^{-3} pF. The introduction of a carrier alternating voltage at a later stage is fundamentally less favourable. . . . The emitting point could also be used as the control electrode . . . but only 50% of the output current could be controlled without distortion.

" Modulation of the photocurrent by an external electrode makes additional electron multiplication within the cathode sphere [*i.e.* the bulb of the tube] possible for multipliers with Sb/Cs cathodes ; this is free from inertia and proportional to the illumination up to frequencies 4 Mc/s. The method breaks down at higher frequencies. . . . Complete current control can be attained with an external electrode. The use of the method is, however limited by the marked dependence on frequency.

" Difficulties of cross-talk are fundamentally eliminated by magnetic modulation of the electron current . . . The distortions are, referred to equal current control, greater than with the electrical methods described. . . Summarising, it may be said that electrical modulation of the photocurrent between the cathode and the first multiplier gauze is the most suitable means of introducing a carrier frequency."

1504. ON THE NATURE OF THE SECONDARY EMISSION FROM COMPOSITE CATHODES.—N. D. Morgulis. (*Journ. of Tech. Phys.* [in Russian], No. 10, Vol. 9, 1939, pp. 853–859.)

It is well known (*cf.* 4045 of 1938) that the secondary emission from composite cathodes, *e.g* of the type (Ag)–Cs_2O,Cs,Ag–Cs, is much higher than that from pure metals. In the present paper a tentative theoretical explanation of this phenomenon is offered, and various processes taking place within a composite cathode are discussed in detail under the following two headings : (a) Excitation of the secondary electrons inside the emitter by primary electrons, and (b) the movement of the secondary electrons towards the surface of the emitter, and their subsequent liberation. The necessity of introducing a metal mixture (Ag and Cs) into the pure semiconductor or dielectric (Cs_2O) is also discussed.

1505. SECONDARY EMISSION FROM THIN DIELECTRIC LAYERS.—A. S. Korshunova & N. S. Khlebnikov. (*Journ. of Tech. Phys.* [in Russian], No. 10, Vol. 9, 1939, pp. 860–869.)

For previous work *see* 4045 of 1938. A description of experiments with thin dielectric layers deposited on bases of Ag, Ni and Cu. KCl was mainly used, since it was found that the properties of thin layers of KCl can also be regarded as typical for such other materials as NaCl and bromides & iodides of K and Na.

Discussion of the results leads to the following main conclusions : (1) Thin dielectric layers are very effective emitters ; (2) the secondary emission is determined entirely by the dielectric layer itself and not by the metal base or by the possible presence of foreign particles in the layer ; (3) there is an optimum thickness of the layer (in relation to σ_{max}) which in the case of KCl is of the order of 3000 A.U ; (4) the secondary emission depends on external factors (electron bombardment, temperature) inasmuch as the structure of the layer is altered thereby ; and (5) the difference between the thin and thick layers is due to the fact that in the former case the conductivity of the layer is increased by primary electrons.

1506. SECONDARY ELECTRON EMISSION OF TUNGSTEN, COPPER, AND IRON AT HIGH VOLTAGES, *and* THE SECONDARY EMISSION FROM EVAPORATED NICKEL AND COBALT.—Rakov & Antonov : Wooldridge. (*See* 1425 & 1426.)

1507. NOTE ON THE PROTECTION OF THIN METAL FILMS AGAINST OXIDATION [as in Construction of Transparent Fluorescent Screens].—Ehrenberg. (*Journ. of Scient. Instr.*, Feb. 1940, Vol. 17, No. 2, pp. 41–42.) The quartz films mentioned by Coeterier & Teves (240 of 1937) give only an uncertain protection ; the use of zinc orthophosphate is recommended.

1508. A NEW TYPE OF LUMINESCENT SCREEN FOR CATHODE-RAY TUBES SPECIALLY CONSTRUCTED FOR TELEVISION PURPOSES.—A. de Quervain. (*Hochf:tech. u. Elek:akus.*, Nov. 1939, Vol. 54, No. 5, pp. 151–153.)

The known forms of screen, (1) that through which the image is viewed (" Durchsichtschirm ") and (2) that on which the image is viewed directly (" Aufsichtschirm ") are first discussed, with their advantages and disadvantages. The new type of screen is the " foil screen " (" Folienschirm "), claimed to combine the optical and constructional advantages of the " Durchsichtschirm " with the freedom from charge and the cooling of the " Aufsichtschirm." The luminescent substance is spread directly on a thin foil of light metal, held in a metal ring. The electrons pass, with negligible scattering, through the metal before they strike the luminescent substance ; the ions are held back by the foil. The foil can also be employed for post-acceleration of the electrons.

The new screen was used in the transmitter scanning tube shown at the 1939 Swiss National Exhibition in Zurich, a cold-cathode tube with about 60 kv anode voltage. The screen was under test for several hours a day for months, with a special loading of about 10 kw/cm², without any appreciable loss of luminosity.

1509. Charging Potentials, Secondary Emission, and Fatigue Phenomena of Metals irradiated by Electrons, and of Luminescent Substances.—C. Hagen. (*Physik. Zeitschr.*, 15th Oct. 1939, Vol. 40, No. 20, pp. 621–640.)

The questions here dealt with are those of the electrical behaviour of luminescent screens struck by electron beams in a high vacuum. § 2 discusses the secondary emission from metals (for measurements *see* Strübig, 3491 of 1936) and gives a theory of the variation of secondary emission with the accelerating voltage on the cathode-ray beam, for perpendicular and oblique incidence of the primary beam. The charging potentials of insulated metal screens (Fig. 11) are then (§ 3) analysed in relation to the accelerating voltage of the cathode-ray beam, and the onset of an unstable charge on the screen discussed (theoretical screen currents Fig. 12, experimental Fig. 13). The charging and secondary emission of insulators (luminescent substances) are measured, using the circuit of Fig. 14 (charging curve Fig. 15); the influence of the screen charge on the light yield is shown in Fig. 19. Fatigue phenomena of luminescent substances irradiated by electrons (§ 5; experimental curves Fig. 20) are measured. The effect of transparency is theoretically discussed (Fig. 22, construction of fatigue curves including this effect), with the regeneration of disturbed luminescent centres. A curve of absolute fatigue is deduced (Fig. 24).

1510. Charging-Up and Fatigue Phenomena of Phosphors under a Stationary Electron Beam [Dispersion of Charge by Secondary Emission: Fatigue due to Ejection of Metal by Primary Beam, producing Light Absorption, and to Disturbance of Light Centres by Metallic Atoms: Partial Recovery (only) on Return of Atoms to Their Lattice Positions: etc.]—C. Hagen. (*Zeitschr. der Fernseh A.G.*, No. 5, Vol. 1, 1939, pp. 187–193.)

1511. The After-Glow of Phosphors and Its Rôle in the Light-Ray Scanner with Cathode-Ray Tube.—K. Brückersteinkuhl. (*Zeitschr. der Fernseh A.G.*, No. 5, Vol. 1, 1939, pp. 179–186.)

Investigation of the building-up and decay processes in various calcium-tungstate and zinc-sulphide materials: the decay curves can in general be represented by two exponential functions, and in practice the decay process can best be represented by two time constants corresponding to the exponential curves which correctly give the beginning and end of the decay curve. For luminous processes dying out within 10^{-5} second, building-up and decay processes are similar; the curve shape depends on the excitation intensity. For scanning at carrier frequencies a phosphor having the greatest possible initial steepness should be chosen; the image quality to be expected can be estimated by a "factor of merit" for the combination phosphor/photocell. Low-frequency scanning demands a phosphor with the shortest possible after-glow and a decay curve as closely exponential as possible: etc. *Cf.* 1105 of March (Müller).

1512. On the Correction of the Distortion due to an Optical [Scanning] Slit.—A. A. Kharkevich. (*Journ. of Tech. Phys.* [in Russian], No. 11, Vol. 9, 1939, pp. 1014–1023.)

This paper deals mainly with the distortion introduced by scanning slits in sound recording or reproducing apparatus, although the conclusions reached are applicable to any apparatus, such as that used for television and picture transmission, in which scanning slits are employed. It is stated that the object of the paper is not to offer any definite suggestions but merely to indicate new directions along which a practical solution of the problem may be found.

The usual method of compensating the distortion by resonant circuits giving a predetermined lift to the slit characteristic is discussed, and the limitations of this method are pointed out. Possibilities are then considered of obtaining complete correction by the use (in the recording channel) of systems satisfying one of the following two conditions: (1) $h.g = 1$ (multiplication method), and (2) $h + g = 1$ (addition method), where h and g are the characteristics of the slit and of the correcting system respectively. For each of the above methods the necessary transient functions of the correcting systems are determined, and actual systems (electrical and mechanical) satisfying these conditions are suggested. The possibility of using the addition method of correction in the reproducing channel, *i.e.* after the slit, is also discussed. Finally, it is pointed out that the slit need not necessarily be of a rectangular shape, and that certain advantages may be gained if the width varies in accordance with, for example, an exponential law.

1513. Multiple Interlaced Scanning [particularly the Quadruple System: Colour Television with Sequential & Double Interlaced Scanning, Triple & Quadruple Interlacing: a Promising System where Each Colour Component has Its Own Interlacing Sequence].—W. Reichel. (*Zeitschr. der Fernseh A.G.*, No. 5, Vol. 1, 1939, pp. 171–179.)

1514. A New Method for determining Sweep Linearity [Defects of Previous Methods: Description of Method (for Magnetic Deflection Systems) using Small Pick-Up Coil within Deflection Yoke: Voltage Wave is Measure of Slope of Saw-Tooth Flux Wave].—S. W. Seeley & C. N. Kimball. (*RCA Review*, Jan. 1940, Vol. 4, No. 3, pp. 338–348.)

515. Ring Focusing of Negative Ions in a Cathode-Ray Beam [probably due to Negative-Ion Liberation by Positive-Ion Bombardment and Effect of Magnetic Deflecting Field on Positive-Ion Paths].—Bachman. (*Journ. of Applied Phys.*, Jan. 1940, Vol. 11, No. 1, pp. 83–85.) For previous work on these negative-ion components (and their effects in television tubes, etc.) *see* 3692 of 1938.

1516. Electron Optics of Cylindrical Electric and Magnetic Fields [Analysis, and Experimental Work on Electron-Image Formation of Optical Picture projected onto Photocathode, when Photocathode & Fluorescent Screen are in Same Plane and immersed in Magnetic Field of Large Horseshoe Magnet].—A. Rose. (*Proc. Inst. Rad. Eng.*, Jan. 1940, Vol. 28, No. 1, pp. 30–40.) Including description of an electron-beam tube device for measuring magnetic fields from 1 to 350 gauss.

1517. Examination of Coloured Alkali Halides for Photoelectric Hall Effect [Null Result].—J. Evans. (*Phys. Review*, 1st Jan. 1940, Series 2, Vol. 57, No. 1, pp. 47–53.)

1518. Work Functions of Different Faces of Silver Single Crystals [determined by Photoelectric Method].—H. E. Farnsworth & R. P. Winch. (*Phys. Review*, 15th Nov. 1939, Series 2, Vol. 56, No. 10, p. 1067.)

1519. Researches on the Photoelectric Effect in Metals at High Temperatures.—della Corte, Ricca. (*See* 1429.)

1520. The Radius of the Electron and the Calculation of the Photoelectric Constant of Metals.—T. Jonescu. (*Comptes Rendus*, 29th Jan. 1940, Vol. 210, No. 5, pp. 170–172.)

1521. The Application of a New Photoelectric Method to the Determination of the Optical Constants of Some Pure Metals [Modification of Drude Method: Eye Replaced by Photocell: Extinction Position determined objectively with Lindemann Electrometer: Results]: *and* The Optical Constants of Copper/Nickel Alloys.—Bor, Hobson, & Wood. (*Proc. Phys. Soc.*, 1st Nov. 1939, Vol. 51, Part 6, No. 288, pp. 932–941: pp. 942–951.)

1522. Volume Rectifying Action in Cu_2O Crystals [Connection with Crystal Photoelectric Effect].—J. M. Lambert. (*Phys. Review*, 1st Jan. 1940, Series 2, Vol. 57, No. 1, p. 73: abstract only.)

1523. "Photowiderstände" [Selenium & Other Photocells: Book Review].—Thirring & Fuchs. (*See* 1706.)

1524. Effects of Double Refraction in Liquids, due to Supersonic Waves.—R. Lucas. (*Revue d'Acoustique*, July/Sept. 1939, Vol. 8, Fasc. 4, pp. 121–129.) A *Comptes Rendus* note and a summary were dealt with in 2472 of 1938 and 1566 of 1939.

1525. New Apparatus for Picture Telegraphy.—K. Reche. (*E.T.Z.*, 14th & 21st Dec. 1939, Vol. 60, Nos. 50 & 51, pp. 1413–1417 & 1449–1452.) From the Siemens & Halske laboratory.

MEASUREMENTS AND STANDARDS

1526. Resistance Measurements on Iron Wires in the Frequency Range 10^7 to 3×10^8 c/s [increased to Equivalent of 1.5×10^9 c/s (assuming Unchanged Permeability) by lowering to Temperature of Liquid Oxygen: No Anomalies at Room Temperature, Gradual Alteration of Properties at −183° C with Increasing Frequency: Indication of Size of Weiss Domains: etc.].—M. J. O. Strutt & K. S. Knol. (*Physica*, Feb. 1940, Vol. 7, No. 2, pp. 145–154: in German.) Using the methods dealt with in 1527, below.

1527. Measurements of Currents and Voltages down to a Wavelength of 20 Centimetres.—M. J. O. Strutt & K. S. Knol. (*Proc. Inst. Rad. Eng.*, Dec. 1939, Vol. 27, No. 12, pp. 783–789.) A longer German version was dealt with in 4067 of 1939.

1528. Ultra-Short Waves: Physics, Technique, and Fields of Application.—Hausser. (*See* 1676.)

1529. Contact-less Fine Tuning of Lecher-Wire System excited at Ultra-High Frequencies and Roughly Tuned to Resonance [Fine Tuning by Movable Metal Plate ("Hand Effect")].—P. Santo Rini. (*Praktika Acad. Athènes*, Special Number, Vol. 14, 1939, pp. 124–131.)

1530. Measurement of Dielectric Loss at Ultra-High Frequencies [Ordinary Lecher-Wire System is Inaccurate below about 3 m, owing to High Radiation Resistance, etc., of Circuit Itself: Modified System & Technique for Accurate Measurement even at Decimetric Wavelengths].—K. Morita. (*Electrot. Journ.*, Tokyo, Dec. 1939, Vol. 3, No. 12, pp. 267–271.)

1531. High-Frequency Dielectric-Loss Measurement by Varying-Gap Method [and Comparison with Usual Pasted-Tinfoil Method: Advantages of Varying-Gap Method, particularly when Sample has Large Capacity or Very Small Loss Angle, and for High Temperatures].—T. Sakamoto & H. Uno. (*Electrot. Journ.*, Tokyo, Dec. 1939, Vol. 3, No. 12, pp. 276–279.)

1532. A Measuring Method of H.F. Dielectric Loss Angles at Higher Temperatures [Resistance-Substitution Method with Differential Condenser: Applicable also to Determination of Humidity Characteristics of tan δ], *and* Temperature Characteristics of H.F. Dielectric Loss Angles [Borosilicate Glasses, Steatite & Micarex Series].—S. Okazaki & B. Itijo. (*Electrot. Journ.*, Tokyo, Dec. 1939, Vol. 3, No. 12, p. 287: pp. 287–288.)

1533. An Oscillating System with Small Losses [for Micro-Wave Frequency-Stabilisation].—Bunimovich. (*See* 1380.)

1534. The Absolute Value of the Principal Piezoelectric Modulus of Quartz [Differences in Crystal Quality explain Divergences in Measured Values of Modulus: Consistent Results for Plates without Twinning].—A. Langevin. (*Comptes Rendus*, 23rd Oct. 1939, Vol. 209, No. 17, pp. 627–630.)

1535. "Quartz Oscillators and Their Applications" [Book Notice].—P. Vigoureux. (*Electrician*, 9th Feb. 1940, Vol 124, p. 110.) New edition, largely re-written.

1536. The Elastic, Dielectric, and Piezoelectric Constants of Heavy-Water Rochelle Salt [Rise of Upper Curie Point, Drop of Lower Point, due to Crystallisation from Heavy Water: Other Properties Unchanged].—A. N. Holden & W. P. Mason. (*Phys. Review*, 1st Jan. 1940, Series 2, Vol. 57, No. 1, pp. 54–56.) For preliminary description *see* 253 of January.

1537. The Spark Chronograph [for Continuous Check on Crystal Clocks].—W. A. Marrison. (*Bell Lab. Record*, Oct. 1939, Vol. 18, No. 2, pp. 54–57.)

1538. Internal Strains and Magnetism.—R. Becker. (*Proc. Phys. Soc.*, 1st Jan. 1940, Vol. 52, Part 1, No. 289, pp. 138–151: paper from Conference on Internal Strains in Solids: Discussion pp. 175–178.)

1539. Internal Friction in Solids [Effect of Thermal Currents due to Inhomogeneous Strains set up by Vibrations in Solid and to Variations in Elastic Constants from Point to Point in Polycrystalline Materials: Influence of Ferromagnetism].—C. Zener. (*Proc. Phys. Soc.*, 1st Jan. 1940, Vol. 52, Part 1, No. 289, pp. 152–166: paper from Conference on Internal Strains in Solids.)

1540. A Frequency Monitor [particularly for Relay Broadcasting Stations].—T. L. Glerum. (*Communications*, Dec. 1939, Vol. 19, No. 12, pp. 13 and 26.)

1541. Electronic Valves [Pentodes] as Controlled Switching Devices [with Application to Direct-Reading Frequency Meters, Phase Meters, Production of Square Wave Forms, Reduction of Dependence of Multivibrator & Relaxation-Oscillator Circuits on Valve Characteristics & Working Voltages, Production of Very Deep Distortionless Modulation by Anode-Voltage Control, Relays, etc].—F. Vecchiacchi. (*Alta Frequenza*, Dec. 1939, Vol. 8, No. 12, pp. 789–794.)

Author's summary:—"By the use of pentodes of suitable type it is possible to arrange that in the condition of zero grid bias the anode-voltage drop is extremely small; thus if the grid bias is varied down to the cut-off point the valve behaves, with regard to the load, as a controlled switching device passing from the 'off' to the 'on' condition. This particular mode of action of the valve is shown to be of considerable use in various practical applications." For some of the applications *see* 3086 of 1937 and 2016 of 1938: *also* Pajetta, 2898 of 1939.

1542. A Simple Method of Direct Measurement of the Group Transit Time of Transmission Systems.—E. Hölzler & W. Lenth. (*E.N.T.*, Nov./Dec. 1939, Vol. 16, No. 11/12, pp. 275–278.)

A discussion is first given of the known methods of transit-time measurement; these are in general based on phase measurements which must subsequently be differentiated. Fig. 1 shows the circuit given by H. F. Mayer (*E.N.T.*, 1926). The arrangement here described is developed from that given by Nyquist & Brand (1931 Abstracts, pp. 44–45) and works with amplitude modulation. The circuit is shown in Fig. 4 and is described in detail. The modulator used is a rectifier bridge (Walter, 1932 Abstracts, pp. 593 & 651). The group transit time is read directly on a d.c. instrument. Fig. 5 shows the calibration curve, Fig. 6 results of measurements on an artificial cable. The advantages claimed by the method, besides that of direct reading, are (1) a high degree of accuracy, even for small transit times, (2) independence of variations of the frequency at which the measurements are made, and (3) simplicity in use and relatively small cost of apparatus.

1543. "Q" Measurements: the Home Measurement of Coil Merit Factor.—C. B. Stafford. (*QST*, Jan. 1940, Vol. 24, No. 1, pp. 48–51 and 106..114.)

1544. A Method for the Selective Measurement of Very Small Alternating Voltages [Separately Excited Electrodynamometer with Special Band Amplifier].—O. Schäfer. (*Zeitschr. f. tech. Phys.*, No. 12, Vol. 20, 1939, pp. 335–340.)

Even with the best valves now available the "equivalent grid resistance" (representing valve noise) is of the order of 1 kilohm. If the internal resistance of the alternating-voltage source is small compared with this, the uncertainty of measurement is governed exclusively by the properties of the first amplifier valve. Jacobi & Pforte's valve-noise values (1459 of 1936) thus indicate that the measurement of a voltage of 10^{-8} v with the help of valves requires an extraordinary expenditure in filtering equipment even when the voltage to be measured is of a single simple frequency: if it is made up of several frequency components, with an effective value of 10^{-8} v, its measurement is definitely impossible. These considerations, and some successful tests, have led to the writing of the present paper, describing a method, in no way new in principle, which with simple apparatus will measure extremely small voltages over a wide frequency range (10–5000 c/s) to about 10^{-8} v, when the first valve has an equivalent grid resistance less than 5 kilohms and the indicating instrument has a period of 10 seconds.

Various ways are suggested for providing the necessary auxiliary current, of suitable frequency and phase, for the separate-excitation of the fixed coil of the electrodynamometer: at low frequencies this current, while kept very constant, could have a frequency slightly different from that of the voltage under measurement, so that the pointer of the indicating instrument would show slow beats whose amplitude would give the required voltage. In order to reduce the energy consumption, the dynamometer could be replaced by a differential circuit with thermo-converters (indirectly heated thermojunctions, as in Fig. 5).

1545. Sensitivity and Resolution of Moving-Coil Galvanometers, *and* Resolving Power and Efficiency of Moving-Coil Galvanometers.—C. H. Cartwright. (*Review of Scient. Instr.*, Jan. 1940, Vol. 11, No. 1, pp. 25–30: pp. 31–36.)

1546. Increasing the Sensitivity of Measuring Instruments by means of Retroaction [particularly Regulable Gravity Retroaction].—E. Perucca. (*Boll. del Centro Volpi di Elett.*, English Edition, April/May/June 1939, Year 2, No. 2, Abstracts p. 147d.)

1547. Balance Detectors for A.C. Bridges [Survey of Recent Developments].—N. F. Astbury. (*Journ. of Scient. Instr.*, Feb. 1940, Vol. 17, No. 2, pp. 25–32.)

1548. A Stabilised Bridge Circuit.—Kalmus. (*See* 1369.)

1549. Bridged-T and Parallel-T Null Circuits for Measurements at Radio Frequencies.—W. N. Tuttle. (*Proc. Inst. Rad. Eng.*, Jan. 1940, Vol. 28, No. 1, pp. 23–29.) A summary was referred to in 3736 of 1938. Some of the circuits described, particularly suitable for high-frequency work, have neither coils nor variable resistors.

1550. Precision Current-Transformer Testing Set.—Elliott Brothers. (*Journ. of Scient. Instr.*, Feb. 1940, Vol. 17, No. 2, pp. 43–45.)

1551. A Differential Arrangement, for Medium Frequency and with Amplifier, enabling the Magnetic Permeability of Very Small Samples of Substance to be Demonstrated and Measured [within about 2% or less: Application to Thin Films of Nickel].—A. Colombani. (*Comptes Rendus*, 3rd Jan. 1940, Vol. 210, No. 1, pp. 47–48.)

1552. A New Magnetometric Instrument with Compensation [particularly for Measurement of Vertical Component of Earth's Field].—G. Valle & G. Tribulato. (*Nuovo Cimento*, Nov. 1939, Year 16, No. 9, pp. 441–446.) A preliminary paper was dealt with in 4094 of 1939.

1553. Resistance Change of Thin Bismuth Films in Magnetic Fields [Method of Preparation of Films for Magnetic Measurements, instead of Spirals].—Z. Yamaguti. (*Electrot. Journ.*, Tokyo, Jan. 1940, Vol. 4, No. 1, pp. 7–10.)

1554. An Electron-Beam Device for the Measurement of Magnetic Fields between 1–30 Gauss].—Rose. (In paper dealt with in 1516, above.)

1555. The Measurement of Coercive Force.—H. Neumann. (*E.T.Z.*, 14th & 28th Dec. 1939, Vol. 60, Nos. 50 & 52, pp. 1436 & 1485: summaries only.)

1556. "Appareils de Mesures Électriques" [Book Review].—A. Palm. (*Rev. Gén. de l'Élec.*, 20th/27th Jan. 1940, Vol. 47, No. 3/4, p. 42.) Translated from the German book, an *Electrician* review of which was referred to in 2326 of 1937.

1557. "Les Mesures en Radioélectricité" [Book Review].—P. Abadie. (*Alta Frequenza*, Nov. 1939, Vol. 8, No. 11, pp. 746–747.)

SUBSIDIARY APPARATUS AND MATERIALS

1558. The Amplidyne [Motor-Driven Compensated Generator giving High Amplification of D.C. Input (*e.g.* from Photocell Circuits): Negligible Time Lag].—(*Gen. Elec. Review*, Jan. 1940, Vol. 43, No. 1, p. 21.)

1559. The Problem of the Direct Production of Electricity from Combustible Elements [Zurich Researches].—Bauer. (*Rev. Gén. de l'Élec.*, 25th Nov./2nd Dec. 1939, Vol. 46, No. 21/22, p. 498: summary only.) *Cf.* Hirschfeld & Vanduzer, 2103 of 1939.

1560. Recording Transient Disturbances [Automatic Recording Oscillographs], *and* Automatic Cathode-Ray Oscillograph.—Grismore: Gaines. (*Bell Lab. Record*, Jan. 1940, Vol. 18, No. 5, pp. 140–144.)

1561. Papers on Applications of Cathode-Ray Oscillographs.—de Bruin: Hollins: van Suchtelen. (*See* 1697/1699.)

1562. A New Method for determining Sweep Linearity.—Seeley & Kimball. (*See* 1514.)

1563. Limiting Current Densities in Electron Beams.—Pierce. (*See* 1419.)

1564. Ring Focusing of Negative Ions in a Cathode-Ray Beam.—Bachman. (*See* 1515.)

1565. A Gas-Filled Cathode-Ray Commutator.—Goncharski. (*Journ. of Tech. Phys.* [in Russian], No. 11, Vol. 9, 1939, pp. 1037–1038.)

A new electron-beam switching device in which the intensity of the beam is increased 100-fold by using ionised-gas molecules for compensating the space charge of the hot cathode. A controlled current up to 90 mA is thus obtained.

1566. Increase of the Resolving Power of the Magnetic Semicircle Method for Velocity Analysis of Cathode Rays [Superposition of Inhomogeneous Field along Ray Path decreases Natural Lack of Focus of Method and increases Resolving Power Threefold].—Voges & Ruthermann. (*Zeitschr. f. Physik*, No. 11/12, Vol. 114, 1939, pp. 709–718.)

1567. An Ionic Probe of Great Sharpness [and Its Applications].—von Ardenne. (*Zeitschr. f. tech. Phys.*, No. 12, Vol. 20, 1939, pp. 344–346.)

The development of this ion probe followed naturally on that of the electron probe of submicroscopic fineness (1667 of 1939 & back reference); the short-focus electrostatic high-voltage lens which plays an important part was dealt with in 280 of January. A simple design of probe is shown in Fig. 1; the canal-ray tube (producing J. J. Thomson's "positive rays") has both its perforated cathode and its anode water-cooled. The ions passing through the cathode channel arrive in a strong accelerating field which bunches them together still further, and finally reach the short-focus lens mentioned above, which reduces the ray diameter in the ratio of about 1 : 200. The fine beam then falls on a fluorescent screen (fine-grained zinc sulphide) only long enough for the spot to be observed and measured by a microscope (at the bottom end of the diagram), or on the object, which is mounted in the same plane as the screen. The vacuum in the canal-ray tube can be adjusted to give the strongest ray: since, with electrostatic lenses, the particles are focused according to their volt-velocity and independently of their charge or mass, air can be used as the gas filling. The effect of the unfocused neutral particles can be neglected for most purposes of the probe, but these particles can, if desired, be kept away from the lens opening by adding a deflecting field to produce a slight change in the ray path. With the simple arrangement described, probes with a sharpness of about 3×10^{-2} mm and an intensity of 5–50 watts per square millimetre of surface were obtained. For finer probes two reducing stages would be necessary, and a modern ion source (such as the capillary type of Tuve, Dahl, & Hafstad) to give a homogeneous beam of ions of a value around 10^{-4} A.

In a previous communication the writer suggested the use of electron probes for micro-manipulations (376 of 1939). This idea can be used in conjunction with the new ion probe, since an arrangement (Fig. 2) combining an electron super-microscope with an ion probe enables the latter to be directed and focused on the object by watching the electron-optical image: for the refracting action of electrostatic lenses is the same for electrons and ions. Another application is to the carrying out of point-concentrated chemical reactions; another (particularly important) the boring of extremely fine holes and channels. The suggestion of von Borries & Ruska, to prepare filters and "ultra-filters" of known pore size by means of the electron probe, now appears to be practicable by replacing the electron probe by an ion probe (German patent of 30.4.1938). Examination of the boring action, in the final paragraph, suggests that with the simple probe described above the time required (for gold) would be about 30 minutes per 0.1 mm of thickness. Spinning technique and electron-microscope apertures (*cf.* 769 of February) are mentioned as possible uses.

1568. New Type of Electron Microscope [with Magnetic Lens for High Concentration of Beam, giving Exposures of Fraction of Second: Several Internal Photographs without Interruption].—Rigamonti. (*Boll. del Centro Volpi di Elett.*, English Edition, April/May/June 1939, Year 2, No. 2, Abstracts p. 197d.)

1569. A New, Simple Super-Microscope [with Electrostatic Lenses] and Its Application in Bacteriology.—Brüche & Haagen. (*Naturwiss.*, 8th Dec. 1939, Vol. 27, No. 49, pp. 809–811.) For this instrument *see* Mahl, 1570, below.

1570. The Electrostatic Electron Microscope of High Resolving Power [with Two Electrostatic Lenses (Central Electrode of Each connected direct to Hot Cathode, greatly simplifying H.T. Arrangements—Stabilisation, etc: Electrical Focusing replaced by Mechanical Adjustment of Object): Resolving Power Limit below 15 mμ].—Mahl. (*Zeitschr. f. tech. Phys.*, No. 11, Vol. 20, 1939, pp. 316–317 and Plate.) Already briefly described in the letter referred to in 3717 of 1939.

1571. The Electron Shadow Microscope: I—Geometrical-Optical Researches.—Boersch. (*Zeitschr. f. tech. Phys.*, No. 12, Vol. 20, 1939, pp. 346–350 and Plate.)

"The wavelength of the electrons in the magnetic and electrostatic super-microscopes [von Borries & Ruska, 4104 of 1939: Mahl, 1570, above] is smaller by about three orders of magnitude than the resolving power to-day attainable. With this ratio of wavelength to resolving power it is to be expected that a similar order of resolution would be reached with an electron-shadow projection [3715 of 1939: *cf.* also 4106 of 1939] which, at any rate in principle, works more simply than the electron-microscopic image formation." In the shadow microscope here described and investigated, the smallest possible electron source is obtained by forming a reduced image of a hot hairpin-type cathode by two short-focus high-voltage lenses (each consisting of three perforated diaphragms, the middle one negative to both the others: Fig. 2) whose focus is unaffected by fluctuations of the high voltage. The resulting electron source is so small that the resolution is limited by diffraction phenomena at the object. Resolving powers of 5×10^{-6} cm have already been attained, far beyond those of optical microscopes; a conservative estimate of 10^{-6} cm, as the final result, brings the shadow microscope up to the level of the other super-microscopes.

1572. The Limit of Magnification by a Magnetic Lens for Electron Microscope [Theory].—Sugata. (*Electrot. Journ.*, Tokyo, Dec. 1939, Vol. 3, No. 12, pp. 271–275.)

If a ray of 100 ekv is used and the distance between object plane and image plane is 50 cm, "it may be impossible to raise the magnification at one stage higher than 550 times by using the magnetic materials of today." For previous work, on electrostatic lenses, *see* 2072 of 1939.

1573. The Electron Telescope [for Objects illuminated by Infra-Red Light].—Malatesta. (*Rev. Gén. de l'Élec.*, 11th/18th Nov. 1939, Vol. 46, No. 19/20, pp. 455–461.) Previous papers (in Italian) were dealt with in 4543 of 1938 and back reference.

1574. The Use of Ballistic Models for the Study of Energy Exchange Conditions in Velocity-Modulated & Other Devices.—Hollmann. (*See* 1376.)

1575. Electron Optics of Cylindrical Electric and Magnetic Fields.—Rose. (*See* 1516.)

1576. Electron-Optical Cylinder-Lens Effect of the Leakage Fields of a Condenser.—Herzog. (*Physik. Zeitschr.*, 1st Jan. 1940, Vol. 41, No. 1, pp. 18–26.)

These calculations show that "the field of a condenser can, to a very good approximation, be replaced by an equivalent homogeneous field, whose length does not however in general coincide with the length of the condenser plates." It is shown how to calculate this equivalent length. "For exact investigations, an additional cylinder-lens effect of the leakage fields must be taken into account, which is superposed on the cylinder-lens effect of the equivalent field." The paths of the particles in the actual condenser are calculated and compared with those in the equivalent field with a potential discontinuity (4099 of 1939).

In § 2 the deflection of the electron beams at the edge of the equivalent field is worked out, in § 3 the deflection in the real leakage field, in § 4 the lens effect of the whole field; § 5 gives numerical applications to the examples of a cylindrical condenser and a plane plate condenser. From Fig. 3 the amount by which the equivalent field projects beyond the condenser plates can be read off directly for any adjustment of the stop. "Rays which pass non-axially through the leakage field are deflected differently from those in the equivalent field. This additional deflection angle is proportional to the distance from the axis, and the effect of the leakage field can be described as that of a thin lens whose focal length is derivable from Figs. 4, 5 and eqn. 7. In most practical cases, however, the focal length is so great that it can be neglected. This shows that it is justifiable to replace the real field by a sharply bounded equivalent field when calculating the lens effect of transgradient electrical fields."

1577. Application of Abelian Finite Group Theory to Electromagnetic Refraction.—Whiteman. (*See* 1307.)

1578. Note on the Protection of Thin Metal Films against Oxidation [as in Construction of Transparent Fluorescent Screens].—Ehrenberg. (*See* 1507.)

1579. Papers on Charging-Up and Fatigue Phenomena of Metals and Phosphors under an Electron Beam.—Hagen. (*See* 1509 & 1510.)

1580. The Luminescent Mechanism of Crystal Phosphors [Completion of Schön's Model: Comparison with Experiment].—Riehl & Schön. (*Zeitschr. f. Physik*, No. 11/12, Vol. 114, 1939, pp. 682–704.) *See* 4263 of 1937 and 1674, 2934, & 4125 of 1939.

1581. A New Type of Luminescent Screen for Cathode-Ray Tubes specially constructed for Television Purposes.—de Quervain. (*See* 1508.)

1582. The After-Glow of Phosphors and Its Rôle in the Light-Ray Scanner with Cathode-Ray Tube.—Brückersteinkuhl. (*See* 1511.)

1583. The Fluorescence of Sodium Formate in Soda Solution.—Grumbach & Millet. (*Comptes Rendus*, 3rd Jan. 1940, Vol. 210, No. 1, pp. 49–50.)

1584. On the Friction in a Vacuum.—Rakov & Sokolova. (*Journ. of Tech. Phys.* [in Russian], No. 9, Vol. 9, 1939, pp. 785–789.)

1585. Recent Advances in Barium Getter Technique [New Form of "Batalum" Getter using Barium Berylliate].—Lederer. (*RCA Review*, Jan. 1940, Vol. 4, No. 3, pp. 310–318.)

1586. A Discharge Tube for Impulse Voltages up to 2.7 Million Volts.—Singermann & others. (*Journ. of Tech. Phys.* [in Russian], No. 10, Vol. 9, 1939, pp. 883–889.)

1587. The Mechanism of the Ignition of Long Discharge Tubes.—Bartholomeyczyk. (*Ann. der Physik*, Series 5, No. 6, Vol. 36, 1939, pp. 485–520.)

1588. The Temperature of High Pressure Arcs [calculated from Measured Values of Arc Gradient and Current Density], *and* Current Densities, Lumen Efficiency, and Brightness in A, N_2, He, and H_2 Arcs.—Suits. (*Journ. of Applied Phys.*, Oct. 1939, Vol. 10, No. 10, pp. 728–729: 730–732.)

1589. The Mutual Interaction of Plasma Electrons.—Haseltine. (*Journ. of Math. & Phys. of M.I.T.*, July 1939, Vol. 18, No. 3, pp. 174–201.)

1590. Note on the Behaviour of High-Intensity Mercury Arcs Falling Freely under Gravity [Experiments show Convection Losses relatively Negligible].—Kenty. (*Journ. of Applied Phys.*, Oct. 1939, Vol. 10, No. 10, p. 714.)

1591. The Design and Construction of a Mercury-Vapour Rectifier Tube [specially for Oscillator Plate Supply of Cyclotron, to withstand Surges & Overload Currents].—Allen & Nester. (*Review of Scient. Instr.*, Jan. 1940, Vol. 11, No. 1, pp. 43–44.)

1592. A New Ignitron Firing Circuit.—Klemperer. (*See* 1691.)

1593. A Differential Pulse-Amplitude Selector [primarily for Nuclear Investigations: Range of Operation from below 1 Volt to 125 Volts: Two Thyratrons & Amplifier, transmitting to Recorder only Pulses between Arbitrary Limits].—Roberts. (*Review of Scient. Instr.*, Jan. 1940, Vol. 11, No. 1, pp. 44–45.)

1594. Starting Characteristics of a "Trigger" Tube with a Radioactive Cathode [Westinghouse WL-759 for operating Small Relays: controlled by Currents below 10^{-11} A in Starting-Anode Circuit: "Avalanche" Effect due to Cold Radioactive Cathode: etc.].—Nottingham. (*Review of Scient. Instr.*, Jan. 1940, Vol. 11, No. 1, pp. 2–6.)

1595. Contribution to Electron Emission at the Cathode of the Glow Discharge [Critical Examination of Hypotheses used in Its Determination from Cathode Heating: Its Dependence on Cathode Drop].—Fischer. (*Naturwiss.*, 15th Dec. 1939, Vol. 27, No. 50, pp. 838–839.) *See* Güntherschulze & Bär, 3226 of 1938.

1596. Time-Lag Analysis of the Townsend Discharge in Argon with Activated Caesium Electrodes [Source of Lag is Diffusion of Metastable Argon Atoms and Release of 0.4 Secondary Electron per Metastable Atom reaching Cathode].—Engstrom. (*Phys. Review*, 1st Jan. 1940, Series 2, Vol. 57, No. 1, p. 73: abstract only.)

1597. The Townsend Ionisation Coefficients for Ni and Al Cathodes in an Atmosphere of Hydrogen [Measurements: Calculated Sparking-Potential Curves compared with Those Determined Experimentally].—Hale. (*Phys. Review*, 15th Dec. 1939, Series 2, Vol. 56, No. 12, pp. 1199–1202.)

1598. The Discharge through Air Layers in Solid Dielectrics.—Kanonykin. (*Journ. of Tech. Phys.* [in Russian], No. 10, Vol. 9, 1939, pp. 876–882.)

Experimental observations were made on the discharge between two glass plates (Fig. 1) separated by mica insulators (or between a glass plate and an electrode—Fig. 2). A number of experimental curves are shown and from an examination of equivalent circuits the mechanism of the discharge is discussed. The main conclusions reached are as follows: Under certain conditions the distributed discharge in the air layer (uniform luminosity) may be converted into a concentrated discharge (sparking). The factor determining this transformation is the surface resistance of the dielectric. The distributed discharge may form a thin semi-conducting layer on the surface of the dielectric, and thus in time a concentrated discharge may appear. The initial potential gradients of the air layer are equal to the breaking-down gradients of the air between two metal electrodes. Formulae (6) and (7) are quoted for determining these gradients.

1599. Insulating Materials: Principal Developments of the Past Year [Distrene, Polythene, etc.].—Dunton. (*Electrician*, 26th Jan. 1940, Vol. 124, pp. 57 and 56.)

1600. Plastic Materials: Effect of War on the Plastics Industry.—(*Electrician*, 12th Jan. & 9th Feb. 1940, Vol 124, pp. 23 & 108.)

1601. "Kunstharzpressstoffe und andere Kunststoffe" [Synthetic-Resin Plastics & Other Synthetic Materials: Properties, Manufacture, & Application: Book Review].—Mehdorn. (*Zeitschr. V.D.I.*, 6th Jan. 1940, Vol. 84, No. 1, p. 23.) Second edition of "Kunstharzpressstoffe" (1934 Abstracts, p. 513).

1602. On After-Effects in Solid Dielectrics [Two General Relations between Discharge- and Residual-Charge-Curves in Anomalous Dielectrics].—Gross. (*Phys. Review*, 1st Jan. 1940, Series 2, Vol. 57, No. 1, pp. 57–59.)

1603. Oppanol B, a New Hydrocarbon Polymer [with Excellent Dielectric & Other Properties].—Schwarz. (*E.T.Z.*, 14th Dec. 1939, Vol. 60, No. 50, pp. 1441–1442: summary only.)

1604. The Effects of Neutralisation and Crystallisation in reducing High-Frequency Losses in Glass.—Skanavi & Martushov. (*Journ. of Tech. Phys.* [in Russian], No. 11, Vol. 9, 1939, pp. 1024–1031.)

For previous work *see* 1200 of March. The present paper gives an experimental study of the effects of the following factors on the loss angle of glass: (a) Simultaneous action of ions of different metals present in the glass (neutralisation), and (b) crystallisation of the glass itself. A number of experimental curves are shown and a theoretical interpretation of the results obtained is offered. Wavelengths of 10.6 and 132 m were used.

1605. Dielectric Strength of Porcelain.—Bellaschi & Manning. (*Elec. Engineering*, Dec. 1939, Vol. 58, No. 12, Transactions pp. 651–656.)

1606. Research on Japanese Lacquer with Phenolic Resin and Amber [as Insulating Varnish: Determination of Best Proportions], *and* Dielectric Loss of Japanese Lacquer and Its Copolymer.—Shimizu & Inai. (*Electrot. Journ.*, Tokyo, Dec. 1939, Vol. 3, No. 12, pp. 280–282: Jan. 1940, Vol. 4, No. 1, pp. 22–23.)

1607. The Dielectric Constant in the Neighbourhood of the Melting Point [Tests on Non-Polar Liquids down to & past Their Freezing Points].—Guillien. (*Journ. de Phys. et le Radium*, Jan. 1940, Series 8, Vol. 1, No. 1, pp. 29–33.)

1608. Influence of Quasi-Crystalline Structure on Molecular Rotation and Relaxation in Dipole Liquids [from Dispersion Measurements in Wavelength Range 150–10 cm: Peculiarities in Liquids with Long-Chain Molecules].—Fischer & Klages. (*Physik. Zeitschr.*, 15th Dec. 1939, Vol. 40, No. 23/24, pp. 721–727.)

1609. Improvements in the Construction of Condenser Bushings [Condenser-Type Paper-Insulation Bushings for Transformers, etc.].—Peterson. (*Elec. Engineering*, Dec. 1939, Vol. 58, No. 12, Transactions pp. 646–650.)

1610. Water-Cooled High-Frequency Condensers [for Induction Furnaces].—Marbury. (*E.T.Z.*, 14th Dec. 1939, Vol. 60, No. 50, p. 1434.) Summary of an *Electric Journal* article.

1611. Self-Induction and Attenuation of Wound [Roll-Type] Condensers.—Leider. (*Hochf:tech. u. Elek:akus.*, Nov. 1939, Vol. 54, No. 5, pp. 153–156.)

Equivalent circuits for a wound condenser are shown in Figs. 1a, b; Fig. 3 shows a circuit for several electrodes for connection to the condenser, Fig. 4 types of electrode connection. Experiments were made with windings of widely different capacity and different types of connection, to determine their degree of usefulness for high frequencies; voltage and current measurements were made to determine the h.f. impedance (curves of results Figs. 5, a–c). From these the construction of condensers with the least possible self-induction (Fig. 4, II), and least damping (Fig. 4, III), can be deduced. Curves (Fig. 6) also show the great influence of the inductance of the leads; this proves to be greater than that of the winding inductance, so that it is of the greatest importance to have short leads in h.f. apparatus. *Cf.* 4330 & 4694 of 1939 (Linder & Schniedermann: Ferrari).

1612. New Electrothermic Joining Method for the Fixing of Metal Parts to Ceramic Bodies.—Osenberg. (*E.T.Z.*, 7th Dec. 1939, Vol. 60, No. 49, pp. 1401–1402: summary only.)

1613. On the Electrochemical Behaviour of Selenium.—Sella. (*La Ricerca Scient.*, Dec. 1939, Year 10, No. 12, pp. 1143–1144.)

1614. Comparative Merits of Dry-Plate Rectifiers for Heavy Duty.—Harty: Kotterman. (*Elec. Engineering*, Dec. 1939, Vol. 58, No. 12, p. 536.) *See* 324 of January.

1615. Volume Rectifying Action in Cu_2O Crystals [Connection with Crystal Photoelectric Effect].—Lambert. (*Phys. Review*, 1st Jan. 1940, Series 2, Vol. 57, No. 1, p. 73: abstract only.)

1616. A Converter for Low-Frequency Sinusoidal Voltages and a Source of Sinusoidal Radiation Intensity [primarily for Study of Characteristics of Thermocouples at 0.7–10 c/s].—Harris & Scholp. (*Review of Scient. Instr.*, Jan. 1940, Vol. 11, No. 1, pp. 23–25.)

1617. Electronic Voltage and Speed Control of Alternators [15 kVA Sine-Wave Alternator Test Set: using Ordinary Receiver Valves & Components: Frequency Stability to 0.004%, Voltage Stability to 0.008%].—Piddington. (*Journ. Inst. Eng. Australia*, Nov. 1939, Vol. 11, No. 11, pp. 375–379.)

1618. Supply-Mains Voltage Fluctuations and the Power Consumption of Commercial Lamps [including High-Pressure Mercury-Vapour Lamps: Stabilising Effects of Iron Barretters & Incandescent Lamps: etc.].—Strauch. (*Zeitschr. f. tech. Phys.*, No. 11, Vol. 20, 1939, pp. 317–325.)

1619. The External Protection of [Buried] Electric Cables by Tarry and Bituminous Materials.—Heilmann. (*Rev. Gén. de l'Élec.*, 16th/23rd Sept. 1939, Vol. 46, No. 11/12, pp. 327–333.)

1620. Crimping Tool for Coaxial Conductors [to squeeze Ferrule onto End].—Hey. (*Bell Lab. Record*, Jan. 1940, Vol. 18, No. 5, p. 152.)

1621. Measurement of the Plastic Deformation of Wires with Synthetic Insulation under Conditions of Crushing and Heat [German Aviation Research Establishment's Method].—Viehmann. (*E.T.Z.*, 21st Dec. 1939, Vol. 60, No. 51, p. 1459: summary only.)

1622. Continuous Breakdown Test for Enamelled Wire.—Pape. (*Bell Lab. Record*, Oct. 1939, Vol. 18, No. 2, pp. 58–61.)

1623. New Type of Installation System with Synthetic-Resin Tubes [Multi-Channel, with Bare Aluminium Conductors: using Materials of German Source only].—(*E.T.Z.*, 30th Nov. 1939, Vol. 60, No. 48, p. 1378.)

1624. Conductivity and Mobility of Thin Lead Films [Measurements].—Foster. (*Phys. Review*, 1st Jan. 1940, Series 2, Vol. 57, No. 1, pp. 42–46.)

1625. Heat Dissipation of Nichrome Wire [investigated by Optical Interferometer Method: Ambiguity of the So-Called "Safety Current"].—Shimizu & Nishifuji. (*Electrot. Journ.*, Tokyo, Dec. 1939, Vol. 3, No. 12, p. 288.)

1626. Wire-Wound Resistors [overcoming Certain Basic Limitations of Previous Types: Insulation sintered onto Wire: Ceramic Cores: etc.].—Sprague Products. (*Proc. Inst. Rad. Eng.*, Dec. 1939, Vol. 27, No. 12, p. ii.)

1627. Rhodium Mirrors for Scientific Purposes.—Auwärter. (*Journ. of Applied Phys.*, Oct. 1939, Vol. 10, No. 10, pp. 705–710.)

1628. Beryllium Copper [combining Corrosion Resistance of Copper with Hardening Characteristics of Steel].—(*Bell Lab. Record*, Oct. 1939, Vol. 18, No. 2, p. 62.)

1629. The Theory of the Structure and Formation of a Certain Type of Immobile Adsorbed Film, with an Application to the Adsorption of Oxygen on Tungsten.—Roberts. (*Proc. Camb. Phil. Soc.*, Jan. 1940, Vol. 36, Part 1, pp. 53–68.)

1630. An Accurate Hard-Valve Counter Chronograph.—Uppelmann. (*Proc. Phys. Soc.*, 1st Nov. 1939, Vol. 51, Part 6, No. 288, pp. 1028–1033.)

"A 10-unit scale-of-two circuit is used to count the number of periods of a 100-kc/s crystal-controlled oscillator in the required time interval. The result is given instantly, correct to one period of the oscillator; the maximum error is 10^{-5} sec."

1631. A Simple Multi-Speed Pencil Polygraph [with Resolving Power up to 100 Impulses per Second].—Craik. (*Journ. of Scient. Instr.*, Feb. 1940, Vol. 17, No. 2, pp. 38–39.)

1632. Gas-Expansion Electric Relays [Development and Latest Forms].—(*E.T.Z.*, 28th Dec. 1939, Vol. 60, No. 52, p. 1483.)

1633. Fundamental Points on Metallic Contacts.—Holm. (*Zeitschr. f. tech. Phys.*, No. 12, Vol. 20, 1939, pp. 332–335.)

Author's summary :—" Lift-off contacts are chiefly spoilt by oxide layers and the migration of material, including wear. 'Coarse' migration, occurring at an arc, consists chiefly of a kind of vaporisation which (apart from arc-reducing connections) can be kept low by the choice of an oxidisable material. 'Fine' migration occurs in the absence of an arc; its chief danger is that it readily produces small protuberances and craters which may cling together. This 'fine' migration also can be decreased by a suitable choice of material [the protuberances and craters are so small that they would do no harm in themselves if they were distributed uniformly over the surface: it is only the interlocking which causes sticking. The use of an oxidisable—but not too oxidisable—material causes the protuberances to oxidise by their heating-up, so that they do not grow at the next contact: another preventive of sticking is to arrange that the points of contact are repeatedly changed]. Every good contact by oxidised surfaces depends on rents in the insulating film due to the contact pressure, or on cohesion " [metallic bridge formation by ion movement under the influence of the field]. *Cf.* Went, 1237 of March.

1634. Resistance Measurements on Iron Wires in the Ultra-High-Frequency Range.—Strutt & Knol. (*See* 1526.)

1635. Notes and Abacs on the Penetration of Medium-Frequency Electromagnetic Waves in Ferromagnetic Materials [*e.g.* in Induction Furnaces].—van Lancker : Ribaud. (*Bull. de la Soc. franç des Élec.*, Dec. 1939, Series 5, Vol. 9, No. 108, pp. 969–980.)

1636. Some Quantitative Relations governing the Working of the Ferromagnetic Frequency Demultiplier.—Dehors & Rouelle. (*Comptes Rendus*, 3rd Jan. 1940, Vol. 210, No. 1, pp. 44–47.)

1637. World's Most Powerful Magnet [Fields of 325 000 Gauss attained].—Kapitza. (*Current Science*, Bangalore, Dec. 1939, Vol. 8, No. 12, p. 572 : summary only.)

1638. Magnetic Materials Testing.—Ashworth. (*Bell Lab. Record*, Oct. 1939, Vol. 18, No. 2, pp. 49–53.)

1639. Dependence of Ferromagnetic Anisotropy on the Field Strength [Measurements on Single-Crystal Discs & Ellipsoids, Polycrystalline Discs : Discussion] : *also* Ferromagnetic Anisotropy of Iron and Iron-Rich Silicon Alloys [measured by Magnetic Torque Method] : *and* Ferromagnetic Anisotropy of Low Nickel Alloys of Iron.—Tarasov. (*Phys. Review*, 15th Dec. 1939, Series 2, Vol. 56, No. 12, pp. 1224–1230 : pp. 1231–1240 : pp. 1245–1246.)

1640. Passage of Magnetisation into Saturated State for Nickel between + 135° C and − 253° C : Temperature Variation of the Crystal Energy.—Polley. (*Ann. der Physik*, Series 5, No. 7, Vol. 36, 1939, pp. 625–650.)

1641. The Ferromagnetic Relaxation Constant [Behaviour of Susceptibility of Iron in High Radio-Frequency Range : Comparison with Dispersion Equation : Value of Relaxation Constant].—Hoag. (*Phys. Review*, 1st Jan. 1940, Series 2, Vol. 57, No. 1, p. 71 : abstract only.)

1642. Magnetic Studies of Solid Solutions : I—Methods of Observations and Preliminary Results on the Precipitation of Iron from Copper.—Bitter & Kaufmann. (*Phys. Review*, 15th Nov. 1939, Series 2, Vol. 56, No. 10, pp. 1044–1051.)

1643. The Ballistic Demagnetising Factor for Cylindrical Rods [Calculations : Importance for Evaluation of Magnetic Measurements].—Warmuth. (*Arch. f. Elektrot.*, 10th Dec. 1939, Vol. 33, No. 12, pp. 747–763.)

STATIONS, DESIGN AND OPERATION

1644. The Service Range of Frequency Modulation [Derivation of Formula for Relation of Signal/Noise Ratio and Distance : Phenomenon of " Improvement Threshold " and Its Effect in Range Limitation : Effect of Pre-Emphasis of Higher Modulation Frequencies : Comparison of Relative " Annoyance " Effects of Triangular F-M Noise Spectrum & Rectangular A-M Noise Spectrum : etc.].—Crosby. (*RCA Review*, Jan. 1940, Vol. 4, No. 3, pp. 349–371.)

1645. Frequency Modulation [Survey].—Yocum. (*Communications*, Nov. & Dec. 1939, Vol. 19, Nos. 11 & 12, pp. 5–8 & 14–16 and 27 . . 30.)

1646. Wide-Band Frequency Modulation in Amateur Communication : Its Application and Advantages for U.H.F. Work.—Grammer & Goodman. (*QST*, Jan. 1940, Vol. 24, No. 1, pp. 11–19 and 92, 94.)

1647. Boston Police Radio.—(*Communications*, Nov. 1939, Vol. 19, No. 11, pp. 10–11 and 13.)

1648. Radio over the Mains : Capt. Eckersley's Lecture to the E.P.E.A's London Technical Group.—Eckersley. (*Electrician*, 2nd Feb. 1940, Vol. 124, p. 95 : summary only.)

1649. Weather by Telephone [New York Telephone Service], *and* Weather-Announcing Tape Machine.—Bennett: Cushman. (*Bell Lab. Record*, Nov. 1939, Vol. 18, No. 3, pp. 66–69: pp. 70–72.)

1650. EW-Telephony Long-Distance Connections in "Line Traffic" on High-Tension Lines [Advantages in Economy in Carrier Waves, Conference Service, etc.].—du Mont & Baranowsky. (*E.T.Z.*, 28th Dec. 1939, Vol. 60, No. 52, pp. 1469–1472.)

1651. A Remotely Controlled Radio Receiver [for Isolated Shore Sites of Coastal Radiotelephone Circuits: Operation controlled over Single Telephone Line], *and* Remote Control of Radio Systems.—McKennie: Pruden. (*Bell Lab. Record*, Nov. 1939, Vol. 18, No. 3, pp. 76–80: pp. 91–94.)

1652. The Broadcasting Centre "Radio-Andorra" [Station in Valley at 890 m Altitude, with Three-Section 850 m Feeder to Medium-Wave Aerial rigged across Lake at 1640 m: Short-Wave Horizontal Array 80 m above Bottom of Valley: the Transmitters: Hydroelectric Power Supply].—Adam. (*Rev. Gén. de l'Élec.*, 23rd/30th Dec. 1939, Vol. 46, No. 25/26, pp. 547–550.)

1653. The New Swiss National Short-Wave Broadcasting Station at Schwarzenburg.—Abel. (*L'Onde Élec.*, Aug./Sept./Oct. 1939, Vol. 18, No. 212/213/214, Supp. pp. 9–12.)

1654. Timing Carrier Breaks [at Broadcasting Stations].—Remley. (*Communications*, Nov. 1939, Vol. 19, No. 11, pp. 18–19.)

GENERAL PHYSICAL ARTICLES

1655. On the Motion of an Electrified Corpuscle in the Presence of a Magnetic Dipole.—Manarini. (*See* 1312.)

1656. Symmetrical Electromagnetic Propagation in Relation to an Axis.—Agostinelli. (*See* 1311.)

1657. New Form of the Gravitational Equations of General Relativity: Deduction of the Undulatory Equations of the Electromagnetic Field and of the Material Field [and the Mechanics of the Particle].—Caldirola. (*Boll. del Centro Volpi di Elett.*, English Edition, April/May/June 1939, Year 2, No. 2, Abstracts p. 215d.) *See* also 2151 of 1939.

1658. Electrodynamical Conception of Magnetic Energy [Relations between Vectors of Electric & Magnetic Fields: New Conception modifying Procedure for Calculation of Magnetic Energy: Its Superiority].—Puccianti. (*Boll. del Centro Volpi di Elett.*, English Edition, April/May/June 1939, Year 2, No. 2, Abstracts p. 217d.)

1659. The Equations of Dirac-Madelung [and the Magnetic Electron].—Yvon. (*Journ. de Phys. et le Radium*, Jan. 1940, Series 8, Vol. 1, No. 1, pp. 18–24.)

1660. The Radius of the Electron and the Calculation of the Photoelectric Constant of Metals.—Jonescu. (*Comptes Rendus*, 29th Jan. 1940, Vol. 210, No. 5, pp. 170–172.)

1661. Natural Unit of Measurement for the Phenomena of Radiation.—Laboccetta. (*La Ricerca Scient.*, Dec. 1939, Year 10, No. 12, pp. 1137–1139.)

1662. The Light Field.—Gershun. (*Journ. of Math. & Phys. of M.I.T.*, May 1939, Vol. 18, No. 2, pp. 51–151.) Translation of Gershun's 1936 book.

1663. On Potential Momentum and Momentum Fields in Dynamics.—Watson. (*Canadian Journ. of Res.*, Jan. 1940, Vol. 18, No. 1, Sec. A., pp. 1–21.)

MISCELLANEOUS

1664. "Rutherford: being the Life and Letters of the Rt. Hon. Lord Rutherford, O.M." [Book Reviews].—Eve. (*Electrician*, 19th Jan. 1940, Vol. 124, p. 41: *Science*, 12th Jan. 1940, Vol. 91, pp. 46–48.) The second review is by W. F. G. Swann.

1665. On the Foundation and Import of the Heaviside Operational Calculus.—Wagner. (*Zeitschr. f. tech. Phys.*, No. 11, Vol. 20, 1939, pp. 301–313.)

Author's summary:—"It is shown that the operational calculus, used by Heaviside with great success but not adequately explained mathematically, is derived physically from the following considerations. The operator function, obtained in the known way from the equations for the periodic régime, represents (with the exception of one factor) the frequency spectrum of the desired time function giving the temporal course of the transient process. The 'algebrising' of the Heaviside operator function thus presents itself as a functional transformation. It is brought about through a complex integral. Its inversion is the well-known Laplace transformation. From the understanding of this relation there arises a new, flawlessly based conception of the Heaviside method. This new operational calculus avoids the uncertainties and sources of error which have attached themselves to the old procedure, and extends the latter to the calculation of transient processes for an arbitrarily prescribed initial régime. The operational treatment almost always leads far more simply and quickly to the desired end than the methods most commonly employed."

1666. Operational Calculus for Technical Problems [and the Application of the Laplace Transformer Theory], *and* Elements of Functional Calculus for the Calculation of Electrical Systems.—Ghizzetti: Blanchi. (*Boll. del Centro Volpi di Elett.*, English Edition, April/May/June 1939, Year 2, No. 2, Abstracts p. 209d: p. 211d.)

1667. Transient Phenomena due to Starting and Stopping of Currents in Electric Circuits [and the Use of Abridged Methods of Calculation].—Giorgi. (*See* 1354.)

1668. Algebraic Equations with Complex Coefficients [such as arise in Transient-Current Problems].—Hitchcock. (*Journ. of Math. & Phys. of M.I.T.*, July 1939, Vol. 18, No. 3, pp. 202–210.)

1669. An Outline of the Theory of Algebraic Complex Operators, with Applications to Electric Circuit Theory.—Hirst. (*Journ. Inst. Eng. Australia*, Nov. 1939, Vol. 11, No. 11, pp. 391–395.)

1670. An Application of Polynomial Approximation to the Solution of Integral Equations arising in Physical Problems.—Crout. (*Journ. of Math. & Phys. of M.I.T.*, Jan. 1940, Vol. 19, No. 1, pp. 34–92.)

1671. Some New Properties of Bohr Almost-Periodic Fourier Series.—Takahashi. (*Jap. Journ. of Math., Transactions & Abstracts*, Sept. 1939, Vol. 16, No. 2, pp. 99–133.)

1672. Graphical Integration of the Linear Differential Equation of the Second Order.—Nagai. (*Mem. of Ryojun Coll. of Eng.*, No. 4, Vol. 12, 1939, pp. 89–99: in French.)

1673. Statistics and Engineering Practice.—Dudding & Jennett. (*Nature*, 20th Jan. 1940, Vol. 145, p. 117: notes on recent I.E.E. paper.)

1674. Physiological Effects of Ultrasonics.—Ponzio. (*Boll. del Centro Volpi di Elett.*, English Edition, April/May/June 1939, Year 2, No. 2, Abstracts p. 203d.)

1675. Action of Micro-Waves on the Vegetable Cycle of Different Vegetables.—Mezzadroli. (*Boll. del Centro Volpi di Elett.*, English Edition, April/May/June 1939, Year 2, No. 2, Abstracts p. 234d.) For previous work *see* Abstracts, 1929, p. 465; 1930, p. 413; 1931, p. 286; and 1932, p. 541.

1676. Ultra-Short Waves: Physics, Technique, and Fields of Application [Methods of Generation, Reception, & Measurement: Use in Medicine and Chemistry: Literature References (over 50)].—Hausser. (*Sitzungsberichte Heidelberger Akad.*, No. 4, 1939, 42 pp.) Published by the Weiss'sche Universitätsbuchhandlung, Heidelberg.

1677. The Influence of the Radio-Geological Properties of the Subsoil on the Propagation of Electromagnetic Waves.—Fritsch. (*See* 1324.)

1678. Remarks on "Direct-Lighting Strokes . . . and Experiments with Hazel-Twig Divining."—Baumeister. (*E.T.Z.*, 14th Dec. 1939, Vol. 60, No. 50, p. 1444.) *See* 897 of February.

1679. A New, Simple Super-Microscope and Its Application in Bacteriology.—Brüche & Haagen. (*See* 1569.)

1680. The Electrification of Insulating Powders by Free Fall [Charge caused by Impact of Powder at End of Fall: Quantity of Charge Generated is proportional to Square Root of Energy of Impact].—Morris: Fleming. (*Proc. Phys. Soc.*, 1st Nov. 1939, Vol. 51, Part 6, No. 288, pp. 1010–1013.) *Cf.* Fleming, 3012 of 1939.

1681. Instantaneous Electroconvective Eddies [in Moving Air Stratum: Analogy with Instantaneous Eddies in Insulating Liquids].—Avsec. (*Comptes Rendus*, 8th Jan. 1940, Vol. 210, No. 2, pp. 76–78.) *See* 1286 of March for previous work.

1682. Sterilisation of Food by Glow Discharge in Low-Pressure Gases or Vapours.—Toriyama & Takada. (*Electrot. Journ.*, Tokyo, Jan. 1940, Vol. 4, No. 1, p. 24.)

1683. Impedance of Bimolecular Films.—Dean & others. (*Science*, 12th Jan. 1940, Vol. 91, pp. 50–51.)

"The constant phase angle and a capacity of about one microfarad/cm^2 is a striking characteristic of all living cell membranes so far measured, and we believe these to be the first artificial films produced between two aqueous phases which had these properties."

1684. The Argument for Chemical Mediation of Nerve Impulses.—Cannon. (*Science*, 8th Dec. 1939, Vol. 90, pp. 521–527.)

1685. Nervousness Meter [Nervous State indicated by Electric Impulses generated by Nerve or Muscle Activity].—Jacobson. (*Sci. News Letter*, 6th Jan. 1940, Vol. 37, No. 1, p. 14.)

1686. Special Report of Investigation on Electrical Shock.—Underwriters' Laboratories. (*QST*, Jan. 1940, Vol. 24, No. 1, pp. 41 and 63: summary only.)

1687. The Lowering of the Domestic Mains Voltages [to the Safe Region below 65 Volts].—Kervran. (*Rev. Gén. de l'Élec.*, 30th Sept./7th Oct. 1939, Vol. 46, No. 13/14, pp. 347–348.) Continuing the work referred to in 732 & 1697 of 1938.

1688. The Measurement of Low-Speed Air Flow by means of a Thermoelectric Anemometer.—Wassiliew. (*Journ. of Tech. Phys.* [in Russian], No. 8, Vol. 9, 1939, pp. 724–729.)

1689. Simplified Precision Resistance-Welder Control [Synchronised Magnetic Contactor & Motor-Driven Timer].—Roby. (*Elec. Engineering*, Oct. 1939, Vol. 58, No. 10, Transactions pp. 528–534.)

1690. Ignitron Contactor Control of Resistance Welding.—Hutchins. (*Gen. Elec. Review*, Dec. 1939, Vol. 42, No. 12, pp. 544–547.)

1691. A New Ignitron Firing Circuit [Wider Fields of Application with Thyratron replaced by Saturable-Core Reactor].—Klemperer. (*Electronics*, Dec. 1939, Vol. 12, No. 12, pp. 12–15.)

1692. A Combined Optical and Electro-Mechanical Method for Determining the Pressure of the Soil on the Casing of a Cylindrical Tunnel.—Pokrovski & Klemtz. (*Journ. of Tech. Phys.* [in Russian], No. 8, Vol. 9, 1939, pp. 697–702.)

1693. Application of Sonic Method to Freezing and Thawing Studies of Concrete.—Hornibrook. (*ASTM Bulletin* of American Society for Testing Materials, Dec. 1939, No. 101, pp. 5–8.)

1694. The Magneto-Inductive Testing of Tubes [Ferrous and Non-Ferrous].—Schirp. (*E.T.Z.*, 20th July 1939, Vol. 60, No. 29, pp. 857–860.)

1695. The Employment of Magnetoscopic Tests [for Flaws in Metals].—Portevin. (*Génie Civil*, 16th Dec. 1939, Vol. 115, No. 25, pp. 437–438.)

1696. The Use of an Ionic Probe for Micro-Manipulations, the Boring of Extremely Small Holes for Spinning Technique, etc.—von Ardenne. (*See* 1567.)

1697. The Investigation of Rapidly Changing Mechanical Stresses with the Cathode-Ray Oscillograph [using a Varying-Resistance Strip consisting of a Carbon Line drawn on a Strip of Flexible Insulating Material].—de Bruin. (*Philips Tech. Review*, Jan. 1940, Vol. 5, No. 1, pp. 26–28.)

1698. A Practical Application of Cathode-Ray Tubes [to Series Testing of Small Armatures for Electrical Defects while in Motion].—Hollins. (*E.T.Z.*, 28th Dec. 1939, Vol. 60, No. 52, p. 1490: summary only.)

1699. Application of Cathode-Ray Tubes in Mass Production [of Broadcast Receivers, Motor & Dynamo Armatures, etc.].—van Suchtelen. (*Philips Tech. Review*, March 1939, Vol. 4, No. 3, pp. 85–89.) For previous papers *see* 1663 of 1939.

1700. An Electric Gauge.—Froböse & Schönbacher. (*Rev. Gén. de l'Élec.*, 28th Oct./4th Nov. 1939, Vol. 46, No. 17/18, pp. 431–432.) Long summary of the German paper dealt with in 3404 of 1939.

1701. A New Electrical Micrometer [for Displacements (5 Millionths of an Inch), Fluid Pressures, as Accelerometer, etc: Fixed Cathode, Two Anodes supported from Elastic Disphragm].—Gunn. (*Science*, 8th Dec. 1939, Vol. 90, Supp. p. 10.)

1702. Application of Piezoelectric Vibration Pick-Ups to Measurement of Acceleration, Velocity, and Displacement.—Baumzweiger. (*Journ. Acoust. Soc. Am.*, Jan. 1940, Vol. 11, No. 3, pp. 303–307.)

1703. The "Blinker" Electrical Moisture Meter: Recent Modifications.—Thomas. (*Journ. of Council for Scient. & Indust. Res.*, Australia, Feb. 1939, Vol. 12, No. 1, pp. 13–16 and Plate 1). For earlier work on this neon-tube device *see* 1932 Abstracts, p. 241 (Suits & Dunlap); *also* 360 of 1939.

1704. Progress in Stroboscopy [including the Use of High-Pressure Mercury Lamps].—Drewell. (*E.T.Z.*, 23rd Nov. 1939, Vol. 60, No. 47, pp. 1335–1340.)

1705. The Use of the Ultra-Rapid Cinema with 80 000 Images per Second: Its Application to Scientific Research in Engineering.—Nierenberger. (*Bull. de la Soc. franç. des Élec.*, Dec. 1939, Series 5, Vol. 9, No. 108, pp. 981–991.)

1706. "Photowiderstände" [Construction & Properties of Selenium, Selenium/Tellurium, & Thallofide Photocells: Their Applications in Laboratory & in Practice: Book Review].—Thirring & Fuchs. (*E.T.Z.*, 7th Dec. 1939, Vol. 60, No. 49, pp. 1411–1412.) May be considered an extension of Lange's 1936 book, an English translation of which was referred to in 4651 of 1938.

1707. An Arrangement for the Direct Photoelectric Measurement of Spark Spectra.—Meyer-Eppler. (*Arch. f. Elektrot.*, 10th Dec. 1939, Vol. 33, No. 12, pp. 763–776.)

1708. A Photometer for the Investigation of the Colour-Rendering Reproduction of Various Light Sources.—van Alphen. (*Philips Tech. Review*, March 1939, Vol. 4, No. 3, pp. 66–72.)

1709. On the Photometric Measurements of Coloured Light Sources.—Putzeiko. (*Journ. of Tech. Phys.* [in Russian], No. 10, Vol. 9, 1939, pp. 950–952.)

1710. A Photometer with Electron Pointer.—Vosinski. (*Journ. of Tech. Phys.* [in Russian], No. 11, Vol. 9, 1939, pp. 1034–1036.) For a previous paper *see* 4802 of 1939.

1711. Application of the Ferro-Resonance Voltage Stabiliser to Photometric Measurements.—Rityn. (*Journ. of Tech. Phys.* [in Russian], No. 11, Vol. 9, 1939, pp. 1032–1033.)

1712. X-Ray Photographs with Extremely Short Exposure Times [Condenser-Discharge Method with Ordinary Tube: No Under-Exposure for Times of a Few Microseconds].—Oosterkamp. (*Philips Tech. Review*, Jan. 1940, Vol. 5, No. 1, pp. 22–25.)

1713. The St. Bartholomew's Hospital X-Ray Tube for One Million Volts.—Allibone, Bancroft, & Innes. (*Journ. I.E.E.*, Dec. 1939, Vol. 85, No. 516, pp. 657–673: Discussions pp. 674–680.)

1714. Communications Engineering in Patent Statistics, 1938.—(*T.F.T.*, Oct. 1939, Vol. 28, No. 10, pp. 392–393.)

1715. Possibilities and Limits in the Construction and Use of High-Frequency Communication [Carrier-Current Telephony] Installations in the Supply Networks of Electricity Works [including Prediction of Single-Sideband Working and of Wide-Band Cable as Earthed Return].—Koske. (*E.T.Z.*, 26th Oct. 1939, Vol. 60, No. 43, pp. 1221–1225.)

1716. The Metameter System of Telemetering.—Bristol & Lunge. (*Gen. Elec. Review*, Nov. 1939, Vol. 42, No. 11, pp. 466–472.)

1717. A Level Compensator for Carrier-Telegraph Systems.—Thorp. (*Bell Lab. Record*, Oct. 1939, Vol. 18, No. 2, pp. 46–48.)

1718. Testing the Shields for Carrier-Frequency Line Structures [Metal-Tape Cylindrical Structures on Cables: Importance of Iron Layer sandwiched between Copper Layers].—Biskeborn. (*Bell Lab. Record*, Nov. 1939, Vol. 18, No. 3, pp. 88–90.)

1719. The Longitudinal Circuit [formed by the Two Wires of a Telephone Circuit and the Ground: Action as Introducer of Noise & Cross talk: Methods of Treatment].—Shetzline. (*Bell Lab. Record*, Sept. 1939, Vol. 18, No. 1, pp. 2–7.)

1720. The International Telecommunication Convention: Summary of Organisation, Provisions, and Operation.—Loring. (*Elec. Communication*, Oct. 1939, Vol. 18, No. 2, pp. 160–167.)

1721. The I.R.E.-R.M.A. Rochester Fall Meeting [Summaries].—(*Electronics*, Dec. 1939, Vol. 12, No. 12, pp. 20–25.)

1722. Some Recent American Advances in Apparatus and in the Technique of Experimental Physics [with Literature References].—Overbeck. (*Journ. of Scient. Instr.*, Jan. 1940, Vol. 17, No. 1, pp. 1–17.)

1723. "The Engineers' Manual: Second Edition" [Book Review].—Hudson. (*Communications*, Aug. 1939, Vol. 19, No. 8, p. 11.)

1724. "The History of the Institution of Electrical Engineers" [Book Notice].—Appleyard. (*Wireless Engineer*, Dec. 1939, Vol. 16, No. 195, p. 597.)

1725. The National Physical Laboratory: Radio Department [Sounding Balloons: C-R Direction Finder: Stability of Circuits: Atmospherics].—(*Engineering*, 8th Dec. 1939, Vol. 148, pp. 644–646.)

1726. Report on the Activity of the "G. Marconi" Radioelectric Centre during the Year 1938.—Bottini. (*See* 1310.)

1727. The Teaching of Physics in Schools and Technical Institutions.—Barton: Owen. (*Reports on Progress in Physics*, Physical Society, Vol. 5, pub. 1939, pp. 422–445: Vol. 6, pub. 1940, pp. 431–434.)

1728. A Simple Method for the Filing of Microfilm Records in Short-Length Strips.—Brown & Austin. (*Science*, 15th Dec. 1939, Vol. 90, pp. 573–574.)

1729. Vision of Future Developments [including Fields other than Radio Communication].—Sarnoff. (*RCA Review*, Jan. 1940, Vol. 4, No. 3, pp. 259–268.)

1730. Engineering Administration in a Small Manufacturing Company.—Burke. (*Proc. Inst. Rad. Eng.*, Jan. 1940, Vol. 28, No. 1, pp. 17–22.) A summary was referred to in 454 of January. The writer is Engineering Manager of the General Radio Company.

1731. Modern Radio Plant Practice.—Chase: Stromberg-Carlson Company. (*Electronics*, Dec. 1939, Vol. 12, No. 12, pp. 9–11.)

1732. Corrosion Tests in Communication Apparatus [and the Advantages of Accelerated Laboratory Tests].—Franz. (*E.T.Z.*, 21st Dec. 1939, Vol. 60, No. 51, pp. 1453–1456.) For a recent survey *see* 4257 of 1939.

1733. Current Literature, *and* Booklets, Catalogues, and Pamphlets.—(*Proc. Inst. Rad. Eng.*, Jan. 1940, Vol. 28, No. 1, pp. iv: pp. vi, viii.) A regular feature.

1734. Electrical Developments of 1939.—(*Gen. Elec. Review*, Jan. 1940, Vol. 43, No. 1, pp. 3–54.)

1735. Science in 1939.—(*Science*, 22nd Dec. 1939, Vol. 90, Supp. pp. 14..18.)

1736. High Lights in the Progress of Science in 1939.—(*Sci. News Letter*, 23rd Dec. 1939, Vol. 36, No. 26, pp. 403–405 and 412–416.)

1737. The Mechanism of Applied Research, and the Possibilities of a Collective Organisation.—Bertin. (*Génie Civil*, 13th Jan. 1940, Vol. 116, No. 2, pp. 33–34: summary only.)

1738. Research in 1939 [including Acoustics, "Metrosil" Resistance Material with Non-Linear Voltage/Current Characteristic, etc.].—(*Met.-Vick. Gazette*, Feb. 1940, Vol. 18, pp. 328–334.)

1739. Expectations in Radio: a Preview of 1940.—Rettenmeyer. (*Communications*, Jan. 1940, Vol. 20, No. 1, pp. 9–13 and 29..32.)

1740. How "Emergency Coördinators" Work [appointed by A.R.R.L.].—Corderman. (*QST*, Jan. 1940, Vol. 24, No. 1, pp. 54–56.)

1741. "Il Manuale del Radiomeccanico" [for Wireless Mechanics & Repairers: Book Review].—Angeletti. (*Alta Frequenza*, Nov. 1939, Vol. 8, No. 11, pp. 745–746.)

1742. "Radiotecnica: Volume II—Tubi Elettronici" [Book Review].—Montù. (*Alta Frequenza*, Nov. 1939, Vol. 8, No. 11, pp. 744–745.)

Wireless Patents

A Summary of Recently Accepted Specifications

The following abstracts are prepared, with the permission of the Controller of H.M. Stationery Office, from Specifications obtainable at the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1/- each

ACOUSTICS AND AUDIO-FREQUENCY CIRCUITS AND APPARATUS

516 250.—Negative feed-back circuit for volume compression.
H. A. M. Clark. Application date 16th July, 1938.

516 286.—Negative feed-back circuit for controlling tone in a low-frequency amplifier.
The Mullard Radio Valve Co. and R. G. Clark. Application date 20th June, 1938.

AERIALS AND AERIAL SYSTEMS

515 795.—Short-wave aerial of the dipole type in which each limb is of conical shape, suitable for transmitting or receiving a wide band of frequencies, as in television.
Marconi's W.T. Co. (assignees of P. S. Carter). Convention date (U.S.A.) 12th June, 1937.

515 892.—Telescopic rod aerial for a motor-car, arranged so that it can conveniently be collapsed when out of use, or its height adjusted to control signal-strength.
Transitone Automobile Radio Corpn. (assignees of M. F. Shea and E. A. Speakman). Convention date (U.S.A.) 17th June, 1937.

516 263.—Lattice type of aerial intended to reduce the effect of "static" interference.
R. N. Reed. Application date 22nd July, 1938.

DIRECTIONAL WIRELESS

516 563.—Means for improving the electrical symmetry of directive aerial systems of the Adcock type.
W. W. Triggs (communicated by Pan-American Airways). Application date 21st April, 1938.

516 567.—Radio receiver for indicating the gliding path to an aviator when he is making a "blind" landing down a wireless beam.
S. Smith & Sons (Motor Accessories) and F. W. Meredith. Application date 25th May, 1938.

516 642.—Aerial arrangement for radiating a navigational course-line of the overlapping-beam type.
Marconi's W.T. Co.; B. J. Witt; and J. G. Robb. Application date 2nd July, 1938.

517 099.—Wireless direction-finding system utilising "impulse" signals in order to eliminate the space-wave component.
Telefunken Co. Convention date (Germany) 28th August, 1937.

RECEIVING CIRCUITS AND APPARATUS

(*See also under Television*)

515 693.—Remote tuning-control by a bridge circuit with variable tappings on the adjacent pairs of impedance arms.
Telefunken Co. Convention date (Germany) 5th June, 1937.

515 710.—Aerial coupling circuit for the alternate reception of short- and long-wave signals (addition to 501 051).
Telefunken Co. Convention date (Germany) 9th June, 1937.

515 898.—Transformer coupling-device between aerial and receiver for balancing-out static interference.
F. J. Chart (assignee of M. G. Clay). Convention date (U.S.A.) 15th June, 1937.

516 385.—Radio receiver with an auxiliary switch for changing over from push-button to manual tuning control.
Kolster-Brandes and W. A. Beat. Application date 24th June, 1938.

516 495.—Differential system of automatic volume control for a wireless receiver with a number of amplifying stages in cascade.
Marconi's W.T. Co. (assignees of W. R. Koch). Convention date (U.S.A.) 30th June, 1937.

516 504.—Switch-controlled negative feed-back arrangement for "muting" a wireless receiver when tuning between stations.
N. H. B. Brown. Application date 19th July, 1938.

516 631.—Alternative arrangement of the viewing-screen and the station-indicating scale, according to whether a combination set is being used to receive television or ordinary broadcast signals.
Kolster-Brandes and C. E. Lock. Application date 1st July, 1938.

516 697.—Amplifier in which a comparatively small negative feed-back maintains a constant output impedance.
Standard Telephones and Cables and A. H. Roche. Application date 5th July, 1938.

517 068.—Wireless receiver with push-button tuning by remote control, and with frequency-correction and other automatic tuning adjustments.

Marconi's W.T. Co. (assignees of W. E. Newman). Conventdon date (U.S.A.) 10th July, 1937.

TELEVISION CIRCUITS AND APPARATUS

(For Transmission and Reception)

515 800.—Intervalve coupling for a high-frequency amplifier handling a wide band of frequencies, as in television.

Baird Television and C. E. Maitland. Application date 13th June, 1938.

515 801.—Means for preventing the kind of distortion known as "tilt and bend" in television transmitters of the cathode-ray type.

Baird Television and V. A. Jones. Application date 13th June, 1938.

515 947.—Time-base circuit for a cathode-ray tube of the kind in which the screen to be scanned is set at an angle to the normal path of the electron stream.

Baird Television and G. R. Tingley. Application date 14th June, 1938.

516 246.—Electrode arrangement in a cathode-ray tube to prevent image-distortion due to undesired secondary emission.

Telefunken Co. Convention date (Germany) 24th June, 1937.

516 247.—Television system in which slight departures from exact synchronism in mechanical scanning are tolerated.

Scophony; A. F. H. Thomson; and A. H. Rosenthal. Application date 24th June and 8th July, 1938.

516 252.—Separating the signal and synchronising signals in a television system in which the sound and vision channels include a common frequency-changer.

The General Electric Co. and D. C. Espley. Application date 19th July, 1938.

516 335.—Ruled screen with variably-spaced lines to be used in conjunction with the viewing-screen in stereoscopic systems of television.

R. S. Clay. Application date 25th July, 1938.

516 351.—Cathode-ray television receiver in which the secondary emission produced by scanning a primary screen is projected first on to a fluorescent and then on to a viewing screen.

Baird Television and V. A. Jones. Application date 20th June, 1938.

516 357.—Saw-toothed oscillation generator with means for preventing variations in frequency due to alterations of grid impedance.

Telefunken Co. Convention date (Germany) 21st June, 1937.

516 581.—Saw-toothed oscillation generator, for television, designed to facilitate the separation of the frame and line synchronising impulses.

Telefunken Co. Convention date (Germany) 29th June, 1937.

516 596.—Volume-control potentiometers free from frequency-discrimination and suitable for wide-band amplifiers such as are used in television.

Marconi's W.T. Co. (assignees of J. P. Smith). Convention date (U.S.A.) 30th June, 1937.

516 620.—Construction of a screen for a cathode-ray tube in which a received television picture is made visible by incandescence as distinct from fluorescence.

F. J. G. van den Bosch. Application date 2nd June, 1938.

516 737.—Scanning system for a television tube with a double-sided storage electrode.

Fernseh Akt. Convention date (Germany) 6th July, 1937.

TRANSMITTING CIRCUITS AND APPARATUS

(See also under Television)

515 684.—Tubular conductor with a longitudinal slit for the transmission or radiation of the magnetic flux set up by circulating currents of high frequency.

A. D. Blumlein. Application date 7th March, 1938.

515 762.—Amplifier for feeding a wireless transmitter and for offsetting any distortion due to grid current.

Marconi's W.T. Co. and E. Green. Application date 11th June, 1938.

515 824.—Modulating system, particularly for very high frequencies, depending upon the use of a quarter-wave transmission-line between the load and a rotary coupling-condenser.

Inter-Continental Service Corpn. Convention date (U.S.A.) 2nd December, 1937.

515 864.—Screening arrangement to prevent undesirable feed-back in a power amplifier of the triode type as used for transmitting ultra-short waves.

E. L. C. White. Application date 30th June, 1938.

516 067.—Means for balancing or neutralising self-oscillation in a push-pull amplifier for a short-wave transmitter.

Marconi's W.T. Co. (assignees of N. E. Linden Blad). Convention date (U.S.A.) 19th June, 1937.

516 088.—Signalling system in which secrecy is ensured by manipulating the two side bands in a way which does not involve band-splitting but does include transposing the signal from one band to the other.

Standard Telephones and Cables (assignees of C. C. Taylor and S. B. Wright). Convention date (U.S.A.) 11th August, 1937.

516 359.—Attenuator network for the selective coupling of a number of different circuits to a common high-frequency transmission-line.

Standard Telephones and Cables and R. A. Meers. Application date 21st June, 1938.

516 388.—Cathode-ray device for calibrating the frequency of a thermionic oscillator of the so-called "decade" type.

Standard Telephones and Cables and R. M. Barnard. Application date 24th June, 1938.

516 643.—Keying system for a radio transmitter arranged so that the final keyed valve takes maximum dead loss when the other keyed valves are in the "cut-off" condition.

Marconi's W.T. Co. and H. J. H. Wassell. Application date 2nd July, 1938.

517 036.—Multiplex carrier-wave signalling system with "staggered" frequency-channels to minimise cross-talk.

Standard Telephones and Cables (assignees of G. H. Huber). Convention date (U.S.A.) 18th August, 1937.

517 052.—High-frequency transmission-line fitted with "re-entrant" sections for filtering and impedance-matching.

Standard Telephones and Cables (assignees of A. Alford) addition to 491 359. *Convention date (U.S.A.) 16th November, 1937.*

CONSTRUCTION OF ELECTRONIC-DISCHARGE DEVICES

516 110.—Construction of a screen-grid amplifier with a flat glass closure-plate at the base of the bulb through which the socket-plugs project.

Hygrade Sylvania Corpn. Convention date (U.S.A.) 28th May, 1937.

516 193.—Electrode construction and arrangement to facilitate the cooling of high-powered thermionic valves.

Telefunken Co. Convention date (Germany) 24th July, 1937.

516 282.—Construction and assembly of a short-wave valve, with external screening members, designed to minimise inter-electrode capacitances.

J. H. Ludlow and Metropolitan-Vickers Electrical Co. Application date 5th May, 1938.

516 387.—Flexible support for the coated cathode of a thermionic valve.

Standard Telephones and Cables and F. D. Goodchild. Application date 24th June, 1938.

516 455.—High-emission "cold" pointed-wire cathode arrangement for a cathode-ray tube.

The British Thomson-Houston Co. Convention date (Germany) 30th June, 1937.

516 551.—Electrode arrangement of a valve in which the electron stream is formed into a number of well-defined "beams," controlled by comparatively low voltages.

Marconi's W.T. Co. (assignees of O. H. Schade). Convention dates (U.S.A.) 29th June, 1937, and 29th January, 1938.

516 621.—Construction and arrangement of the target electrodes in an electron-multiplier tube.

F. J. G. van den Bosch. Application date 2nd June, 1938.

516 637.—Design of cathode-ray tube to enable the use of a shorter glass tube than usual.

Baird Television and L. R. Merdler. Application date 2nd July, 1938.

SUBSIDIARY APPARATUS AND MATERIALS

515 786.—Stabilising the frequency of an oscillation-generator of the multi-vibrator type.

E. L. C. White. Application date 13th April, 1938.

515 982.—Thermionic rectifier with two anodes, one of which is perforated and placed in front of the second to receive electrons passing through the latter.

The M-O Valve Co.; W. H. Aldous; and D. C. Espley. Application date 7th July, 1938.

516 047.—Thermionic-valve circuit for maintaining a constant terminal voltage across a load, particularly an X-ray tube.

Philips' Lamp Co. Convention date (Germany) 27th January, 1937.

516 081.—Circuit arrangement for measuring the strength of large currents of very high frequency.

Siemens and Halske Akt. Convention date (Germany) 19th June, 1937.

516 628.—Inductively-wound resistances for stabilising amplifiers using negative feed-back.

Standard Telephones and Cables and A. H. Roche. Application date 1st July, 1938.

516 648.—Remote-control system adapted to respond to signals of predetermined frequency transmitted over power-supply lines.

Marconi's W.T. Co. (assignees of S. W. Seeley). Convention date (U.S.A.) 3rd July, 1937.

516 723.—Cathode-ray tube for indicating the direction and change of direction of a magnetic field.

H. Hughes & Son; D. D. Sproule; and A. J. Hughes. Application date 21st May, 1938.

517 033.—Photo-electric distant control apparatus in which each step-by-step or other movement is automatically indicated.

Soc. Anon. Fimi. Convention date (Italy) 22nd July, 1937.