THE

WIRELESS ENGINEER

Vol. XVI. FEBRUARY, 1939 No. 185

Editorial

Heinrich Rudolph Hertz

Fifty Years After

It was during the two years, 1886–1888, that Hertz carried out the experiments which may be regarded as the birth of radio. He began them in Karlsruhe in November, 1886, and already in the following month he was able to write to Helmholtz reporting some initial successes. In 1887 he published a paper,* "On Very Rapid Electrical Oscillations," and in 1888 his classical paper,† "On the Radiation of Electric Force." In September, 1889, he gave a lecture before the Physical Congress at Heidelberg "On the Relation Between Light and Electricity." In this same year he was appointed Professor of Physics at Bonn in succession to Clausius. On January 1st, 1894, he died at the age of 36.

The object of his researches was to obtain experimental confirmation of the Maxwellian concept of the nature of electromagnetic waves—the production of a magnetic field by the electric displacement current in space. In 1884 he had published a theoretical paper‡ on this subject, but his two years of experimental work with the production of waves on wires, their propagation through space, their reflection, refraction and interference, carried out and interpreted by a man who was a mathematical physicist of the first rank, and described with great clarity and brevity, will always rank as one of the greatest human achievements.

Hertz was born at Hamburg in 1857, his father a lawyer and later a Senator of the city, his mother the daughter of a doctor of medicine and descended from a long line of Lutheran pastors. He studied at Dresden, Munich and Berlin, the original intention being that he should become an engineer; with this end in view he did a year's practical work at Frankfurt and a year's military service in the railway battalion in Berlin. It was at Munich that he finally decided to devote himself to mathematics and physics in preference to engineering, and he went to Berlin to study under Helmholtz and Kirchhoff. In 1880 he took his Doctor's degree with a thesis on induction in rotating spheres and was appointed a demonstrator under Helmholtz. In 1883 he was appointed lecturer in theoretical physics at Kiel, and in 1885 Professor of Experimental Physics at Karlsruhe.

In 1887 he published a paper on a phenomenon which he had discovered during his wave experiments, viz., the effect of ultra-violet light on the electric discharge.

* "Wiedemann's Annalen," 31, p. 41.
† "Wiedemann's Annalen," 36, p. 769.
‡ "Wiedemann's Annalen," 23, p. 84.

Although best known for his electromagnetic discoveries and as an exponent of the Maxwell theory, he was outstanding in another branch of physics, and his energies during the final years of his life were largely concentrated on the completion of a book on "The Principles of Mechanics." This he finished shortly before his death and it was posthumously published with an introduction by Helmholtz. It was an attempt to build the whole structure of mechanics upon the foundation of the principle of least work. It is interesting to note that in a short biographical article recording the fiftieth anniversary of his great discovery in a recent number of the *Elektrotechnische Zeitschrift*, the opinion is expressed that "'The Principles of Mechanics' is of a speculative character, complicated and difficult to follow, and remained unfruitful. This was due apparently to his half-Jewish ancestry."

One cannot but wonder whether the idea ever occurred to Hertz that his great discovery might have a practical application. In his "Pioneers of Electrical Communication," Rollo Appleyard says: "It can be definitely stated that concerning the future employment of Hertzian waves for telegraphy and telephony he had no premonitions. For there exists a letter written by him to one Herr Huber, who wanted to know whether there was a prospect in that direction. Hertz regarded it as impracticable. His reply was to the effect that the application of such a mode of electrical communication to practical telegraphy or telephony would need a mirror as large as a continent." This is a striking example of the way in which one should not treat original documents. Hertz's letter which is reproduced in the book does not mention telegraphy but speaks of the "Schwingungen eines Transformators oder eines Telephons" being much too slow. In the translation Appleyard replaces telephone by telegraph, and then in the explanatory text makes Hertz's reply cover telegraphy or telephony. It is fairly obvious that this correspondence had nothing to do with telegraphic signalling by making and breaking a circuit, but was concerned solely with the possibility of the radiation of electromagnetic waves from telephonic currents. Nevertheless, it is probably true that Hertz had no premonitions concerning the practical utility of his discovery. To him his work confirmed and crowned the theories of Maxwell, whereas we are more inclined to regard it as the foundation upon which the science of radio-communication has been erected.

During the last few years of his life honours were showered upon him; he was made an honorary member of a number of scientific academies, and our Royal Society awarded him the Rumford medal. It was typical of him that on the latter occasion nobody in Bonn knew why he was absent for a few days, and also that he declined to let the editor of *The Electrician* have his photograph, but asked him to wait a year or two to "see if the general approbation which my work meets with is of a lasting kind." It was on his death four years later that the photograph was published. The biographical obituary address which was published in the *Chronik* of Bonn University closed with the words: "More lasting and almost greater than our sorrow at his death is our pride to have counted him as one of us if only for a few years." How true this was, not only of Bonn University, but of the whole of Germany, can be seen from the 1930 volume of *Elektrische Nachrichten-Technik*, which contains an account of a special commemorative meeting of the Heinrich Hertz Gesellschaft—a society for the promotion of wireless research—at which the Heinrich Hertz Gold Medal was presented to Dr. K. W. Wagner; also of another special meeting of the same society held in the Heinrich Hertz Memorial Hall and attended by Frau Professor Hertz—his widow—who was welcomed in a speech by the Secretary of State, Dr. Bredow; also of another meeting held in the former Upper House, at which a large-scale replica of the Heinrich Hertz Gold Medal was presented to his widow as a memorial gift to the family of the "great genius." In the same volume there is a full account of the proceedings at the opening of the Heinrich Hertz Institute for oscillation research in Charlottenburg of which Dr. K. W. Wagner was appointed director.

He was also honoured in another way by the adoption of his name as the name by which German scientists, and those of several other countries, refer to the unit of frequency, the cycle per second, the ordinary power frequency being referred to as "50 Hertz."

G. W. O. H.

The "Variable Q" Amplifier*

A Power Amplifier with Inherent Voltage Compensation for Load Variations

By Alan Fairweather, M.Sc., Grad. I.E.E., and F. C. Williams, M.Sc., D.Phil., Grad. I.E.E.

Contents

1. Introduction

AN apparatus which delivers a sinusoidal oscillation whose voltage amplitude is independent of load variations has many obvious applications in light-current engineering. Amongst these may be noted the production of signals for voice-frequency signalling, drive stages for Class C amplifiers and the measurement of coil power factors by the reactance-distuning method.

A constant-current source is already provided by the pentode valve but no constant-voltage equivalent has hitherto been available. This paper describes an extension of a little-known principle due to P. Boucherot[1] which converts the constant current property of the pentode into one of constant voltage.

2. Basic Circuit

The circuit devised by Boucherot[2] is shown in Fig. 1: here X represents the magnitude of a reactance and the convention is adopted of designating an inductive reactance as $+X$ and a capacitive reactance as $-X$. It was shown that the magnitude of the current traversing R was always E/X whatever the value of R. Thus a constant-voltage supply could be transformed into a source of constant current.

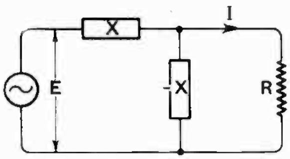
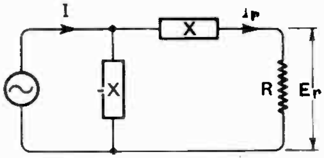


Fig. 1.



(*Right*) Fig. 2.

This suggested that the network of Fig. 2 might exhibit the converse property which, in fact, it does. In both figures X itself may be either positive or negative; the precise significance of this will be discussed later. The converse property is easily proved; thus referring to Fig. 2:

$$E_r = RI_r$$

$$I_r = [-jX/(R + jX - jX)]I$$

$$= -(jX/R)I$$

$$\text{so } E_r = -jXI \qquad \ldots \qquad (1)$$

*MS. accepted by the Editor, October, 1938.

[1] *Rev. Gen. de L'Elec.*, Feb. 8th, 1919, p. 203.

[2] *loc. cit.*

and is independent of R. The impedance presented to the constant current generator is:

$$Z = -jX(R + jX)/(R + jX - jX)$$
$$= -jX + (X^2/R)$$

or,

$$|Z| = X\sqrt{1 + (X^2/R^2)} \quad \ldots \quad \ldots \quad (2)$$

It is of interest to discuss the physical significance of (1) and (2). As R increases the Q (i.e. quality $= X/R$) of the tuned circuit decreases; Z decreases and, since I is constant, the terminal voltage of the generator decreases. Thus both branch currents decrease, although their resultant remains constant, and the product of R and the current traversing it tends to remain constant.

The succeeding sections describe the application of this principle to the sensibly constant current delivered by pentode valves; the limitations imposed by valve parameters and by inherent resistance in the reactances are fully discussed. A somewhat large number of symbols will be required; for convenience, therefore, these have been listed and defined in an Appendix, in addition to being defined when first introduced.

3. Distortion with Pentodes

(a) Resistive Loads

A typical set of pentode characteristics is shown in Fig. 3. With resistive loading the operating conditions are defined by a load line such as AOA', the point O representing the "no-signal" condition. The location of the line AOA' is fixed by consideration of several factors which may be summarised as follows:—

(i) A current limitation; here the lower limit is set by unidirectional current-flow in the valve and the upper limit usually by the requirement that the grid shall never become positive.

(ii) A voltage limitation; here the lower limit is set by distortion introduced by pronounced curvature of the characteristics at low anode voltages. No fundamental upper limit exists, but a practical one is introduced by the relation between the lower limit and the permissible steady anode potential (see Fig. 3). These considerations permit of the evaluation of an optimum load resistance R_0 given by E_m/I_m.

(b) Complex Loads

Inspection of typical families of anode-current anode-voltage characteristics for pentodes shows that, as the magnitude of the negative grid bias is increased, the curves become progressively flatter and the "knee" always occurs in the same range of anode voltage. Hence, if a rectangle be drawn with the optimum resistive load line as diagonal, the portions of the characteristics enclosed by the rectangle are sensibly straight, regions of pronounced curvature

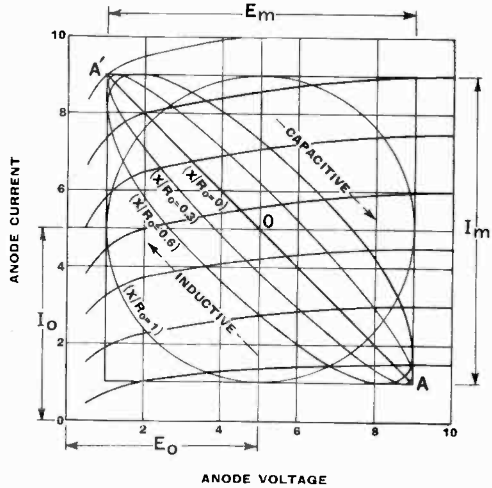


Fig. 3.

being largely excluded. It follows that if, with complex loads, the operating point be always confined within this rectangle, the distortion introduced by departure from strict linearity will never exceed that occurring with resistive loads.

Let the complex load be of the form $Z = r' + jx'$: then, referring to Fig. 3, if i is to lie within the prescribed limits, the maximum value allowable for I_p is, ideally, $I_m/2$. Let a grid voltage be applied such that the anode current is of the form:

$$i = I_0 + (I_m/2) \sin \omega t \quad \ldots \quad \ldots \quad (3)$$

The corresponding instantaneous magnitude of the anode potential is:

$$e = E_0 - |Z|\,(I_m/2) \sin(\omega t + \tan^{-1} x'/r') \quad \ldots \quad (4)$$

which has peak and trough values,

$$E_0 \mp \frac{|Z| I_m}{2}.$$

Thus, as ωt varies, it is obvious that anode voltage excursions may be limited to the working rectangle by ensuring that:

$$|Z| = R_0 = E_m/I_m \quad \ldots \quad \ldots \quad (5)$$

If x' and r' are varied subject to this condition it follows that a family of skew ellipses will result, every member of which will touch all four sides of the working rectangle. The adequacy of this criterion may be illustrated as follows: (4) may be rewritten:

$$e = E_0 - (I_m/2)(r' \sin \omega t + x' \cos \omega t) \quad \ldots \quad (6)$$

Inserting the above limit, $\sqrt{r'^2 + x'^2} = R_0$, this becomes

$$e = E_0 - R_0(I_m/2)[\sqrt{1 - (x'^2/R_0^2)} \sin \omega t + (x'/R_0) \cos \omega t] \quad \ldots \quad \ldots \quad (7)$$

Since $R_0 I_m = E_m$, (7) may be written:

$$e = E_0[1 - (E_m/2E_0)\{\sqrt{1 - (x'^2/R_0^2)} \sin \omega t + (x'/R_0) \cos \omega t\} \quad \ldots \quad \ldots \quad (8)$$

and similarly:

$$i = I_0[1 + (I_m/2I_0) \sin \omega t] \quad \ldots \quad \ldots \quad (9)$$

Given E_0, I_0, $E_m/2E_0$ and $I_m/2I_0$ these two expressions enable the complete family of skew ellipses to be drawn for values of x'/R_0 varying from zero to unity. The limiting configurations are given by the straight line forming the diagonal of the working rectangle for purely resistive loading ($x'/R_0 = 0$), and the (non-skewed) ellipse for purely reactive loading ($x'/R_0 = 1$). In Fig. 3, which has been drawn for the case where $E_m/2E_0 = I_m/2I_0 = 0.8$, this has been done for values of x'/R_0 of 0, 0.3, 0.6 and 1. It is obvious from these that a pentode will deliver a sensibly undistorted sinusoidal anode current into any complex impedance Z in its anode circuit provided only that $|Z| \leqslant R_0$. It may be noted that this statement refers to a pentode with full grid drive. If some lower value of driving voltage be adopted the statement still holds provided that the value taken for R_0 is that relevant to the lower drive.

4. Analysis

(a) Neglecting Circuit Losses

Consideration of the simple circuit of Fig. 2 and the analysis of the preceding section, suggests that, from the point of view of design, the most significant variables are X, $Q(= X/R)$ and R_0. The subsequent analysis will accordingly be carried out in terms of these quantities.

From (2) the impedance experienced by I is,

$$|Z| = X\sqrt{1 + (X^2/R^2)}$$

and it follows, as is otherwise physically obvious, that $|Z|$ is greatest when R is least. If R could be made zero then $|Z|$ would become infinite, a well-known property of a tuned rejector circuit. Let R_m be the least allowable value of R; then the condition that $|Z| \leqslant R_0$ will be satisfied for all greater values of R provided that:

$$|Z|_{R=R_m} = X\sqrt{1 + (X^2/R_m^2)} = R_0 \quad \ldots \quad \ldots \quad \ldots \quad (10)$$

i.e. provided,

$$1/R_m = (1/X)\sqrt{(R_0^2/X^2) - 1} \quad \ldots \quad (11)$$

Since (10) is a quadratic in X^2 this can be rewritten as:

$$X^2 = (R_m^2/2)(\sqrt{1 + (4R_0^2/R_m^2)} - 1) \quad .. \quad (12)$$

The power dissipated in R is:

$$W = E_r^2/R$$

and substituting for E_r from (1) this becomes:

$$W = X^2I^2/R \quad \ldots \quad \ldots \quad \ldots \quad (13)$$

The corresponding expression for the maximum power, which occurs when $R = R_m$ is:

$$W_m = X^2I^2/R_m \quad \ldots \quad \ldots \quad (14)$$

On substituting for X^2 from (12) this becomes:

$$W_m = (I^2R_m/2)(\sqrt{1 + (4R_0^2/R_m^2)} - 1) \quad \ldots \quad (15)$$

Differentiation of this expression with respect to R_m shows that it has a minimum value of zero when R_m is infinite, and has no other stationary values. That with R_m infinite the power must be zero is physically obvious, for the anode load is then purely reactive, but the necessity for the absence of other stationary values is not so apparent. At first sight the power might appear to be zero with R_m zero, but it is actually finite since the circulating current is then infinite. However, practical limitations, not envisaged in this simple theory, do in fact introduce a second stationary value for the power. The impedance X

must have an associated series loss resistance, r say. With $R_m = r$ the external resistance is zero and the available power is zero; the finite power suggested previously is then dissipated entirely in the circuit loss resistance r. Before proceeding to a detailed discussion of the effect of circuit losses it is instructive to consider this simple theory from the point of view of efficiency, i.e. the proportion of the normal power handling ability of the pentode which is available. It then follows that the power dissipated increases steadily as R_m is decreased from infinity, thus suggesting the desirability of low values of R_m. For maximum efficiency it is necessary that W_m shall approach as closely as possible W_0, the maximum undistorted power output of the pentode. Now:

$$W_0 = I^2R_0 \quad \ldots \quad \ldots \quad \ldots \quad (16)$$

and (15) may be written in the form:

$$W_m = I^2R_0[\sqrt{1 + (R_m^2/4R_0^2)} - (R_m/2R_0)] \quad \ldots \quad \ldots \quad (17)$$

The efficiency is given by:

$$\eta = W_m/W_0$$
$$= [\sqrt{1 + (R_m^2/4R_0^2)} - (R_m/2R_0)] \quad \ldots \quad (18)$$

and this can be made very high if R_m is made sufficiently small. It remains to be seen whether the lower limit imposed upon R_m by circuit losses vitiates this finding.

(*b*) *Effect of Circuit Losses.*

(i) *General.*

Analytical attention will be confined to the simplest case of residual resistance in $+X$. The arrangement visualised is shown in Fig. 4. Here r is the loss resistance associated with $+X$ and R' is the added load resistance. Hence R of the previous section is now replaced by:

$$R = R' + r \quad \ldots \quad \ldots \quad \ldots \quad (19)$$

and similarly

$$R_m = R_m' + r \quad \ldots \quad \ldots \quad \ldots \quad (20)$$

W of the previous section now represents the total power dissipated, of which W' only is available in the load, the remainder being dissipated in the form of circuit losses. Hence:

$$W' = [R'/(R' + r)]W$$
$$= (1 - r/R)W \quad \ldots \quad \ldots \quad \ldots \quad (21)$$

which, on substituting for W from (13), becomes

$$W' = (X^2I^2/R)(1 - r/R) \quad \ldots \quad \ldots \quad (22)$$

With a given X this has a maximum value when $R = 2r$ but it will be seen later that distortion sets in before R reaches this low value (i.e. $R_m > 2r$). Hence the maximum value of W will usually occur with $R = R_m$, and then:

$$W_m' = (X^2I^2/R_m)(1 - r/R_m) \quad \ldots \quad (23)$$

The actual working efficiency W_m'/W_0, which will be denoted by η', is given by:

$$\eta' = (X^2/R_0)(1/R_m)(1 - r/R_m) \quad \ldots \quad (24)$$

On substituting for $1/R_m$ from (11) and writing $X/r = Q$ this becomes:

$$\eta' = \sqrt{1 - (X^2/R_0^2)}[1 - (\sqrt{(R_0^2/X^2) - 1})/Q] \quad \ldots \quad \ldots \quad (25)$$

$$= \sqrt{1 - (X^2/R_0^2)} - [(R_0/X) - (X/R_0)]/Q \quad \ldots \quad \ldots \quad (26)$$

(ii) *Optimum Conditions.*

It may be seen by inspection of (26) that, for given values of Q and R_0, an optimum value of X exists which will yield maximum efficiency. Differentiation with respect to X shows that this occurs when:

$$1/\sqrt{1 - (X^2/R_0^2)}$$
$$= (R_0^2/X)(1/Q)[(R_0/X^2) - (1/R_0)]$$

i.e. when:

$$(R_0^6/X^6) - (R_0^4/X^4) = Q^2 \quad \ldots \quad \ldots \quad (27)$$

Since $|Z| \gg R_0$, $X/R_0 < 1$, and hence for a first approximation the term (R_0^4/X^4) can be neglected yielding:

$$(R_0/X) = Q^{1/3} \quad \ldots \quad \ldots \quad \ldots \quad (28)$$

A closer approximation can now be achieved by replacing the neglected fourth power term in (27) by its approximate value $Q^{4/3}$ obtained from (28) which gives:

$$(R_0/X) = (Q^2 + Q^{4/3})^{1/6}$$
$$= Q^{1/3}(1 + Q^{-2/3})^{1/6} \quad \ldots \quad \ldots \quad (29)$$

Since $Q > 1$ this may be written:

$$(R_0/X) = Q^{1/3}[1 + (1/6)Q^{-2/3}] \quad \ldots \quad (30)$$

and further, since Q will usually not be less than 30, it is clear that the first approximation is quite adequate and the optimum value of X may be taken as :

$$X_0 = R_0/Q^{1/3} \quad \ldots \quad \ldots \quad \ldots \quad (31)$$

For a given R_0 it may be noted that, due to the presence of the cube root, X_0 will not vary greatly over a fairly wide range of Q.

Substituting for X_0 from (31) into (26) gives the maximum value of η', i.e.

$$\eta_m' = \sqrt{1 - Q^{-2/3}} - Q^{-2/3} + Q^{-4/3}$$

which reduces approximately to :

$$\eta_m' = 1 - (3/2)(Q^{-2/3}) \quad \ldots \quad \ldots \quad (32)$$

If Q is large, of the order of 30, the efficiency should be very good, a finding which justifies the earlier statement that usually $R_m > 2r$.* The truth of this remark is also apparent from other considerations for,

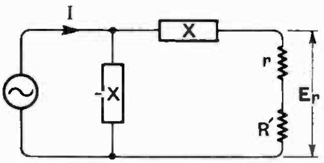


Fig. 4.

on substituting for X_0 from (31) into the expression for R_m given in (11) and remembering that with optimum conditions $X_0/r = Q$, it follows that :

$$I/R_m = (1/rQ)\sqrt{Q^{2/3} - 1}$$

i.e., since $Q \gg 1$,

$$R_m \approx Q^{2/3}r \quad \ldots \quad \ldots \quad (33)$$

and obviously $Q^{2/3} > 2$.

Replacing r by X_0/Q, (33) becomes :

$$R_m \approx X_0/Q^{1/3}$$

or substituting for X_0 from (31)

$$R_m \approx R_0/Q^{2/3} \ldots \quad \ldots \quad \ldots \quad (34)$$

(iii) *Regulation.*

The analysis of Subsection (a) suggests that the inherent regulation of the system is perfect, but circuit loss resistance prevents the practical achievement of this result. Referring to Fig. 4 the available output voltage is $R'/(R' + r)$ of the constant resistance voltage. Hence the actual output voltage is :

$$= [R'/(R' + r)]XI \quad \ldots \quad \ldots \quad (35)$$

and the regulation δ is given by :

$$\delta = R'/(R' + r)$$
$$= 1 - r/R \ldots \quad \ldots \quad \ldots \quad (36)$$

* With $R_m = 2r$ the efficiency is necessarily less than 50 %.

The value of regulation of interest is obviously that existing at maximum output, i.e. :

$$\delta_m = 1 - r/R_m \quad \ldots \quad \ldots \quad \ldots \quad (37)$$

subject to the proviso that $\delta_m \not< 0.5$, (i.e. $R_m < 2r$, see Subsection (b) (i), equation (22) *et seq.*). Substituting for R_m from (11) it follows that

$$\delta_m = 1 - (1/Q)\sqrt{(R_0^2/X^2) - 1} \quad \ldots \quad (38)$$

Hence $\delta_m \to 1$ as $R_0/X \to 1$ and if the best regulation is wanted the highest value of X/R_0 consistent with good efficiency should be chosen.

Inserting the value of X_0 from (31) into (38) it may be noted that, with optimum efficiency,

$$\delta_m \approx 1 - 1/Q^{2/3} \quad \ldots \quad \ldots \quad (39)$$

Elimination of r between (36) and (37) yields :

$$\delta = 1 - (R_m/R)(1 - \delta_m) \quad \ldots \quad (40)$$

Hence δ varies linearly with $1/R$, which is a close approximation to δ varying linearly with the load current.

(iv) *Effect of Departure from Optimum Conditions.*

Although (31) yields the optimum value of X_0 the penalties of departure from this

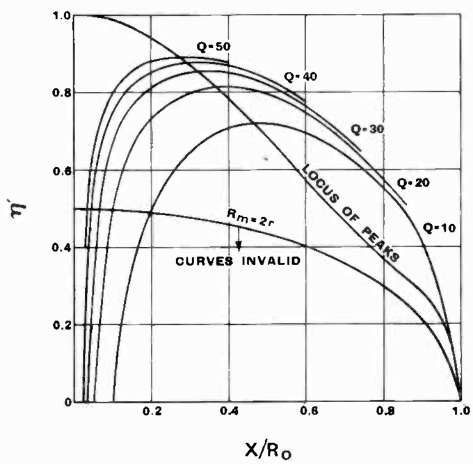


Fig. 5.

optimum are not at once apparent, and it has been noted above that good regulation corresponds with high values of X. Accordingly the curves of Figs. 5 and 6 have been drawn. These show, respectively, η' and δ_m as functions of X/R_0 for various Q. Fig. 6 was plotted from (38) and Fig. 5 from (25); in the interests of simplicity, however, this latter expression was first cast in the form:

$$\eta' = \delta_m\sqrt{1 - (X^2/R_0^2)} \quad \ldots \quad \ldots \quad (41)$$

by comparing (38) with (25).

It may be noted that both η' and δ_m

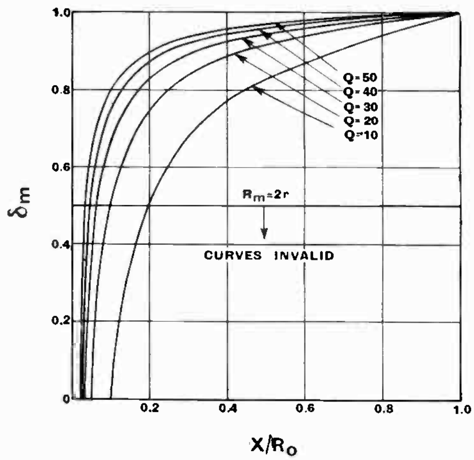


Fig. 6.

become zero with finite values of X/R_0. Thus from (41) it is apparent that η' is zero when X/R_0 is unity and also when δ_m is zero; from (38) δ_m is zero when:

$$Q^2 = (R_0^2/X^2) - 1$$

i.e. when

$$X/R_0 = 1/Q$$

This is, at first sight, somewhat surprising, but it must be remembered that (38) and (41) depend on the assumption that $|Z|_{R=R_m} = R_0$ corresponds with maximum power output, which is true only when $R_m \nless 2r$ and $\delta_m \nless 0.5$ (see (37) *et seq.*). The curves ignore this proviso and they are valid only within the regions corresponding with $\delta_m \nless 0.5$. These regions have been indicated on the figures, and it may be seen by inspection that the proviso is always satisfied within the range of interest. It is clear that X_0 is not critical, and that with high values of Q, values of X considerably greater than X_0 are permissible: the extent of this latitude (which is desirable since the output is thereby adjustable) allowable in a given case depends on the required efficiency and regulation, and may be inferred from the curves.

(v) *Variation of Q' with Load.*

It is of interest to assess the working range of the actual quality of the circuit, Q' say, as R' varies from R'_m to ∞: thus if Q_m' is the value of Q relevant to R_m' then:

$$Q_m' = X_0/R_m \quad \ldots \quad \ldots \quad \ldots \quad (42)$$

Substituting for R_m from (33) there follows:

$$Q_m' \approx Q^{1/3} \quad \ldots \quad \ldots \quad \ldots \quad (43)$$

and obviously

$$Q' = (R_m/R)Q_m' \quad \ldots \quad \ldots \quad (44)$$

Thus the circuit is always heavily damped.

5. Design Procedure

The foregoing analysis permits of the rapid design of any specified amplifier embodying the "Variable Q" principle. Thus, if the maximum power output required is known, a suitable valve

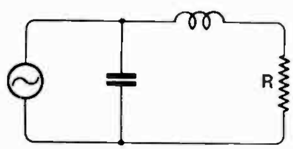
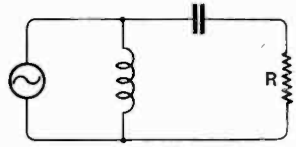


Fig. 7.



(*Right*) Fig. 8.

can easily be selected from published characteristics, W_0 usually being stated. Reference to (31) then yields the relevant value of X_0, Q being supposed known. The open circuit voltage follows from (1) and it may be necessary to adjust this to the value required, either by a slight departure from X_0, or by the use of a transformer as described in the next section. The permissible departure from X_0 is indicated by Figs. 5 and 6; wherever possible the use of a transformer should be avoided in the interests of economy and good regulation. The circuit now being completely specified it remains only to assess the efficiency and regulation. Conversely, if the regulation be specified the minimum permissible value of Q may be determined.

Some latitude, however, exists in circuit arrangement, for the sign of X has not yet been specified. If X is positive the circuit takes the form shown in Fig. 7. In this arrangement the circuit tends to reduce the proportion of harmonics transmitted and may be termed the low-pass (L.P.) connection. If a high-pass (H.P.) characteristic is desired X may be made negative when the circuit appears as in Fig. 8. It may be noted that physically the loss resistance will usually be associated with the inductance, thus Fig. 8 lies outside the scope of the foregoing analysis. The first connection will be the more usual one, but since in practice Q will be fairly high, it is unlikely that the exact location of the loss resistance will be of great importance, and, from the design point of view, it will be immaterial whether the connection of Fig. 7 or that of Fig. 8 is employed.

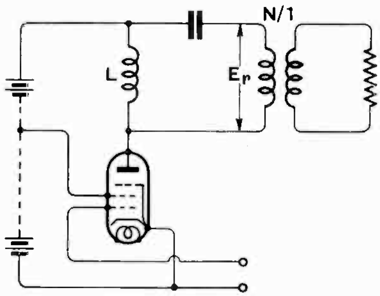


Fig. 9.

Experimental confirmation of this view is given in Section 7.

6. Practical Circuit Arrangements

The most usual practical arrangement utilising the L.P. connection is shown in Fig. 9. Transformer output is adopted in order that the constant output voltage E_r $(= X_0 I)$ may be adjusted to the value suited to particular requirements by adjustment of N. The transformer must be highly efficient and have a primary inductance large compared with L in order that the load may remain sensibly resistive. The minimum permissible value for the load resistance, R_{m2}' say, is given by

$$R_{m2}' = \frac{R_m - r}{N^2},$$

which, on substituting for R_m from (34), and if $r \ll R_m$, reduces to

$$R_{m2}' \simeq (1/N^2)(R_0/Q^{2/3}) \quad \ldots \quad \ldots \quad (45)$$

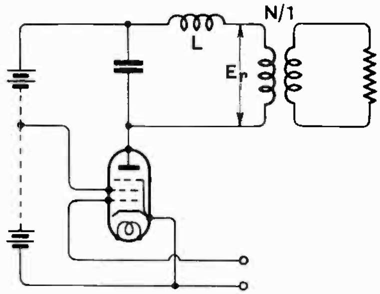


Fig. 10.

If R_{m2}' be reduced below this value distortion will ensue since the permissible anode swing is exceeded.

The corresponding circuit with H.P. characteristics is given in Fig. 10.

It may be noted that, when maximum output is not required, the voltage can be varied by alteration of I by means of drive adjustment, the regulation then remaining unimpaired.

The apparatus is suitable for use with unmodulated, slowly modulated or slowly chopped alternating voltages having a fundamental frequency of one particular value or variable over a small range about this value. In addition the principle can be extended to push-pull circuits and also to oscillators whose frequency is continuously variable. This might be achieved by ganging the

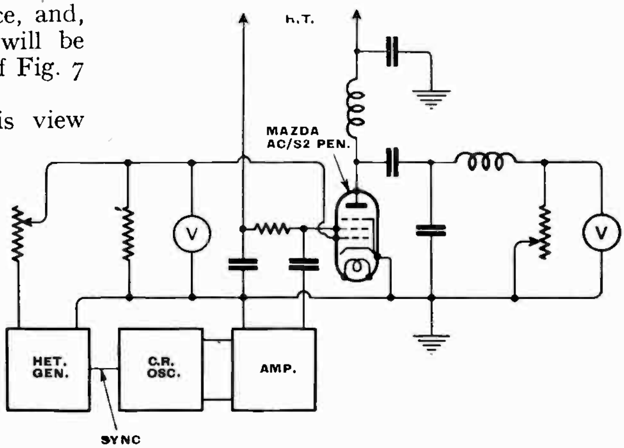


Fig. 11.

tuned circuits in the oscillating and output stages.

As a practical example of the application of the "Variable Q" principle a valve generator incorporating it, and designed to meet specific requirements, has been described elsewhere.[3] The device has been made the subject of a Provisional Patent.[4]

7. Experimental Verification

The experimental arrangement used to check the analysis of the preceding sections is shown in Fig. 11. The valve used was a Mazda AC/S2 PEN and the operating voltages, which were maintained constant throughout the tests, were as follows:

Anode	96
Screen	84
Grid-bias	− 1.5
Grid-drive	0.5 (R.M.S.)

Except where remark is made to the contrary all experiments were carried out at 500 c/s and with the L.P. connection in which the location of the circuit loss resistance is identical with that discussed in the

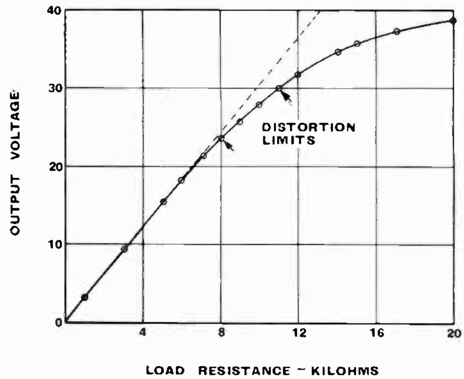


Fig. 12.

analysis. A set of seven tuned circuits was prepared, the members of which each had a Q of 30 but whose element reactances X increased in steps of 500 ohms from 500 to 3,500 ohms. By using these separately or in combination any desired element reactance could be obtained without alteration of Q. The limits defining the inception

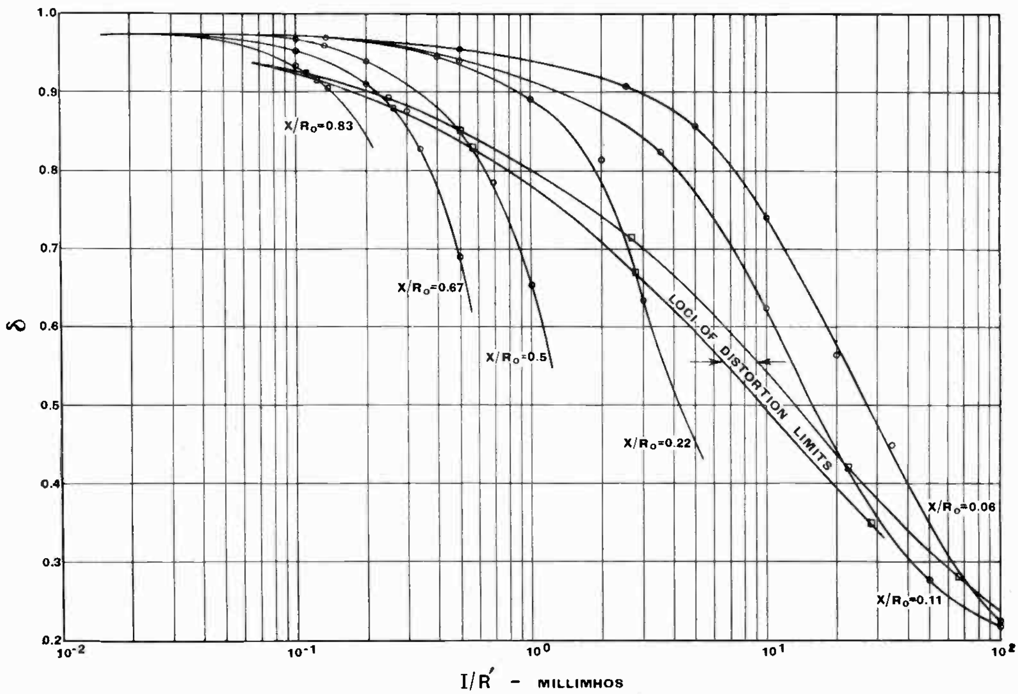


Fig. 13.

[3] *P.O. Elec. Eng. Journal*, Jan., 1939, Vol. 31, Part 4.

[4] *Prov. Specn.* No. 5969, Feb. 25th, 1938.

of distortion, i.e. the points at which it was possible to assert that distortion either did or did not exist, were determined by oscillographic observation of the screen current. The screen current was observed in preference to the anode current since the distortion was relatively greater and its inception much more clearly defined. The method used may be ascertained from Fig. 11, whence it is apparent that a picture of the screen current waveform was obtained by amplifying the voltage developed across a small resistance inserted in the screen circuit.

In order to determine the optimum load resistance R_0 some observations were taken with purely resistive loading. These are shown in Fig. 12 and it may be seen that the precise value is somewhat indefinite but is probably of the order of 8–9,000 ohms: using the latter figure an output voltage of 25.8 was available corresponding with an optimum undistorted power output of 74 milliwatts.

Regulation characteristics were next taken and are given in Fig. 13, the distortion limits are indicated by their appropriate loci and the improvement with increasing X/R_0 is at once apparent; be it noted, however, that such increase limits the permissible range of output resistance.

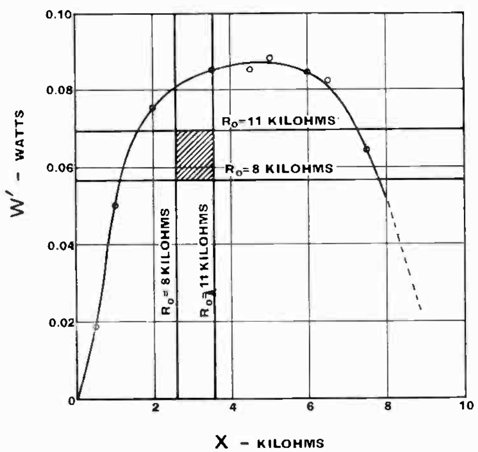


Fig. 14.

The occurrence of an optimum value of X was next sought and the results are shown in Fig. 14: this shows the measured output in watts at the distortion limit as a function of X. The shaded rectangle defines the limiting positions of the peak efficiency calculated from (31) and (32) when the two extreme values of R_0 of 8.000 and 11,000 ohms respectively are adopted. The general conclusions arrived at in the analysis are seen to be verified, but discrepancy exists between the observed and calculated values of efficiency. This is believed to be due to the difficulty experienced in the visual observation of distortion, which changes its character with the nature of the anode load, being more apparent with resistive than with reactive loads.

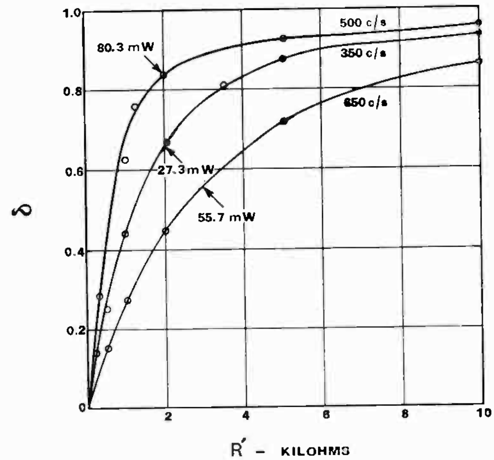


Fig. 15.—*Arrows indicate the distortion limits.*

Experimental attention was then transferred to conditions not rigorously dealt with in the analysis. In Sections 4 and 5 it was suggested that general behaviour of the device did not depend very greatly upon either the precision of tuning or upon the exact location of the circuit loss resistance. The truth of these remarks was tested in the following manner: optimum conditions were set up relevant to an assumed value of R_0 of 8,000 ohms. From (31) it was ascertained that this necessitated a value of X_0 of 2,500 ohms. The variation of output voltage with load resistance was then observed for three different drive frequencies of 350, 500 and 650 cycles per second. The experiment was then repeated using the H.P. connection in which the losses did not conform with their analytical representation. The results are shown in Figs.

15 and 16: it appears that the behaviour of both modes of connection is sensibly identical and that appreciable departures from resonance can be tolerated. If, however, such departure becomes excessive a serious falling off in power output ensues.

8. Acknowledgment

The research described in this paper was carried out partly in the Signalling Apparatus Laboratory of the Post Office Engineering Research Station and partly in the Electrotechnics Department of the Victoria University of Manchester. The authors' thanks are due, therefore, both to Captain B. S. Cohen, O.B.E., F.Inst.P., M.I.E.E., and to Professor R. Beattie, D.Sc. for the facilities provided.

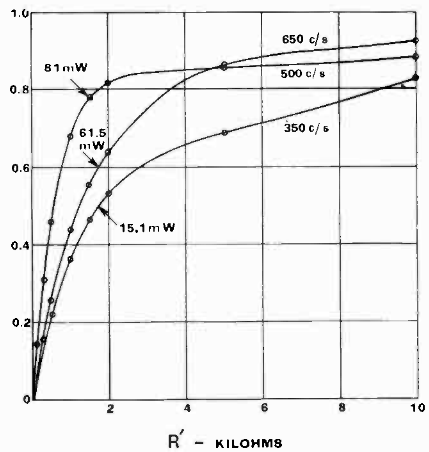


Fig. 16.—*Arrows indicate the distortion limits.*

Symbols Used

e	= instantaneous value of pentode anode voltage.
E_0	= "No signal" value of e
E_m	= maximum permissible value of e
E_r	= R.M.S. value of load voltage
i	= instantaneous value of pentode anode current
I_0	= "no signal" value of i
I_m	= maximum permissible value of i
I	= R.M.S. value of current supplied by constant-current source
	= R.M.S. value of oscillating component of pentode anode current
I_p	= peak value of I
I_r	= R.M.S. value of load current
r	= inherent loss resistance of tuned circuit
R'	= added load resistance
R_m'	= minimum permissible value of R'
R	= total load resistance
	= $(R' + r)$
R_m	= minimum permissible value of R
	= $(R_m' + r)$
R_0	= optimum resistive load of pentode
	= E_m/I_m
R_{m2}'	= minimum resistance across transformer secondary
W_0	= maximum undistorted power output of pentode
	= I^2R_0
W	= total power output
W_m	= (maximum) value of W when R is R_m
W'	= useful power output
W_m'	= value of W' when W is W_m
δ	= fractional voltage regulation
δ_m	= value of δ when W' is W_m'
η	= overall efficiency
	= W/W_0
η'	= working efficiency
	= W'/W_0
η'_m	= optimum value of η' with respect to X
Z	= complex impedance in anode circuit
	= $(r' + jx')$
X_0	= optimum value of X when η' is η_m'
Q	= quality of tuned circuit
	= X/r
Q'	= working value of $Q = \frac{x}{R}$
	= X_0/r
Q_m'	= value of Q' when $R' = R_m'$

N.P.L. Radio Department

DR. R. L. SMITH-ROSE has been appointed Superintendent of the Radio Department of the National Physical Laboratory, which includes the Radio Research Station at Slough and the Department at Teddington. He joined the staff of the N.P.L. in 1919 as a member of the Electricity Department, and later formed the nucleus of the wireless division of that department, conducting investigations on thermionic valves, radio reception and direction finding. Later research has included the measurement of electrical constants of the ground and their influence on the propagation of waves—especially those below ten metres.

Following the formation of the Radio Department in 1933, Dr. Smith-Rose became Principal Scientific Officer under Mr. R. A. Watson Watt, who was Superintendent, and has been in charge of both the Teddington and Slough divisions of the Department since Mr. Watson Watt left in 1936 to take up a post at the Air Ministry.

"The Stability of a Triode Oscillator with Grid Condenser and Leak"

IN the Appendix to the article under the above heading, published in the January issue of *The Wireless Engineer*, ω was erroneously printed for w in the fourth line and subsequently.

The Temperature Response of the Shot Effect of Valves with Oxide-coated Cathode*

By Z. Szepesi, D.Phil.

(*Tungsram Research Laboratory*)

THE new theory of Schottky and Spenke[1] of the shot effect has been verified by Rothe and Engbert[2] and by experiments carried out in our laboratory for valves having oxide-coated cathode at normal operating temperature. Thus the shot noise of a commercial triode in the frequency range df can be given by the following formula :

$$\overline{I^2} = 0.64 \times 4kT_c \frac{S}{\sigma} df \quad \ldots \quad \ldots \quad (1)$$

where

$k = 1.37 \times 10^{-23}$ Joule per degree is Boltzmann's constant

T_c the temperature of the cathode in degrees Kelvin

S the slope in A/V

$\sigma = \dfrac{1}{1 + D\left(1 + \dfrac{4}{3}\dfrac{d_2}{d_1}\right)}$ the so-called "Steuerschärfe" of Schottky

$1/D$ the amplification factor

d_1 and d_2 the cathode-grid and the grid-anode distances.

The so-called "weakening factor" that gives the ratio of the shot effect of the space-charge-limited valve to that of a temperature-limited diode having the same plate current may be calculated with the aid of the formula (1) as follows :

$$F = \frac{\sqrt{\overline{I^2}}}{\sqrt{2\, eidf}} \quad \ldots \quad \ldots \quad \ldots \quad (2)$$

where $e = 1.59 \times 10^{-19}$ Coulomb is the electron charge

i the plate current.

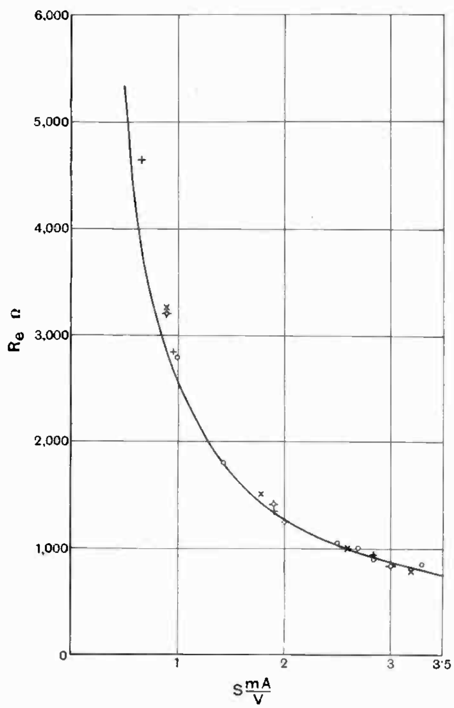


Fig. 1.—*Equivalent resistance plotted against slope. Measured points were observed on 4 valves type HL4G. Full line is a theoretical curve calculated from observed data.*

The equivalent resistance can be computed from (1) as :

$$R_e = 0.64 \frac{T_c}{T_0} \frac{1}{\sigma S} \quad \ldots \quad \ldots \quad \ldots \quad (3)$$

where T_0 is the absolute room temperature.

The Johnson noise of the equivalent resistance R_e connected to the grid circuit causes a current fluctuation as great as the shot noise. The mean square voltage fluc-

* MS. accepted by the Editor, September, 1938.

[1] W. Schottky : *Wiss. Veröff. Siemens-Werk*, 1937. Vol. 16, No. 2, p. 1. E. Spenke : *Wiss. Veröff. Siemens-Werk*, 1937, Vol. 16, No. 2, p. 19. J. B. Thompson and D. O. North at a meeting of the Inst. of Radio Engineers on Nov. 16th, 1936, gave similar results.

[2] H. Rothe and W. Engbert : *Telefunken Röhre*, 1937, No. 11, p. 183.

tuation on the terminals of a resistance R of Temperature T deg. K is

$$\overline{E^2} = 4kTRdf$$

In Fig. 1 the equivalent resistances of 4 different valves type HL4G are plotted against their slopes. (The slope has been varied by the alteration of the grid bias.) The figure shows also the theoretical curve according to formula (3) with the measured data $T_c = 1020$ deg. K, $T_0 = 297$ deg. K, $\sigma = 0.84$, i.e.,

$$R_e = \frac{2.6}{S}$$

The shot effect is a function of the cathode temperature according to the formulas (1), (2), and (3). It was our intention to confirm experimentally this theoretical result.

Method of the Measurement

We have measured the temperature of the cathode above 1,000 deg. K pyrometrically, at lower temperatures by measuring the anode current in the retarding field condition connecting grid and plate together[1]. At higher temperatures, applying the pyrometrical method, we have used a 650 $\mu\mu$ filter glass. The light emission of the coated and uncoated nickel cathode was tested and the temperature of the former derived by putting the absorption of the coated cathode equal to that of the uncoated nickel sleeve.

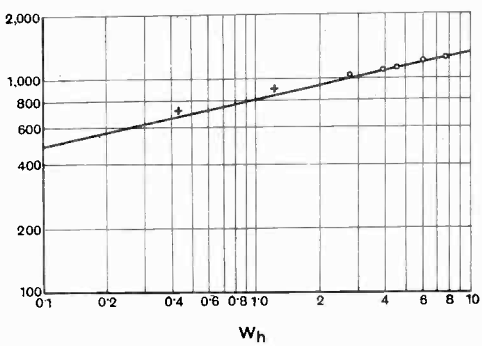


Fig. 2.—Cathode temperature plotted against the heater watts. The points o were measured pyrometrically, points + by means of the retarding field current method. The straight line is $T_e = KW_h^{1/4.5}$.

Fig. 2 shows the cathode temperature of a valve type HL4G plotted in double logarithmic scale as a function of the heating power ($W_h = i_h V_h$). The temperatures found pyrometrically from the end of the cathode were corrected by the addition of 30 deg. K in order to get the average temperature of the cathode. The straight line on the figure is drawn according to the equation: $W_h = CT_c^{4.5}$.

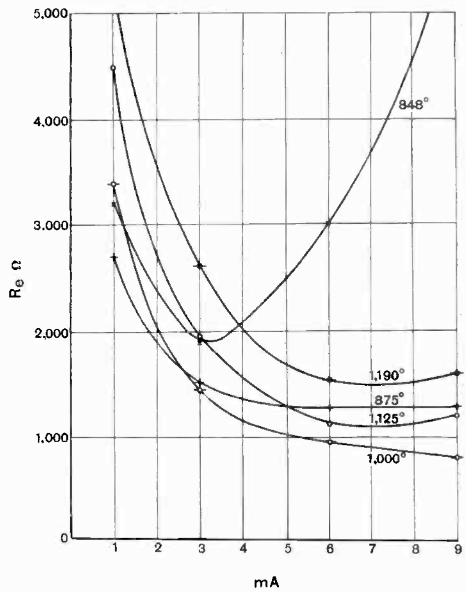


Fig. 3.—The equivalent resistances of a valve type HL4G plotted against anode current for various cathode temperatures.

The valve under test was connected to a tuned amplifier (100 kc/s) feeding a square-law dry-cell rectifier. (Syrutor type).

The equivalent resistance was measured by varying a resistance put into the grid circuit of the valve. That value of the resistance which doubles the deflection of the square law rectifier instrument is the equivalent resistance.

The measurement of the weakening factor was carried out by means of a tungsten filament triode (Tungsram H3 type) connected as a diode and comparing its temperature-limited noise with the noise of the valve under test. By adjusting the filament current the anode current of the diode connected in parallel with the tested valve was increased till the output instrument showed

[1] W. Heinze and W. Haas: *Zeitschr. f. tech. Phys.*, 1938, Vol. 19, No. 6, p. 166.

twice the deflection. Noting the corresponding value of the diode current (i_D) and taking its ratio to the plate current of the valve under test we get the square of the weakening factor. Thus:

$$2ei_D df = F^2 2eidf$$

from which

$$F^2 = \frac{i_D}{i}$$

Experimental Data and their Discussion

Figs. 3 and 4 represent the experimentally observed equivalent resistances and weakening factors of a HL4G valve plotted against the anode current at several temperatures. They show how the noise level is increased by overheating or underheating the valve. The increase is especially large in the underheated state and grows with the anode current. (The mutual conductance of the valve under these conditions can be regarded as constant for the same anode current. The actual differences are less than 10 per cent.)

The observed equivalent resistances—all reduced to the slope $S = 2.6$ mA/V for normal temperature and 6 mA anode current—are

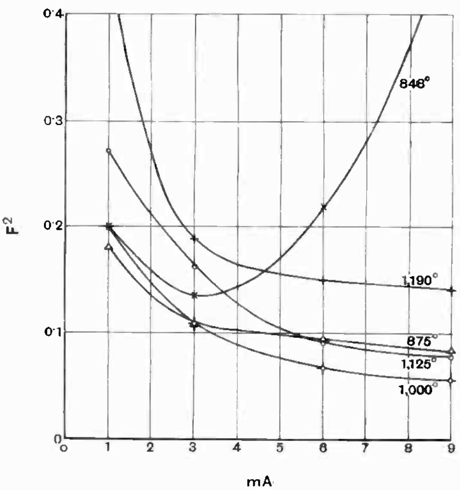


Fig. 4.—*The weakening factors plotted against anode current for various cathode temperatures.*

plotted in Fig. 5 against the cathode temperature and the heater voltage for various plate currents. The straight line is the theoretically calculated equivalent resistance derived from equation (3).

At low currents (1mA) in accordance with Fig. 1, the observed equivalent resistances

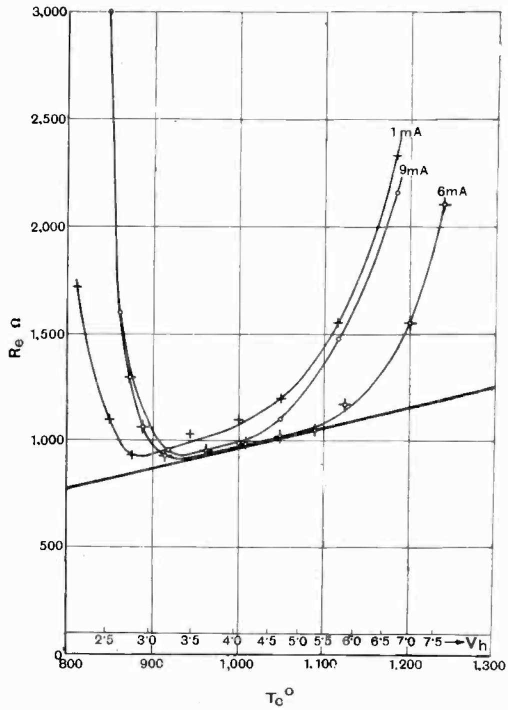


Fig. 5.—*The observed equivalent resistance of a valve type HL4G plotted against cathode temperature and the heater voltage at anode currents of 1, 6, and 9 mA. The straight line is theoretically computed.*

are higher than the theoretical ones. It is striking how rapidly the noise level increases in the region below 875 deg. K and over 1,050 deg. K.

The equivalent resistances measured at 6 mA anode current are in good agreement with the theoretical line in the interval 925 deg.–1,100 deg. K. At the current of 9 mA this temperature interval is reduced to 100 deg. K. Beyond this region the noise is very much increased.

The deviation of the noise value from the theoretical one in the underheated state is to be explained by a non uniformity of the cathode. There are spots on the cathode especially on its end with lower temperature of weak emission where the weakening effect of the space charge is small. By increasing the current the emission of this spots becomes temperature limited and the noise increases rapidly as is shown on Fig. 4 by the curve corresponding to T = 848 deg. K.

With large currents at temperatures below 848 deg. K we obtained weakening factors greater than unity. This leads to the assumption that the increase of the noise in the underheated state is at least partly due to the Flicker effect in spite of the high test frequency of 100 kc/s.

We thought that the increase of noise at higher temperatures might be due to thermal emission from the uncoated ends of the cathode (low space charge), but valves constructed in such a manner that emission from the ends was suppressed did not show any reduction of the noise.

The increased noise at higher temperatures may possibly be explained by the ion emission of the cathode. The positive ions coming from the cathode into the space charge reduce the potential barrier enabling some electrons which cannot normally overcome the barrier to reach the anode. An ion of the mass m_i travelling a long time in the space charge releases $\sqrt{\frac{m_i}{m_{el}}}$ electrons (m_{el} mass of the electron) and gives rise to an increased current fluctuation.[1]

Besides the disturbing effects found at lower and higher temperatures our measurements give evidence that the shot effect of the space charge region can be considered as the Johnson effect of the resistance of the cathode-control-grid gap of the valve. The temperature of the resistance in accordance with formula (1) is that of the cathode multiplied by 0.64. The physical explanation of this fact seems not to be fully understood as yet.[2]

Some tubes show no agreement between the observed and theoretical values over such a wide temperature range as is seen in Fig. 5. The previous treatment of the cathode has a big effect on the magnitude of the noise. The noise changes during the use of the valve and shows a tendency to improve when the valve is used at normal or slightly higher temperatures. It takes sometimes only minutes but sometimes hours before the noise approximates to its theoretical value.

Some valves heated a few tenths of a volt less than the rated value gave an increase of noise, whilst some gave a noise corresponding to formula (1) only when overheated.

The forming of the cathode and the valve noise are closely related to each other. Probably electron-microscopical observation of the cathode surface combined with measurements of the tube noise could give valuable information on electron emission phenomena.

I express my indebtedness to Dr. F. Preisach for his kind help and valuable advice which greatly facilitated my work.

[1] E. Spenke: *Wiss. Veröff. Siemens-Werk.*, 1938, Vol. 17, No. 3, p. 94.

[2] D. A. Bell: *Journ. I.E.E.*, 1938, Vol. 82, p. 522.

Professor E. V. Appleton

THE King has approved the appointment of Prof. E. V. Appleton, D.Sc., LL.D., F.R.S., as successor to Sir Frank Smith, G.B.E., K.C.B., D.Sc., LL.D., F.R.S., who retired at the end of January, as Secretary to the Committee of the Privy Council for Scientific and Industrial Research.

Prof. Appleton, who is forty-six, has been Jacksonian Professor of Natural Philosophy at Cambridge University since 1936 and is a Fellow of St. John's College, Cambridge. He is Chairman of the National Committee for Radio Telegraphy and President of the International Union for Scientific Radio Telegraphy.

Sir Frank Smith is relinquishing his post three years earlier than the compulsory retiring age of sixty-five, and we understand that he is to become adviser on scientific research and development to the Anglo-Iranian Oil Company.

I.E.E. Meetings

Feb. 1st.	Wireless Section. "Electrolytic Condensers" (illustrated by a film and demonstrations), P. R. Coursey, B.Sc. (Eng.), and S. N. Ray, M.Sc., B.Sc. (Eng.).
Feb. 2nd.	Ordinary Meeting. "The Empire Service Broadcasting Station at Daventry," L. W. Hayes and B. N. MacLarty, O.B.E.
Feb. 9th.	Annual Dinner at Grosvenor House, London, W.1.
Mar. 1st.	Wireless Section. Symposium of papers on "Direction Finding," presented by Dr. R. L. Smith-Rose.

The Industry

A TUNGSRAM Comparison Chart, recently issued by Tungsram Electric Lamp Works (Great Britain) Ltd., 82/84, Theobalds Road, London, W.C.1, shows the Tungsram equivalents of various British, American and Continental transmitting and high-power valves.

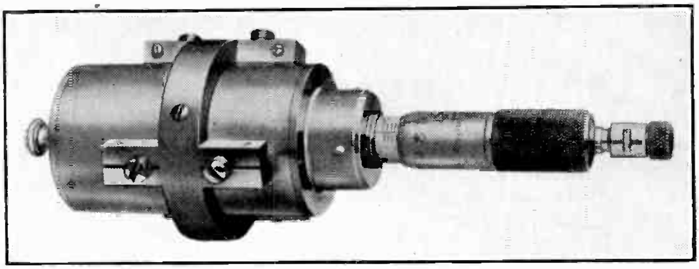
A new edition of the components and accessories catalogue issued by A. F. Bulgin Ltd., Abbey Road, Barking, Essex, has just appeared. Over 1,300 items are described and in many cases reductions in price have been made.

The Physical Society's Exhibition

Recent Developments in Commercial Test Instruments

EACH year the Exhibition of the Physical Society at the Imperial College of Science and Technology affords an excellent opportunity for manufacturers to demonstrate and discuss new measuring equipment with the technical personnel of the wireless industry. This year's exhibition was the twenty-ninth of the series and was held on January 3rd, 4th and 5th.

Television and the current fashion for push-button operated receivers have resulted in a few new and specialised signal generators and oscillators, but the greatest activity seems to have been in connection with measuring devices rather than sources. There has been a marked increase in the number of valve-operated ammeters and voltmeters and a general improvement in the sensitivity of meters of the moving-coil type. Bridges for general impedance measurement are evidently in brisk demand and the new types shown this year are all of exceptional versatility. Cathode-ray indicators for bridge balance are in common use and the "magic eye" type, as used in wireless receivers, is being employed also in beat oscillators for the adjustment of zero beat.

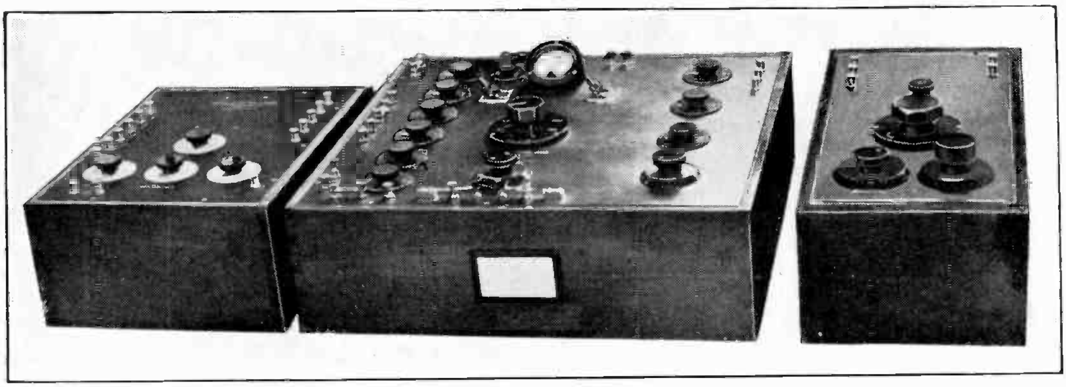


Sullivan silica-insulated micrometer condenser.

H. W. SULLIVAN, LTD., were showing an improved model of the Sullivan-Griffiths direct-reading dynatron oscillating wavemeter. The frequency range is now 120 kc/s.–40 Mc/s. with an accuracy of 1 part in 10,000 and stability of 5 parts in 10^6. A new lens system with self-contained lighting has been devised for observing the direct-reading scales and a mask obscures the irrelevant parts of the scale.

In the improved Sullivan-Griffiths direct-reading universal precision inductance bridge (range 1 μH.–100 H.) temperature-compensated inductance standards give uniform accuracy over a range of temperatures from 30° to 130° F. The overall accuracy is 0.1 per cent. or 0.02 μH. Attachments are available for the measurement of capacity (10 μμF–1 μF) with an accuracy of 0.2 per cent. and iron cored coils with superposed D.C. up to 200 mA. from 1 mH. to 100 H.

A precision heterodyne oscillator with a range of 0–160,000 c/s. has been developed in collaboration with Mr. R. J. Halsey of the Post Office Research Section. Its construction is similar to that of the Ryall-Sullivan oscillator and the output is constant to 0.1 db. between 100 c/s. and 160,000 c/s. Normally a logarithmic scale is fitted, but a linear scale is available for carrier-frequency work, and where accurate interpolation is required. The



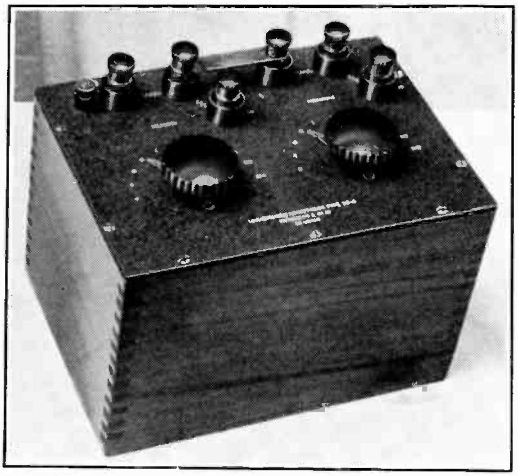
Sullivan-Griffiths direct-reading universal precision inductance bridge.

setting accuracy is 0.5 per cent. from 5 c/s. to 10 kc/s. and $\pm$ 20 c/s. from 10 c/s. to 160 kc/s. The frequency stability is $\pm$ 5 c/s. and the harmonic content 2 per cent. at an output of 1 watt.

Among components on this stand were noted a beautifully made silica-insulated micrometer condenser with a range of 5–13 $\mu\mu$F and an accurately linear law for interpolation when measuring small increments of capacity. Also some new inexpensive temperature-compensated inductance standards tapped in ten equal parts for use if desired with a decade switch. Maximum values of 1,000, 10,000 and 100,000 μH are available and the highest coil is adjusted to 0.1 per cent.

New resistance units shown by MUIRHEAD & Co., LTD., included constant-inductance resistance boxes suitable for frequencies up to 4 Mc/s. or above. These resistances are to the design of the Radio Section of the P.O. Engineering Dept. and have compensating coils of copper to maintain the inductance constant when resistance loops are added or subtracted.

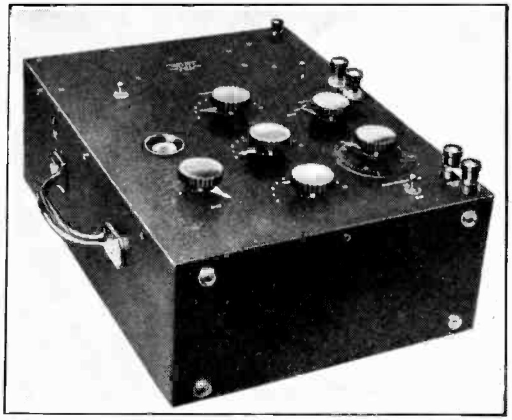
High resistance decades with a total resistance of 1 MΩ are now available, and the " Munit " range includes 80 db. attenuators in 5 db. steps using only three keys and a series of cheap 1 per cent. decades for educational work.



Muirhead Type 38A logarithmic resistance box.

Other resistances include T, H and π networks in soldered metal cases with accessible top terminals, and a useful logarithmic resistor (Type 38A) having two eleven-stud dials with ranges of 0–100,000 Ω and 0–100 MΩ.

The new portable capacity bridge (Type 10A) has been designed for general capacity measurement and is direct reading to 1,110 μF on four decades and has seven multiplying ratios giving a total range from a few $\mu\mu$F to 1,000 μF. The power factor balance control is calibrated in terms of RωC over two ranges. Balance is indicated by a small cathode-ray valve and the source is 50 c/s. through a screened mains transformer.



Muirhead Type 10A portable capacity bridge.

For use in test equipment a new second-grade variable air condenser (Type 30) has been introduced. It is constructed of brass and gunmetal and has a single cone bearing. The stator is supported on " Calit " insulation.

The resistance-capacity audio oscillator shown last year appears in improved form. It now covers 20 c/s. to 90 kc/s. in four ranges. Attention has been given to frequency stability and neon stabilisers are used in the power supply circuit. The harmonic content is constant with frequency and of the order of 1 per cent. with an output of 1 watt. Harmonics above the third are negligible. The Type 14A oscillator is designed to give any ten fixed frequencies between 50 and 10,000 c/s. Dust-cored coils are employed in the master oscillator which is followed by an amplifier giving up to 500 mW. It is mains operated through neon stabilisers.

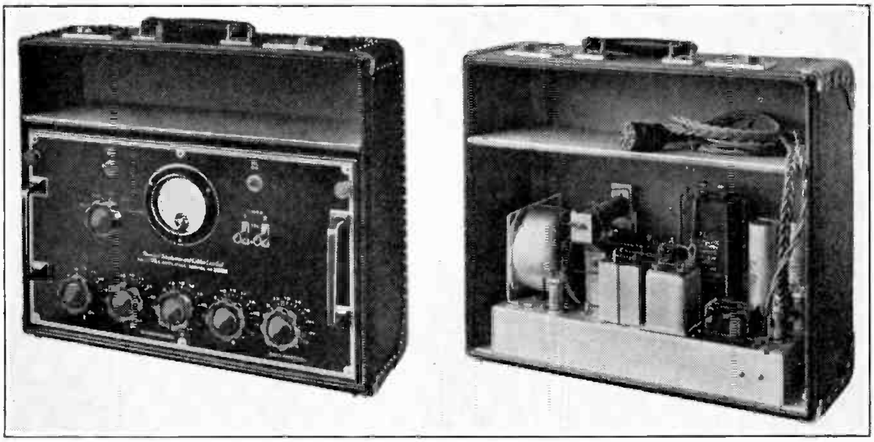
Two other pieces of apparatus which should find frequent use in communication work are the Type 8A amplifier and Type 1A amplifier-detector. The former consists of two stages with a level over-all gain of 90 db. between 40 and 10,000 c/s. Both input and output are matched to 600 Ω and there are two gain controls accurately calibrated in twenty-five steps of 2 db. and five steps of 10 db. The Type 1A amplifier-detector comprises a high gain R.C. coupled amplifier feeding a valve voltmeter. It is sensitive to small inputs (4×10^{-14} W. produces a readable deflection) yet is tolerant to considerable overloads. The response is level within $\pm$ 2 db. from 30 c/s. to 20 kc/s. through its input transformer or to 200 kc/s. with direct connection to the grid.

For checking frequency standards against the clock a new chronograph (Muirhead-Bohn) has been introduced, also a phonic motor counter with starting and stopping clutch going up to 100,000 kc/s. on six dials.

A demonstration oscillograph with moving-iron units for projecting two images on a large screen was shown in operation. The mirrors are arranged for belt or phonic motor drive, the latter giving a stationary 50-cycle image.

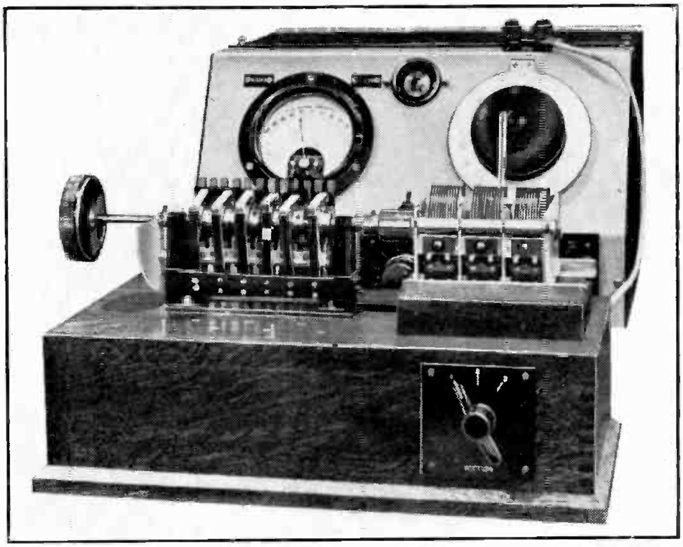
The exhibit arranged by STANDARD TELEPHONES AND CABLES, LTD., dealt with materials as well as instruments, and demonstrations were devised to illustrate the properties of the firm's selenium rectifiers, quartz crystals, nickel-iron alloys, dust cores and valves. Standing waves in neon tubes were used to show that two LS486 valves in push-pull were producing oscillations at a frequency of the order of 250 Mc/s.

A new range of transmission measuring sets was shown and also a compact O.B. amplifier and mains unit housed in light suitcases and designed to operate from a car battery.



(Left) Standard Telephones O.B. amplifier and power supply unit.

(Below) British Physical Laboratories variable condenser ganging bridge.

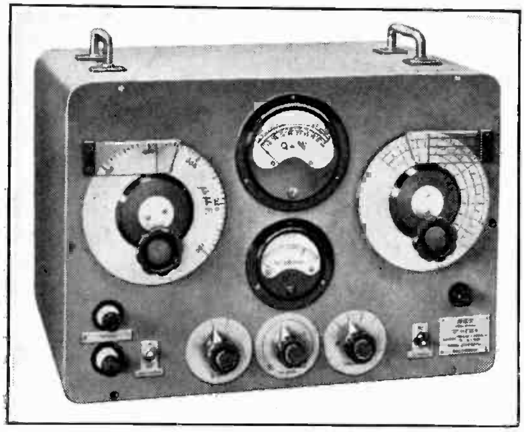


An interesting application of the cathode-ray tube to watch-rate timing was demonstrated on this stand. The watch under test is compared with a standard watch by superimposing the impulses picked up on separate microphones on a circular time base figure on the end of the tube. Adjustments normally take less than a minute instead of several days.

Valves and applications of the cathode-ray oscillograph also formed the backbone of the exhibit of the EDISON SWAN ELECTRIC CO., LTD. The valves included the latest "acorns" and short-wave valves with graphite anodes for use in diathermy apparatus as well as glass transmitting valves up to 1,500 W. dissipation. The complete Ediswan-Walter electro-encephalograph equipment, comprising a three-channel amplifier system with an over-all gain in each channel of the order of 5×10^6, was shown. This apparatus, which is used for studying electrical phenomena in the brain, has three gas-focused cathode-ray tubes in which simultaneous observations may be made.

BRITISH PHYSICAL LABORATORIES, who specialise in instruments for rapid production testing, were showing a capacity bridge with a range of 0.01–10 μF. for the routine testing of paper condensers. The test frequency is 50 c/s. and the direct reading indicator may be calibrated for tolerances up to 10 per cent. The new variable condenser ganging bridge is a modification of the capacity bridge shown last year and works with a test frequency of 1 Mc/s. The alignment may be checked at six angular settings and as in the capacity bridge a "magic eye" indicator is used to show when contact with the test component has been satisfactorily made. The circuit is devised so that the indicating meter deflects in opposite directions for values higher or lower than the standard. Other bridge-type instruments include a "ϕ-meter" in which the power factor of condensers is compared with a self-contained standard consisting of a condenser of negligible power factor in series with a variable resistance.

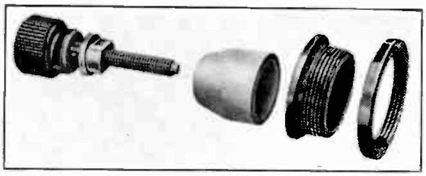
SALFORD ELECTRICAL INSTRUMENTS, LTD., were again showing their miniature moving-coil meters, rectifier and thermo-couple instruments for radio and carrier frequencies. A new dynamometer wattmeter of the precision sub-standard type has been added to the range of meters. Valve-operated instruments include the well-known Salford diode



Salford Electrical Instruments universal "Q" meter.

and acorn triode probe-type valve voltmeters, and a new thermionic test set with all the properties of a sensitive galvanometer without its disadvantages. It is virtually an amplifier followed by a valve voltmeter in which the meter cannot be damaged by overloading and is available for battery or A.C. operation. The ranges are 10^{-8} to 1 amp. D.C., 10^{-4} to 1 amp. A.C. up to 20 Mc/s. and 5 mV. to 50 V. D.C. or A.C. The new universal "Q" meter has a self-contained source covering 100 kc/s. to 5 Mc/s. It is capable of measuring the "Q" factor of coils from 10–500, inductance in two ranges from 1 μH. to 5 μH. and 5 μH. to 25 mH., capacity from 3 $\mu\mu$F. to 500 $\mu\mu$F. and may be also used for the measurement of the power factor of condensers, the distributed capacity of large coils, the permitivity and loss factor of dielectrics and the effective value of high resistances at radio frequencies.

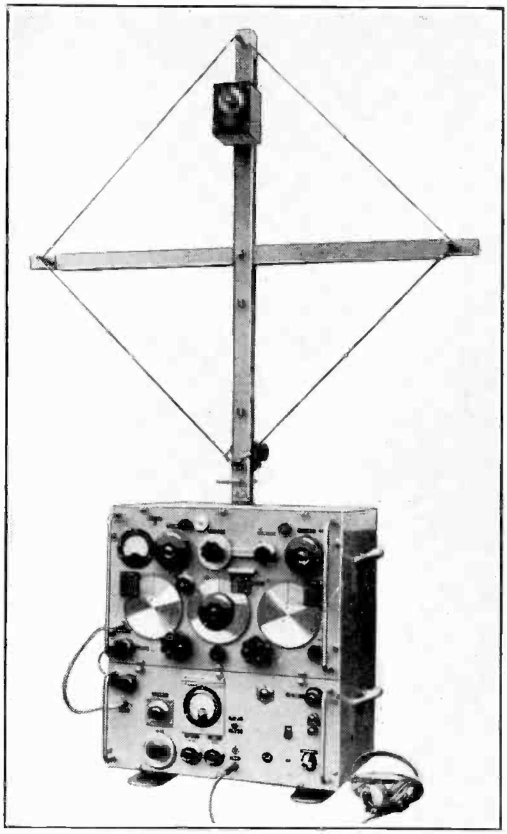
Components were represented by a wide range of "Gecalloy" dust cores including the latest screw-adjustable types and the new H.F. terminal with ceramic insulation designed to reduce the proportion of dielectrics included in the electrostatic field. It has a dry resistance of 10^{-14} ohms and 10^{-10} ohms under conditions of 80 per cent. humidity. The capacity to earth is 2.5 $\mu\mu$F. and the power factor at 1 Mc/s. is 5×10^{-4}. The



Component parts of the Salford H.F. terminal.

breakdown voltage is 2,000 and the working voltage 1,000 A.C.

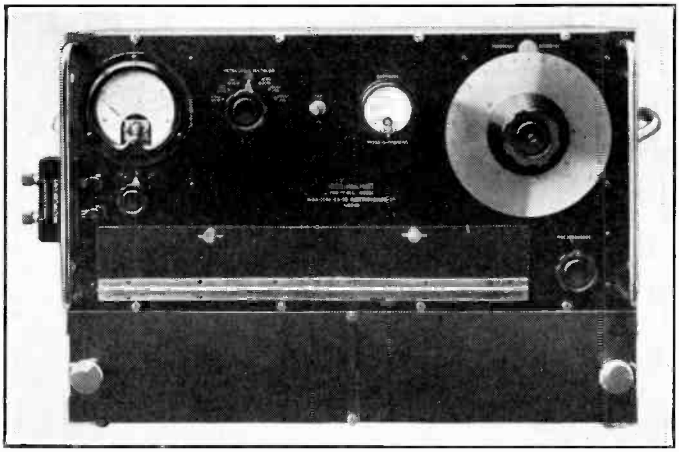
Once again the stand of Marconi-Ekco Instruments, Ltd., was notable for its prolific display of new designs. The range of signal generators has been extended by the addition of three new models. The Type TF492 pre-set signal generator for the production testing and servicing of push-button receivers provides sixteen push-button selected frequencies between 100 kc/s. and 25 Mc/s. The R.F. output is constant at all frequencies and may be modulated internally at 400 c/s. Special attention has been paid to frequency stability in view of the purpose for which this instrument will be

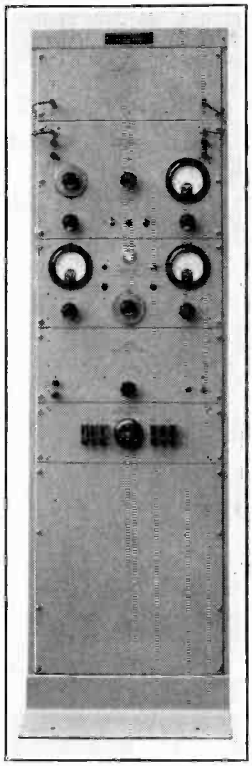


Marconi-Ekco Type TME18 field strength measuring equipment.

used. An acorn oscillator valve working in conjunction with a concentric transmission line is employed in the Type TF517 U.S.W. signal generator covering the range from 150–300 Mc/s. There is a calibrated output attenuator and 400 c/s. internal modulation is provided. The Type TF410 video oscillator has been developed for the testing of television circuits. It covers a range of 10 c/s.–2 Mc/s. and has two output ranges from 1 mV.–1 V. and 1–10 V.

Two new field strength measuring sets have been developed. The Type TME18 succeeds the earlier TME4 and functions on the substitution signal principle; it is virtually direct-reading and there are facilities for internal cross-checking of the calibration. The output is versatile and may be connected to a meter, moving-coil recorder or cathode-ray oscillograph. The alternative power supplies are A.C. mains or 6-volt car battery. The Type TME14 U.S.W. field strength measuring set also works on the substitution signal principle, and covers the range from 3–15 metres. Dipole or frame aerials may be used and the whole receiver, which is screened, may be rotated on a tripod with 360-degree calibrated head for directional work.





Marconi-Ekco (above) Type TF455 wave analyser, (Right) Type OA118 transmission monitor.

On the acoustic side, the Type TF429 Audiograph for taking loud speaker curves is now available in its final form. A new wave analyser (Type TF455) has also been introduced. It operates on the heterodyne principle and a bridge circuit is used to balance out the fundamental. A two-stage crystal filter having a flat-topped characteristic 5 c/s. wide, accepts the 50 kc/s. beat component which is then measured by a valve voltmeter with a range of 100 μV. to 300 V. The analyser may be used for modulating radio signals and a distortion-free detector has been included for this purpose. The power supply is from self-contained batteries.

The transmission monitor Type OA118 has been designed to check the quality of modulation in transmitting stations. Modulation depth is measured by a peak voltmeter which is arranged to observe positive or negative peaks separately. A trigger circuit may be pre-set to give visual warning of over-modulation. For checking distortion the transmitter is modulated by a pure 400 c/s. note generated in the channel and the output is passed through a linear detector followed by a high-pass filter and a valve voltmeter. Measurements of noise may also be made and weighting networks, *e.g.*, following the characteristic of the air, are available.

A series of R.F. impedance bridges for balanced and unbalanced impedance measurements up to 20 Mc/s. have been introduced and a universal impedance bridge, TF373, makes its appearance for the first time. It is direct reading over seven decades for capacity, inductance and resistance, and may also be used for coil magnification and condenser loss. A continuously variable dial is included from which comparative readings to 0.1 per cent. may be made. The absolute accuracy of the bridge is $\pm$ 1 per cent. and a single knob control selects the proper bridge circuit supply and balance indicator.

A phase discriminating visual detector of the cathode-ray type has also been developed for use in A.C. bridge networks where the phase distortion may be serious. One pair of plates is connected to the A.C. source and the other to the out-of-balance bridge voltage. The inclination of the axes of the ellipse indicates phase and the length of one axis the magnitude of the unbalanced voltage.

A cathode-ray balance indicator is also used in the bridge circuit tester which was shown by A. C. Cossor, Ltd. The oscilloscope, Model 3339, used for this purpose is a versatile instrument. It makes use of a $4\frac{1}{2}$-inch tube which may be operated with a single or double beam. Each set of plates has its own amplifier which is level to 2 Mc/s. with a gain of 500. Amplifiers may be connected in cascade for single beam working when a magnification of 3,000 is obtained with a level response up to 100 kc/s. A hard-valve time base with a range of 4 c/s. to 4 Mc/s. is included in the instrument.

Other cathode-ray apparatus shown on this stand include complete pressure recording gear for work on internal combustion engines and a portable cardiograph (Model 3310) with a fluorescent screen having a long after-glow suitable for both visual and photographic observation. A press key injects 1 mV. for standardising the gain of the amplifier.

THE MULLARD WIRELESS SERVICE CO., LTD., were showing their Type GM3152 and GM3153 cathode-ray oscillographs and other service apparatus including the Type GM4140 capacity

Cossor Model 3339 *cathode-ray oscilloscope.*

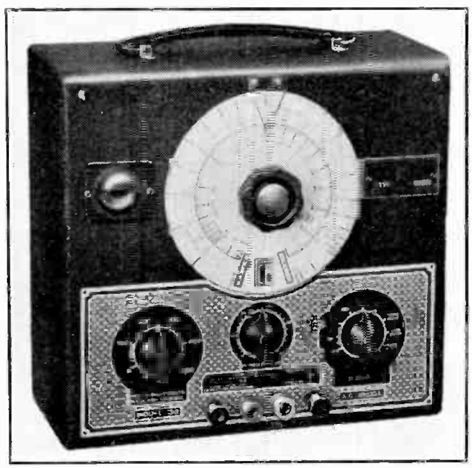
and resistance bridge and the Type GM2304 audio frequency oscillator. Another interesting instrument was the R.A.E.-Mullard detonation meter. This uses a "magic eye" indicator which flashes when detonation is present in the engine under test. The principle of operation depends upon the segregation by a high-pass filter of the frequencies above 2,000 c/s. which are usually associated with the phenomenon of detonation.

A representative selection of American instruments by Ferris, Ballantine, Boonton, Clough Brengle, etc., were shown by LELAND INSTRUMENTS, LTD. Among the signal generators the Ferris Model 22A was noted as a suitable instrument to fill the gap which has hitherto existed between the more expensive laboratory signal generators and servicemen's oscillators. It is compact and works from A.C. mains, has a range of 85 kc/s. to 25 Mc/s., and a calibrated modulation meter. The tuning scales are individually calibrated and a slow-motion drive is included for taking selectivity curves. Another compact signal generator for television development work is the Ferris Model 18B. It has a range of 4–150 Mc/s. and a calibrated attenuator of the transmission line type which

Ferris Model 32 *field strength and noise meter.*

includes the leads and gives outputs from 0.1 μV. to 0.1 V.

The Ferris Model 32 field strength and noise meter is an extremely compact instrument. Its over-all dimensions are approximately 7 × 12½ ×

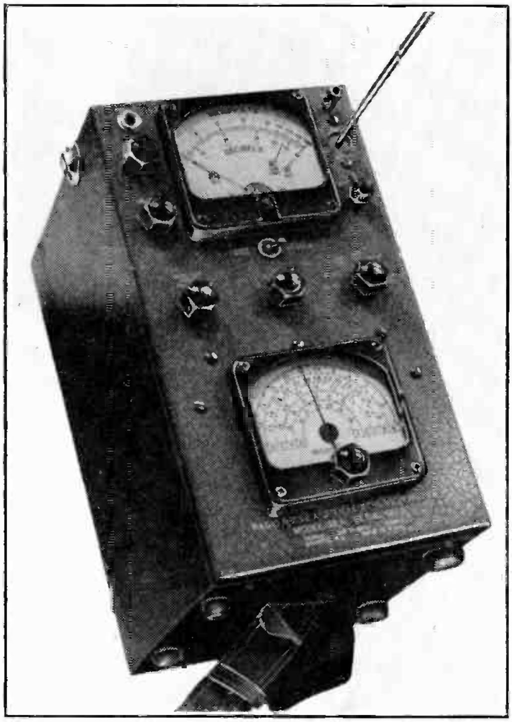


Clough Brengle Model 130 *impedance bridge.*

9in. and it is available for battery, A.C. mains or 6-volt vibratory power supplies. The meter is calibrated both in db. and microvolts and may be used as a two-terminal microvoltmeter without the collapsible external aerial rod. The field intensity range is 0.2 μV/metre–2 μV/metre and the frequency ranges are 150–350 kc/s. and 550 kc/s.–20 Mc/s.

The Clough Brengle instruments would appear to be well suited for works production testing and servicing and a complete rack-mounted serviceman's equipment including cathode ray gear for circuit alignment was shown. A cathode-ray tuning indicator is used in the Clough Brengle Model 130 bridge which may be used to measure transformer turn ratios as well as the usual resistance, capacity, power factor and condenser leakage.

The Boonton "Q" meter (Type 100A) may now be fitted with an attachment which stabilises the frequency source and supplies a backing-off current for the indicating meter, thus increasing the general sensitivity and making possible the accurate measurement of power factor and dielectric constant of insulating materials. The new beat frequency



Ballantine Model 300 *electronic voltmeter.*

generator (Type 140A) by the same firm is a versatile instrument with a range of 20 c/s. to 5 Mc/s. in two bands overlapping at 30 kc/s. With resistance output a continuously variable voltage from 1 mV. to 32 V. is available, or power up to 1 watt may be taken with a suitable external load. A third arrangement gives transformer coupling up to 30 kc/s.

Notable meters shown on this stand were the Clough Brengle Model 120 with a sensitivity of 20,000 Ω/V. and the new Model 185 with 4-inch scale and no fewer than twenty ranges including db. scales referred to 6 mW. The Ballantine Model 300 electronic voltmeter was also shown. This instrument consists of an input amplifier with negative feedback followed by a logarithmic valve voltmeter calibrated with a linear db. scale. The frequency range extends from 10 c/s. to 100 kc/s. and a readable deflection is obtained for an input of 1 mV. With its long scale it can be turned into a noise meter by connecting a high-grade microphone directly to the input terminals. External shunts are available for extending the normal maximum input of 100 V. up to 10 kV.

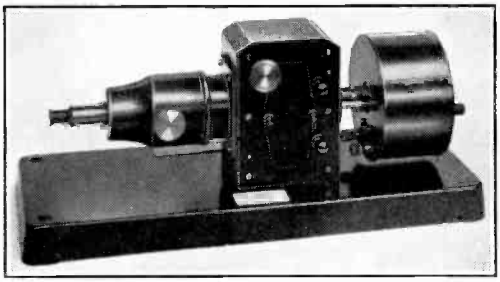
The "AVO" series of meters made by the

"AVO" low-resistance ohmmeter.

Automatic Coil Winder and Electrical Equipment Co. Ltd. has been extended by the addition of a useful low-resistance ohmmeter. This is similar in size to the D.C. "Avominor" and has two ranges of 0–20 and 0–500 ohms. On the lower range 2 ohms results in approximately half-scale deflection and readings down to $\frac{1}{10}$th ohm can be estimated. The new "AVO" test bridge for operation from A.C. mains is capable of measuring resistances from 10Ω to 10 MΩ and capacity from 10 $\mu\mu$F. to 10 μF.; also inductances against an external standard. There is an auxiliary control by means of which the power factor of electrolytic condensers may be measured and a neon indicator is used for leakage in paper condensers. The valve voltmeter balance indicator can be used externally if desired.

This firm was also showing an interesting toroidal coil winder in the experimental stage.

The Baldwin Instrument Co. Ltd. have designed a neat bridge key with terminals which serves as a junction box for assembling components in a bridge circuit. The key has multiple contacts and the initial pressure connects the bridge supply and applies a low resistance shunt to the galvanometer. Further depression of the key reduces and finally removes the shunt across the galvanometer in three stages. They were also showing a voltage variation meter for measuring machine fluctuations in which mains voltage is compared in a differential centre zero voltmeter with a neon stabilised source of voltage. Three degrees of sensitivity are provided for reading the total voltage and voltage variations of ± 1 per cent. or ± 10 per cent. of the normal.



Cambridge permanent magnet Einthoven string galvanometer.

The CAMBRIDGE INSTRUMENT Co. LTD. this year devoted the whole of their stand to meters and galvanometers. A new range of Unipivots has been introduced, the Type LX having an increase in sensitivity of 2.4 times and the Type LY four times that of earlier models.

Advantage has been taken of the new magnetic alloys to produce a permanent magnet version of the Einthoven string galvanometer. The fibre cases are made of a material with negligible temperature coefficient and are made accurately interchangeable.

A series of "Pot" vibration galvanometers were also shown in which mechanical tuning is possible over a few cycles on either side of the standard frequencies of 50, 100, 800 and 1,000 c/s. The same galvanometer is used in the "Spot" instruments which are enclosed in a metal case with lamp and scale. The sensitivity is 15 mm/μA.

ELLIOTT BROS. (LONDON) LTD. were showing a series of long scale moving-coil instruments with angular deflections of 250° and scale diameters of 2½ and 36 ins. Another of their new products is a portable millivolt potentiometer for checking thermo-couples. The ranges are 0–30 and 30–60 mV. and a 2 mV. division on the potentiometer dial represents 0.01 mV. The instruments includes a standard cell and suspended pointer galvanometer for calibration.

EVERETT EDGCUMBE AND Co. LTD. have several new output meters for communication engineering. There is a micro-wattmeter with three ranges of 200, 2,000 and 20,000 μW. full scale in which the first half-inch on the lowest scale is equivalent to 10 μW. There is also a power output meter with four ranges of 5, 50, 500 and 5,000 mW. full scale in which a multi-range input transformer with tappings on both primary and secondary gives a range of impedance values from 2–12,500 Ω. A last-minute arrival on the stand was a thyratron peak voltmeter of the self-resetting type using a neon lamp as an indicator.

This firm has also developed a very practical beat-tone oscillator intended primarily for loud speaker testing. The output is 2 watts and the frequency range 5–10,000 c/s. A novel feature is the production from the rectifier of the instrument of sufficient current for energising the field of the loud speaker under test.

The well-known portable vibration galvanometers made by H. TINSLEY & Co. are now fitted with an improved optical system and the taut-suspension galvanometer has been redesigned giving a seven-fold increase of sensitivity. The period of this instrument is of the order of 2 seconds. It can be supplied in a neat cast metal case or on a temporary baseboard for incorporation in test instruments.

ERNEST TURNER ELECTRICAL INSTRUMENTS, LTD. were showing some of the 6-inch moving-coil meters which they have supplied for use in some of the B.B.C. transmitting stations. They were also showing some miniature horizontal edgewise scale moving-coil meters with scale lengths of just over 2 ins. Another development is the production of shunts and series resistances moulded in solid bakelite and suitable for use where space is limited.

A new series of rotary resistances with vernier dial control consisting of a single turn supplementary resistance operated by a knob concentric with the main control have been introduced by the BRITISH ELECTRICAL RESISTANCE Co. LTD., who have also designed a range of completely shrouded slider resistances which comply with the Home Office regulations for use in factories, schools, etc. For the routine testing of components for flash over at high voltage, this firm has also produced an insulation test set incorporating an H.T. transformer and potentiometer giving continuous variation from 0–2,500 v. and using a valve voltmeter to indicate leakage. The whole is mounted in a metal case with a suitable circuit bracket ready for wall mounting.

On the stand of ERIE RESISTOR LTD. the principal items of interest were the Urdox protective resistances which find application in series with components such as pilot lamps, electrolytic condensers, etc., which may suffer from initial surges particularly in A.C./D.C. receivers. These resistances show a marked negative temperature coefficient and have been used in association with barretter lamps to improve the regulation.

Still further uses are being found for the efficient nickel-cobalt-aluminium magnetic alloys, and DARWINS LTD. were showing a magnet of the disc type which can be used as an electron lens for focusing the beam in cathode-ray tubes.

Although as yet in the experimental stage the cathode-ray mariner's compass shown by HENRY HUGHES & SON LTD. shows distinct promise, since all troubles which have been associated with the inertia of compass cards are circumvented. A special tube has been developed for this purpose, in which the low-velocity electron stream is readily deflected by the horizontal component of the earth's magnetic field.

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

412. The Quasi-Optics of Ultra-Short-Wave Guides [Mathematical Theory]. — H. Buchholz. (*E.N.T.*, Oct. 1938, Vol. 15, No. 10, pp. 297–320.)

Author's summary :—This paper investigates the influence of a long ultra-short-wave cable of circular cross-section on the radiation of electromagnetic waves from a coaxial ring-shaped emitter composed of elementary dipoles parallel to the space axis. In § II a suitable mathematical relation is first found for the primary Hertzian vector of such an emitter, and the nature of the emitted electromagnetic waves is then discussed in detail. For waves of the type thus recognised as predominant, § III deals with the question of behaviour on transit through a coaxial cylindrical surface separating two homogeneous spaces with different material constants. No account is first taken of the fact that the waves travelling in the inner space cannot be propagated undisturbed, owing to their spatial convergence towards the axis. Under these circumstances, the effect of the surface of separation can be uniquely described by various reflection and refraction coefficients, for which definite mathematical relations are deduced. In § IV the investigation of this question is extended to consider the effect of the cylinder axis on the course of the waves. The formulae for the reflection and refraction coefficients in this case are determined.

§ V discusses the fundamental difference between these two groups of reflection and refraction coefficients. While the absolute values of the coefficients R of the first group can never become greater than unity, the coefficients S of the second group can even have infinite absolute values for definite discrete values of their argument. The physical cause of this difference in behaviour is fully discussed. The special values for which the coefficients S are thus abnormally large correspond to the critical natural frequencies characteristic of ultra-short-wave cables. In § VI the formulae developed in preceding paragraphs are used to write down the general integral relations for the field produced by a ring-shaped emitter and acted on by the short-wave guide. In the case of the dielectric short-wave guide, these very complicated expressions are transformed into a form suitable for numerical calculation, for points at a distance from the radiation source large compared with the wavelength.

In the last § VII it is shown that, under suitable conditions as to frequency, the irradiation by the emitter of any point of observation occurs approximately according to optical laws. The total field at any point can thus be split up into as many separate parts as the number of ways by which an optical ray could pass from the emitter to the point. For instance, if the emitter and the point lie outside the wave guide, the point is irradiated by the direct ray, by the ray reflected once at the exterior of the wave guide, and by the infinite number of rays which undergo an increasingly large number of reflections in the interior of the wave guide (Fig. 13). If the wave guide consists of a loss-loaded dielectric or actually of metal, the strong attenuation of the waves within the guide really reduces this infinite multiplicity of rays to the two paths first mentioned.

413. Propagation in Dielectric Cables, *and* The Possible Utilisation of Circular Guide-Cables [including Demonstration of Type H_1 Wave of 2.5 cm along 1.8 cm-Diam. Tube : the Unique Property of the H_0 Wave and Its Suggestiveness for Telecommunication].—L. Brillouin : M. Clavier. (*Génie Civil*, 10th Dec. 1938, Vol. 113, No. 24, pp. 504–505 : p. 505.) Summaries only.

414. The Transmission of Damped Electromagnetic Waves through Small Hollow Metal Tubes [Observations].—H. E. Hartig & A. M. Mellon. (*Phys. Review*, 15th Oct. 1938, Series 2, Vol. 54, No. 8, p. 646.)

415. Reflection and Absorption of Electromagnetic Waves by Dielectric Strata.—G. W. O. H. (*See* 559.)

416. Corrections to the Paper: "Reflection and Absorption of Decimetre Waves at Plane Dielectric Strata."—Dallenbach & Kleinsteuber. (*See* 558.)

417. Ultra-Short-Wave Transmission and Atmospheric Irregularities [Study of 1.6–5 m Fading over 70 Mile Ocean Path: Horizontal and Vertical Polarisations: Simultaneous Observation of Two Different Wavelengths in Same Polarisation: Tentative Explanation of Results: Comparison with Results of Other Observers: "Airplane" Fadings: etc.].—C. R. Englund, A. B. Crawford, & W. W. Mumford. (*Bell S. Tech. Journ.*, Oct. 1938, Vol. 17, No. 4, pp. 489–519.)

418. Limiting Waves [of Length about 10 m] and the Ionosphere: III.—O. Burkard. (*Hochf:tech. u. Elek:akus.*, Oct. 1938, Vol. 52, No. 4, pp. 142–146.)

For previous work *see* 3452 of 1938. Observations made by German amateur stations on waves of length about 10 m during the period Jan.–April 1936 are now analysed to show the propagation phenomena in winter months at times of high solar activity. § I (Figs. 1–4) deals with the traffic density during the day. The afternoon maximum is very marked; there is also a definite maximum during the morning hours. The results are compared with American data of ionisation in F_2 region. In § II the range of these limiting waves is discussed and shown graphically in Fig. 5. The following propagation rules are deduced from the observations: "(1) A limiting wave of about 10 m length is only bent back to earth—at a greater or less distance from the emitter—if at the point where the waves first strike the F_2 region the ionisation is at least large enough to correspond to a critical frequency of about 7.8 Mc/s; (2) propagation in the ionosphere only occurs where the ionisation of F_2 region is stronger than at the point of incidence; (3) the wave reaches the earth's surface again where the ionisation of F_2 region has about the same value as at the point of incidence; (4) ground-wave propagation is independent of the state of F_2 region." Figs. 6–9 compare observation and expectation of traffic possibilities for various distances; Table 3 shows how the communications are distributed over the earth.

419. Remarks on the Paper by E. Fendler: "Variations in the Transmission Conditions of a Limiting Wave (10 m) in the Years 1935 to 1937" [Intra-European Communication due to Processes in F_2 Region rather than in E Region].—O. Burkard: Fendler. (*Hochf:tech. u. Elek:akus.*, Oct. 1938, Vol. 52, No. 4, pp. 147–148.) For Fendler's paper *see* 3451 of 1938.

420. Amateur Observations of Short- [and Ultra-Short-] Wave Propagation, and Scientific Research [Defects to which Amateur Observations are liable: Advice on Useful Fields of Work: etc.].—H. A. Hess. (*Funktech. Monatshefte*, Nov. 1938, No. 11, pp. 339–341.) The writer's own researches, at first as an amateur and then at the Berlin Institute under Leithäuser, have been dealt with in numerous past abstracts.

421. The Complex Structure of the Lower Stratosphere [Results on Invasions of Polar and Tropical Air, etc., based on Radio Soundings].—V. Mironovitch & A. Viaut. (*Comptes Rendus*, 7th Nov. 1938, Vol. 207, No. 19, pp. 866–869.)

422. Propagation of Wave-Packets Incident Obliquely upon a Stratified Doubly-Refracting Ionosphere.—H. G. Booker. (*Phil. Trans. Roy. Soc. Lond.*, Series A, 30th Sept. 1938, Vol. 237, No. 781, pp. 411–451.) For previous references to this work *see* 1286 & 3460 of 1938.

423. New Data on Direction of [Short-] Wave Propagation.—Feldman. (*See* 556.)

424. Characteristics of Sky-Wave Transmission: a Discussion of Some High-Frequency Transmission Effects of Practical Interest to the Amateur.—H. Selvidge. (*QST*, Oct. 1938, Vol. 22, No. 10, pp. 32–35 and 92 . . 100.)

425. Skip Distance of 14 Mc/s Waves appears to be considerably Greater in U.S.A. than in England.—"Log-Roller." (*World-Radio*, 2nd Dec. 1938, Vol. 27, p. 8: paragraph only.)

426. Further Investigations of Very Long Waves reflected from the Ionosphere [Information about Downcoming Wave on 16 kc/s: Reflection Height 67 km: Relation of Anomalous Decreases of Reflection Height to H.F. Fade-Outs, etc.].—K. G. Budden, J. A. Ratcliffe, & M. V. Wilkes. (*Proc. Roy. Soc.*, Series A, 7th Nov. 1938, Vol. 168, No. 934, pp. S 129–S 130: abstract only.) Extension of the work dealt with in 1 of 1937. *See* also Budden, 4225 of 1938.

427. Origin of the E Layer of the Ionosphere [Strong Absorption resulting in Photo-Ionisation of Molecular Oxygen beginning at λ 744 AU].—S. K. Mitra. (*Nature*, 19th Nov. 1938, Vol. 142, pp. 914–915: preliminary letter.)

428. Dissociation, Recombination, and Attachment Processes in the Upper Atmosphere: II—The Rate of Recombination [Possibility of Two-Body Recombination of Negative and Positive Ions].—D. R. Bates, R. A. Buckingham, H. S. W. Massey, & J. J. Unwin. (*Proc. Roy. Soc.*, Series A, 7th Nov. 1938, Vol. 168, No. 934, p. S 132: abstract only.) For I *see* Massey, 1288 of 1938.

429. "NEGATIVE IONS" [Book Review].—H. S. W. Massey. (*Wireless Engineer*, Nov. 1938, Vol. 15, No. 182, p. 615.) Including their formation in glow discharges and in the upper atmosphere.

430. RADIO TRANSMISSION AND THE IONOSPHERE [Dellinger Fade-Outs, Effect of Sunspot Activity & Magnetic Disturbances, Scheduling of Trans-Atlantic Broadcast Programmes, etc.].—(*Nature*, 26th Nov. 1938, Vol. 142, p. 965: notes from article in *Radio Review of Australia*.)

431. ANOTHER LARGE SUNSPOT [in Early Nov. 1938: Data].—(*Nature*, 12th Nov. 1938, Vol. 142, p. 870.)

432. SOME RECENT OBSERVATIONS OF SUNSPOT SPECTRA [particularly in Infra-Red and Ultra-Violet].—H. D. Babcock. (*Proc. Nat. Acad. Sci.*, 15th Dec. 1938, Vol. 24, No. 12, pp. 525–527.)

433. THE HIGHEST ERUPTIVE PROMINENCES.—E. Pettit. (*Scient. Monthly*, Nov. 1938, pp. 421–428.)

434. BOUNDARY WAVES AT A SURFACE OF DISCONTINUITY [Calculations for Two-Dimensional Earthquake Problem: Largest Amplitudes in Horizontal Distortional Waves: Conversion of Energy of Certain Body Waves into Boundary Waves at Surface of Discontinuity: etc.]. — K. Sezawa & K. Kanai. (*Nature*, 26th Nov. 1938, Vol. 142, p. 962: note on paper in *Bull. Earthquake Res. Inst., Tokyo Imp. Univ.*)

ATMOSPHERICS AND ATMOSPHERIC ELECTRICITY

435. "ANNÉE POLAIRE INTERNATIONALE 1932/1933: PARTICIPATION FRANÇAISE, TOME II" [Book Review].—(*Rev. Gén. de l'Élec.*, 1st Oct. 1938, Vol. 44, No. 13, p. 390.)

436. PROGRESSIVE LIGHTNING: VI.—Schonland, Malan, & Collens. (*Proc. Roy. Soc.*, Series A, 25th Nov. 1938, Vol. 168, No. 935, pp. 455–469.) An abstract was dealt with in 44 of January.

437. LIGHTNING TO THE EMPIRE STATE BUILDING [Combined Photographic/Oscillographic Studies: Additional Light on Discharge Mechanism].—K. B. McEachron. (*Elec. Engineering*, Dec. 1938, Vol. 57, No. 12, Sec. 1, pp. 493–505 and 507.)

438. LIGHTNING CURRENT MEASUREMENTS IN NORWAY.—K. Eie. (*E.T.Z.*, 10th Nov. 1938, Vol. 59, No. 45, pp. 1217–1218: summary only.)

439. MECHANISM OF THE LONG SPARK.—T. E. Allibone. (*Electrician*, 11th Nov. 1938, Vol. 121, pp. 567–568: summary of I.E.E. paper and Discussion.)

440. IONISATION OF AIR IN AN AIR-CONDITIONED BUILDING [Increased Ionisation with Slight Excess of Negative over Positive Ions: Resemblance to Mountain Climate].—F. Běhounek & J. Kletschka. (*Nature*, 26th Nov. 1938, Vol. 142, p. 956.)

441. SIGN PREFERENCE IN CLOUD CONDENSATION ON GASEOUS IONS [of Non-Polar Organic Vapours: Any Negative Sign Preferences are probably due to Traces of Water Vapour].—J. W. Beckman & L. B. Loeb. (*Phys. Review*, 15th Nov. 1938, Series 2, Vol. 54, No. 10, pp. 862–863.)

442. PROGRESS IN WEATHER FORECASTING.—W. R. Gregg. (*Elec. Engineering*, Oct. 1938, Vol. 57, No. 10, pp. 405–412.)

443. APPLICATION OF CLAY'S NEW VALUE OF THE JAFFÉ-ZANSTRA COEFFICIENT FOR AIR TO HIGH-PRESSURE ION-CURRENT MEASUREMENTS.—J. W. Broxon & G. T. Merideth. (*Phys. Review*, 15th Oct. 1938, Series 2, Vol. 54, No. 8, pp. 605–608.)

444. THE SYSTEMATIC RECORDING OF THE INTENSITY OF THE COSMIC RAYS, AT THE NATIONAL GEOPHYSICAL INSTITUTE, ROME, *and* MULTIPLICATIVE PROCESSES OF THE COSMIC RADIATION IN THE UPPER ATMOSPHERE.—G. Bernardini: M. Schönberg. (*La Ricerca Scient.*, 15th/31st Oct. 1938, Series 2, Year 9, Vol. 2, No. 7/8, pp. 397–407: pp. 459–461.)

PROPERTIES OF CIRCUITS

445. A NEW METHOD OF CONNECTION OF A MULTI-GRID VALVE FOR D.C. AMPLIFICATION [for Measuring Purposes, Automatic Control (AVC, ATC, Contrast Control, etc.) and Other Applications: Control Voltage less than 1 Volt].—H. Boucke. (*Funktech. Monatshefte*, Nov. 1938, No. 11, pp. 321–325.)

Two of the grids are used as control grids, so as to give two stages of d.c. amplification in one single valve. Fig. 1 shows the circuit for a hexode. "The d.c. voltage to be amplified, E_g, is applied to the first grid. Any change in this negative voltage is transferred, amplified, to the resistance R_1 in the lead to the second, positive screen grid. This voltage change is handed on by the resistance R_2 to the current-distributing grid 4, which in this connection is given a negative voltage regulated by the potentiometer R_3. In this way the current-distributing grid, with a sufficiently loose coupling to the screen grid, functions in the sensitive negative region of its characteristic (Fig. 1b) [the working point P is adjusted, according to the purpose to which the circuit is being put, either to the middle of the characteristic or to somewhere near a bend]. Thus the anode current is subjected to the action of two control electrodes working in opposition, since the production of the second control process by the first is accompanied by a phase reversal. Since, however, the second control voltage is derived through one amplifying stage from the first, the current-distributing control so much predominates, if the circuit values are correct, that a very considerable rise in amplification is obtained [*e.g.* 4.5 instead of the normal 1.5 mA/v]. But considerably steeper slopes can be obtained easily, for instance by providing d.c. regeneration, which is readily accomplished owing to the conditions of phase" [*e.g.* as in Fig. 4 or (more stable and easier to adjust) the slightly modified Fig. 3, which will give a max. slope of 12 mA/v: at the limits of stability, values of 100 mA/v are obtainable, and slopes of 20–30 mA/v are not difficult to deal with if the supply voltages are kept very strictly constant].

446. BRIDGE GRID CIRCUITS.—V. E. Vartel'ski. (*Izvestiya Elektroprom. Slab. Toka*, No. 10, 1938, pp. 49–54.)

A discussion is presented of the operation of an electronic or ionic valve in a phase- and amplitude-regulating circuit. For this purpose the grid circuit of the valve is connected across the diagonal of a bridge circuit, an e.m.f. is applied across the other pair of bridge arms, and the anode circuit is connected across one of the bridge arms. Then, depending on the values of the complex resistances from which the bridge is made up, the grid voltage of the valve will vary with respect to the anode voltage either in amplitude or in phase or in both. Four different cases are considered separately; for each of these, vector diagrams are drawn and formulae are derived determining the ratio of the grid and anode voltages and their phase displacement.

447. ANALYSIS AND DESIGN OF HARMONIC GENERATORS.—Terman. (*See* 474.)

448. ELECTRON-OPTICAL SPECTRUM ANALYSIS OF H.F. OSCILLATIONS.—Hollmann. (*Naturwiss.*, 11th Nov. 1938, Vol. 26, No. 45, p. 742.) Further application of the inversion spectrograph dealt with in 274 of January.

449. ON SOME PROPERTIES OF OSCILLATORY CIRCUITS.—G. Rutelli. (*La Ricerca Scient.*, 15th/31st Oct. 1938, Series 2, Year 9, Vol. 2, No. 7/8, pp. 364–378.)

Author's summary:—"Certain properties of oscillatory circuits are revealed on which can be based various methods for the measurement of inductance and capacitance; in particular it is shown that cymometers [wavemeters] and variometers can be transformed respectively into direct-reading inductometers and capacitance-meters. In the second part of the paper a study is made of the effect, on true resonance, of the parasitic capacitance of the coil which couples the measuring circuit to the source of oscillations; the equations which allow the resulting errors to be eliminated are given. In a further article, to be published later, a r.f. inductometer will be described which has been built on the basis of the present paper, and experimental results with this will be discussed.

450. LOCUS CURVES IN HIGH-FREQUENCY TECHNIQUE [with Construction and Examples: *e.g.* for Finding the Open-Circuit A.C. Resistance of an Impedance Network with Losses].—H. Awender & O. Lange. (*Funktech. Monatshefte*, Oct. 1938, No. 10, pp. 289–299.)

451. ELEMENTARY PROCESS FOR THE CALCULATION OF TRANSIENT RÉGIMES, USING IMAGINARY NOTATIONS.—E. Fromy. (*Rev. Gén. de l'Élec.*, 26th Nov. & 3rd Dec. 1938, Vol. 44, Nos. 21 & 22, pp. 667–681 & 703–715.)

452. AN ANALYSIS OF THE TRANSIENTS PRODUCED WHEN A SINUSOIDAL E.M.F. IS APPLIED TO A CIRCUIT CONTAINING A RECTIFIER.—I. S. Gonorovski. (*Izvestiya Elektroprom. Slab. Toka*, No. 10, 1938, pp. 20–25.)

For previous work *see* 3520 of 1938. A great number of valve circuits can be replaced by an equivalent circuit (Fig. 1) in which a condenser C is shunted by a rectifier having a resistance r_i. In the present paper a mathematical analysis is given of the processes taking place in the circuit when a sinusoidal e.m.f. is applied to it, and methods are indicated for determining the form of the final e.m.f. developed across C. The main conclusions reached are as follows: (1) When a pure sinusoidal e.m.f. is applied to the circuit, the e.m.f. developed across C is as a rule non-sinusoidal. (2) When $1/\omega C$ and r_i are of the same order, the positive half-wave of the e.m.f. is longer than the negative wavelength, while the ratio of the maximum negative amplitude to the maximum positive is greater than unity. (3) A purely sinusoidal e.m.f. across C can only be obtained if $1/\omega C$ is many times smaller than r_i.

453. THE PROPERTIES OF A RESONANT CIRCUIT LOADED BY A COMPLEX DIODE RECTIFIER [Steady State: Response to Modulated Signals: Conditions for Distortionless Rectification (Bias of Either Sign must cause Distortion at Some Level of Input Signal): AVC Rectifier requires as Careful Design as Signal Rectifier: Application of Circuit to give Distortionless Modulation].—F. C. Williams. (*Wireless Engineer*, Nov. 1938, Vol. 15, No. 182, pp. 600–611.) Further development of the work dealt with in 2223 of 1938.

454. CURVE-FORM ERROR IN THE IDEAL RECTIFYING INSTRUMENT.—Klutke. (*See* 691.)

455. APPLICATIONS OF MAXWELL'S EQUATIONS FOR TRANSFORMERS TO CIRCUITS IMPERFECTLY COUPLED BY IRON CORES: REGULATION TO LOW-FREQUENCY RESONANCE.—A. Blondel. (*Comptes Rendus*, 7th Nov. 1938, Vol. 207, No. 19, pp. 822–826.)

456. COUPLING NETWORKS: PART II [Dissipation of Power in Three-Element Networks: Application of Design to Antenna Array: Example of Network with High Frequency Discrimination: etc.].—W. L. Everitt. (*Communications*, Oct. 1938, Vol. 18, No. 10, pp. 12–18 and 22, 30.) For Part I *see* 74 of January.

457. "ELECTRIC CIRCUITS AND WAVE FILTERS: SECOND EDITION" [Book Review].—A. T. Starr. (*Electrician*, 9th Dec. 1938, Vol. 121, p. 695.) The new edition includes some 60 pages on Cauer filter theory, a treatment of crystal filters, and other additions.

458. THE EXPONENTIAL TRANSMISSION LINE [Theory and Experimental Verification: Use as a High-Pass Impedance-Transforming Filter with Cut-Off Frequency depending on Rate of Taper: also as "Resistance" Load of Constant Known Impedance with High Capability for Dissipating Power: etc.].—C. R. Burrows. (*Bell S. Tech. Journ.*, Oct. 1938, Vol. 17, No. 4, pp. 555–573: *Communications*, Oct. 1938, Vol. 18, No. 10, pp. 7–9 and 26 . . 28.)

459. A NOTE ON "ON SINGLE AND COUPLED TUNED CIRCUITS HAVING CONSTANT RESPONSE-BAND CHARACTERISTICS" [and the Question of the Advantages of the "Unequal Circuits" Scheme].—H. S. Loh: Benham. (In paper dealt with in 517, below.) For Loh's paper *see* 2695 of 1938.

460. A 455-KC/S CRYSTAL FILTER WITH WIDE-RANGE BAND-WIDTH CONTROL.—Oram. (*See* 502.)

461. "THE COLLECTED PAPERS OF GEORGE ASHLEY CAMPBELL" [Book Review].—(*Proc. Inst. Rad. Eng.*, Sept. 1938, Vol. 26, No. 9, pp. 1175–1176.)

462. THE CALCULATION OF RESISTANCE-CAPACITY-COUPLED AMPLIFIERS BY THE CURRENT-SOURCE EQUIVALENT DIAGRAM ["Short-Circuit" Diagram: Advantages over the More Usual Voltage-Source ("Open-Circuit") Diagram].—H. Pitsch. (*Funktech. Monatshefte*, Oct. 1938, No. 10, pp. 300–305.)

463. THE FREQUENCY RANGE WITH TRANSFORMER COUPLING.—H. Pitsch. (*Funktech. Monatshefte*, Nov. 1938, No. 11, pp. 325–328.)

"In an earlier paper [462, above] the writer explained the difference between the current-source (short-circuit) and voltage-source (open-circuit) equivalent circuits, and pointed out the advantageous use of the current-source equivalent circuit in resistance amplification. In the present article it will be shown how the two equivalent circuits can be used to calculate the frequency range for transformer coupling. The output transformer will be dealt with in a separate article."

464. CATHODE-COUPLED CIRCUITS: THEIR PECULIARITIES AND APPLICATIONS ["Cathode-Followers" in Television: Phase-Splitter for Push-Pull Amplifiers: etc.].—W. T. Cocking. (*Wireless World*, 15th Dec. 1938, Vol. 43, pp. 531-533.)

465. A SPECIAL RETROACTION CONNECTION [Top of H.F. Choke in Cathode Lead connected to Slider of Potentiometer forming Closed Circuit (Earthed) with Coil coupled to Input Circuit].—R. J. Wittwer. (*Funktech. Monatshefte*, Oct. 1938, No. 10, p. 317.)

TRANSMISSION

466. "MAGNETRON OSCILLATIONS OF ULTRA-SHORT WAVELENGTHS, AND ELECTRON OSCILLATIONS IN GENERAL" [Book Review].—K. Okabe. (*Proc. Inst. Rad. Eng.*, Sept. 1938, Vol. 26, No. 9, pp. 1177–1178.) A little book of 57 pages, including "a complete bibliography on magnetrons."

467. CONTRIBUTIONS TO THE THEORY OF THE TWO-SLIT MAGNETRON IN THE RANGE OF THE HABANN OSCILLATIONS.—Y. Ito. (*Hochf:tech. u. Elek:akus.*, Oct. 1938, Vol. 52, No. 4, pp. 120–124.)

"The purpose of this paper is the representation of the internal dynamic phenomena in a two-slit tube with negligible transit time by conceptions already known from the theory of normal valves." One segment of the anode is regarded as playing the part of a true anode, the other that of the grid (Fig. 1.) The diameter of the electron paths must then be approximately equal to the anode radius, while the magnetic field plays the part of a screen grid in fixing the working point. Fig. 2 shows static characteristics of the magnetron from which its action can be deduced; formulae are found for the steepness (Fig. 3), internal resistance (Fig. 4), and amplification factor (Fig. 5).

In § II the internal phenomena of self-excitation are explained; pure internal retroaction is discussed with the aid of the push-pull circuit of Fig. 6, whose oscillation characteristics are shown in Fig. 7. The case of internal and external retroaction needs push-pull circuits as in Figs. 9, 11, of which the theory is worked out. The uses of the magnetron as an amplifier (§ III) and for production of multiphase currents and voltages (§ IV) are also discussed.

468. INDIRECT METHODS OF MODULATION FOR DECIMETRE-WAVE EMITTERS.—E. Haass. (*Hochf:tech. u. Elek:akus.*, Oct. 1938, Vol. 52, No. 4, pp. 113–120.)

For previous experiments on these lines *see* 1934 Abstracts, pp. 436–437. The principle of the modulation methods here developed is amplitude modulation by means of special modulation tubes and a Lecher system inductively coupled to the emitter. In § I the use of neon glow lamps as modulation tubes is described; Fig. 1 shows a glow lamp with a ring electrode, Fig. 3 one with 4 electrodes, while Fig. 2 gives the connection with the emitter. Resonance curves for various glow currents are shown in Fig. 4; Fig. 6 gives the modulation characteristic with the glow current as the independent variable. Degrees of modulation of 67.5, 52 and 30% were achieved for wavelengths of 64, 12.8 and 4.6 cm respectively.

§ II describes the use of evacuated valves, which could only be used as modulators for wavelengths above 50 cm. The construction of the valves used is shown in Fig. 7; Figs. 8 & 9 give curves for the detector current under various conditions, Fig. 11 resonance curves, Fig. 12 modulation characteristics for anode control, Fig. 13 for grid control, Figs. 14 & 15 the degree of modulation as a function of the emitter wavelength, for grid and anode modulation respectively. It is found that these valves can be used to modulate greater h.f. energies than the neon glow lamps, and with low energy consumption. For a wavelength of 9.4 cm, the percentages of modulation attained were 58 and 42 for anode and grid modulation respectively.

469. THE TRANSMISSION OF SIDEBANDS IN A RADIO TRANSMITTER.—Z. I. Model. (*Izvestiya Elektroprom. Slab. Toka*, Nos. 10 & 11, 1938, pp. 5–18 & 4–13.)

The load on a modulated amplifier usually takes the form of an oscillating circuit coupled to the anode circuit through a number of intermediate tuned circuits. For example, in a final stage the power output is absorbed mainly by the aerial circuit, which is frequently coupled to the intermediate circuit by a feeder. In the present paper the passing of sidebands through a system of coupled circuits is discussed, and methods are indicated for calculating the resonance curves of the individual circuits and the over-all frequency characteristic of the system. The case of two circuits coupled by a feeder is then investigated, and the passing of sidebands through a system comprising a complex aerial (*i.e.* an aerial consisting of active and passive radiators) is also considered.

470. On Comparing the Efficiency of Modulation Systems with One and Two Sidebands.—G. A. Zeitlenok. (*Izvestiya Elektroprom. Slab. Toka*, No. 10, 1938, pp. 18–19.)

In a paper in another journal it was suggested by the writer that various systems of modulation could be compared on the basis of the audio output given at the receiver. This method of comparison can easily be applied to two double-sideband modulation systems (with or without transmission of the carrier), since in this case the same output will be obtained so long as the power in the sidebands remains the same in both cases. It is shown, however, that when two modulation systems are compared, with single and double sideband transmission respectively, the same audio output will only be obtained if the power in the single sideband is twice the power in the two sidebands.

471. The Properties of a Resonant Circuit loaded by a Complex Diode Rectifier [and Its Application to give Distortionless Modulation].—Williams. (*See* 453.)

472. An Analysis of the Transients produced when a Sinusoidal E.M.F. is applied to a Circuit containing a Rectifier.—Gonorovski. (*See* 452.)

473. On the Possibility of Two-Channel Communication with a Single Carrier Wave [by Phase Displacement].—Anitov & Kenigsen. (*See* 791.)

474. Analysis and Design of Harmonic Generators [New Method of Analysis with Accuracy entirely Adequate for Design Purposes].—F. E. Terman. (*Elec. Engineering*, Nov. 1938, Vol. 57, No. 11, pp. 640–645.)

475. Variable Frequency Control for Transmitters [Electron-Coupled Oscillator Unit to plug into Transmitter in place of Crystal]. —D. A. Griffin. (*QST*, Nov. 1938, Vol. 22, No. 11, pp. 28–30.)

476. Refinements in Combination Exciters: Effective Designs for Low-Power R.F. and Audio Stages [with Easy Switching to Five Bands and Band-Spread Tuning in Each].—T. M. Ferrill, Jr. (*QST*, Oct. 1938, Vol. 22, No. 10, pp. 36–41 and 110..118.)

477. How Much Condenser Spacing? Circuits to lower Voltage across Condenser Plates.—T. M. Ferrill, Jr. (*QST*, Dec. 1938, Vol. 22, No. 12, pp. 37–39 and 78, 80.)

478. Automatic Contrast Compression and Expansion free from Time-Lag and Distortion [by Momentary Delay of the Modulation by Steel-Band Recording and Retransmission].—F. Lachner. (*Funktech. Monatshefte*, Oct. 1938, No. 10, p. 318: summary only.) The usual assumption, that the distortions cancel themselves out if the time constants are made the same at transmitter and receiver, is erroneous.

479. The Need for Safety-of-Life Precautions in Amateur Transmitting Installations and Television Receiver Lay-Outs.—R. A. Hull: Warner. (*See* Warner's obituary article on Ross Hull, 802, below.)

RECEPTION

480. Modern Short-Wave Receiving Technique [Part I—particularly the Calibration of Thermocouples at Ultra-Short and Micro-Wave Frequencies, including Lecher-Wire Equipment and the Thermo-Expansion (Compensation) Milliammeter: Part II—Measurement of Valve Input Admittances, etc., at Very High Frequencies: Amplification of Mixing Stages: etc.)—M. J. O. Strutt. (*Funktech. Monatshefte*, Oct. & Nov. 1938, Nos. 10 & 11, pp. 309–313 & 331–339.) *See* also 2485 of 1938.

481. Ultra-High-Frequency Receiver with Wide Range of 60–132 Mc/s [for Aircraft: using Coaxial Lines].—McKeel. (*Sci. News Letter*, 5th Nov. 1938, Vol. 34, No. 19, p. 297: paragraph only.)

482. Ultra-High-Frequency Superhet [5–10 m, with Plug-In Extension to 60 m].—D. W. Heightman. (*Wireless World*, 1st Dec. 1938, Vol. 43, 484–486.)

483. Frequency Throw-Outs of the Oscillator in the Mixing Stage.—E. Kettel. (*Telefunken-Röhre*, Aug. 1938, Special Valve Number, Supp. to No. 13, pp. 105–112.)

"The result of such a throwing-out of the oscillator frequency is a de-tuning of the receiver. A properly tuned-in station will be received in a distorted condition if the d.c. voltage of the receiver, or the fading-compensation voltage, alters. If the oscillator frequency is too dependent on the working voltage, relaxation oscillations may be set up by over-modulation of the output stage. This occurs as follows: a station is received and the output stage is thereby over-controlled, with the result that the whole voltage in the set alters. The oscillator frequency is thrown out, reception (and with it the over-control) diminishes, the voltage returns to its normal value, and so does the oscillator frequency. Reception and over-control returns, and the whole cycle is repeated, with a period depending on the time constants of the anode-voltage filtering arrangements."

Since the seriousness of all these effects depends on the relative widths of the throw-out and the i.f. band, the *absolute* magnitude of the throw-out is involved, so that the avoidance of trouble is the more difficult the higher the oscillator frequency. The writer deals briefly in succession with three causes of frequency throw-outs in mixing valves: (1) alterations of electrode capacities by space charges in the neighbourhood of the grid, dependent on the anode and s.g. voltages: these alterations form the most important cause; (2) variations of the anode internal resistance or grid resistance of the oscillator system: these should not produce a throw-out of more than 1 kc/s in a 15 Mc/s frequency; (3) throw-outs due to non-linear distortions: the extent of these is difficult to estimate, but measurements seem to indicate that they, too, are not of great importance.

The writer then considers cause (1), the most important, in relation to the hexode-triode (ACH 1, ECH 11); first as produced by fading compensation and then as produced by a variation in the general voltage. On the 15 Mc/s frequency considered and with compensation from 2.3 mA to zero, the throw-out for the ACH 1 might be around 1 to 2 kc/s; for the ECH 11 it might be 800 c/s. A variation of the general voltage from 200 to 300 v might produce a throw-out of 300 or 400 c/s, for either valve. The same treatment is then given to the octode AK 2. Here, things are very different, owing to the oscillatory system being much more closely coupled to the rest of the valve than it is in the hexode-triode. Fading compensation bringing down the anode current from 1.6 mA to 0.1 mA may produce a throw-out as large as 11 kc/s, while a general voltage drop of 10% may cause one of 4.5 or 4 kc/s. Something like a 25% improvement may here be obtained by taking the second-grid voltage through a series resistance from the general voltage, instead of from a potentiometer.

Finally, the writer considers the variation of the input capacities of the mixing valves mentioned above, resulting from changes in the space charges near the input grid as the anode current is varied by fading compensation. The consequent grid-circuit de-tuning is in this case considerably less in the octode than in the hexode-triodes, owing to the fact that the input grid of the octode is the fourth, where the space charge conditions are different from those at the first grid.

484. PAPERS ON VARIABLE-MU VALVES FOR AVC, AND ON THE MIXER VALVE ECH 11, WITH "SLIDING" SCREEN-GRID VOLTAGE.—Schiffel: Scheel: Schiffel. (*See* 533/535.)

485. THE LOW-NOISE H.F. PRE-AMPLIFIER AND AVC PENTODE TYPE EF 13.—Ratheiser. (*See* 536.)

486. THE DESIGN OF THE AVC RECTIFIER CIRCUIT AND THE DISTORTION DUE TO BIAS.—Williams. (*See* paper dealt with in 453, above.)

487. A NEW METHOD OF CONNECTION OF A MULTI-GRID VALVE FOR D.C. AMPLIFICATION [for Various Automatic-Control & Other Purposes].—Boucke. (*See* 445.)

488. NEW TYPE OF CONTRAST CONTROL BY VARIABLE NEGATIVE FEEDBACK.—B. J. Stevens. (*Funktech. Monatshefte*, Oct. 1938, No. 10, p. 316.) A critical summary of Stevens's article (2295 of 1938).

489. AUTOMATIC CONTRAST COMPRESSION AND EXPANSION FREE FROM TIME-LAG AND DISTORTION.—Lachner. (*See* 478.)

490. NON-LINEAR CROSS-TALK IN MULTIPLE SYSTEMS WITH TRANSMITTED CARRIERS.—Hölzler. (*See* 790.)

491. CORRECTION OF [Formula in] PAPER: "REDUCTION OF INTERFERENCE BY FREQUENCY MODULATION."—E. H. Plump. (*Hochf:tech. u. Elek:akus.*, Oct. 1938, Vol. 52, No. 4, p. 148.) *See* 115 of January.

492. INVESTIGATIONS ON THE PROBLEM OF INTERFERENCE SUPPRESSION AT TRANSMITTER AND RECEIVER IN THE SHORT-WAVE REGION [Tests on the Wave-Form of Morse Signals, without and with Devices to prevent Key Clicks: Transmission of Such Interference by Radiation and along Mains System: etc.].—K. Schlupp. (*Funktech. Monatshefte*, Nov. 1938, No. 11, pp. 342–345.)

493. REDUCTION OF LIABILITY TO DISTURBANCE OF TRANSFORMERS BY THE USE OF RING TRANSFORMERS [and the Selection of the Best Core Design: Elimination of Hum induced by Leakage Field of Mains Transformer].—G. Schadwinkel. (*Funktech. Monatshefte*, Nov. 1938, No. 11, pp. 348–349). Supplementary to the work dealt with in 120 of January.

494. BROADCAST INTERFERENCE CAUSED BY HIGH-TENSION INSTALLATIONS [Survey: Interference from Glow and Corona Discharges: Effect of Atmospheric Deposits: New Lines worse than Old, Oxide-Coated Lines: Critical Voltages: Effect of Different Types of Suspension: etc.].—E. T. Glas. (*E.T.Z.*, 1st Dec. 1938, Vol. 59, No. 48, pp. 1305–1306: summary of Swedish paper.)

495. NEW IGNITION CABLE CUTS RADIO INTERFERENCE [Seven-Strand Stainless-Steel Wire with Low Capacitance: Other Advantages].—Peters. (*Sci. News Letter*, 5th Nov. 1938, Vol. 34, No. 19, p. 294: paragraph only.)

496. A NEW AUTOMATIC NOISE LIMITER: CARRIER-CONTROLLED SQUELCH CIRCUIT FOR SUPERHET SECOND DETECTORS.—J. E. Dickert. (*QST*, Nov. 1938, Vol. 22, No. 11, pp. 19–22.) A rival to the Lamb i.f. noise-silencing device (2162 of 1936 and back reference): with automatic threshold control on telephony and c.w. telegraphy.

497. RADIO-INFLUENCE CHARACTERISTICS OF ELECTRICAL APPARATUS [Results confirming Satisfactoriness of Joint Co-ordination Committee's Method of Measurement: Comparison of Output Meters for Radio-Noise Meter: Comparison of Radio-Noise Meters: Effect of Humidity: etc.].—P. L. Bellaschi & C. V. Aggers. (*Elec. Engineering*, Nov. 1938, Vol. 57, No. 11, pp. 626–633.)

498. VDE RULES FOR CONDENSERS IN BROADCAST AND INTERFERENCE-SUPPRESSING TECHNIQUE [Emendations].—(*E.T.Z.*, 17th Nov. 1938, Vol. 59, No. 46, p. 1240.)

499. REFERENCES ON RADIO INTERFERENCE.—L. F. Roehmann. (*Electronics*, Oct. 1938, Vol. 11, No. 10, p. 32.)

500. "THE RADIO NOISE REDUCTION HANDBOOK" [Book Review].—Technical Staff of *Radio*. (*Communications*, Sept. 1938, Vol. 18, No. 9, p. 24.)

501. "LES PARASITES INDUSTRIELS" [Industrial Interference: Book Review].—E. Dechange. (*Rev. Gén. de l'Élec.*, 15th Oct. 1938, Vol. 44, No. 15, p. 462.)

502. FULL-RANGE SELECTIVITY WITH 455-KC/S QUARTZ-CRYSTAL FILTERS: A NEW FILTER CIRCUIT WITH WIDE-RANGE BAND-WIDTH CONTROL [High-Impedance Crystal Load Circuit using Permeability Tuning].—D. K. Oram. (*QST*, Dec. 1938, Vol. 22, No. 12, pp. 33–36 and 56 . . 62.)

503. A NOTE ON ASYMMETRIC SIDEBAND PHASE DISTORTION [and the Calculation of the Percentage Second-Harmonic Distortion for Various Degrees of the Necessary Asymmetry of Phase Angles: Maximum Percentage likely for Single or Double Sideband Working when using suitably Designed Band-Pass Coupling].—W. E. Benham. (*Wireless Engineer*, Nov. 1938, Vol. 15, No. 182, p. 616.) Supplement to the paper dealt with in 517, below; prompted by Johnstone & Wright's results (86 of 1937).

504. CATHODE-COUPLED CIRCUITS.—Cocking. (*See* 464.)

505. A LOW-COST SINGLE-SIGNAL RECEIVER: DOUBLE REGENERATION FOR I.F. SELECTIVITY AND IMAGE REDUCTION.—G. Grammer. (*QST*, Oct. 1938, Vol. 22, No. 10, pp. 14–18 and 80 . . 88.)

506. RADIO RECEIVERS AND AMPLIFIERS [Survey of Russian and Other Patents].—V. A. Govyadinov. (*Izvestiya Elektroprom. Slab. Toka*, No. 10, 1938, pp. 41–44.)

507. THE OUTPUT STAGE IN CAR RECEIVERS WITH THE VALVES EBC 11 AND EDD 11.—Scheel. (*See* 541.)

508. VIBRATOR POWER SUPPLIES.—G. Hall. (*Wireless World*, 22nd Dec. 1938, Vol. 43, pp. 553–556.) Based on a Sydney World Radio Convention paper.

509. MYSTERY CONTROL [for Philco Receivers].—R. G. Herzog: Philco. (*Communications*, Oct. 1938, Vol. 18, No. 10, pp. 20–21 and 29, 31.)

510. THE PHILCO "MYSTERY CONTROL" [by Induction on Frequencies around 375 kc/s: Max. Distance 75 Feet: General Considerations].—G. Grammer. (*QST*, Dec. 1938, Vol. 22, No. 12, p. 36.)

511. F.C.C. PROPOSES LIMIT TO DISTANCE FOR RADIO REMOTE CONTROL: DEVICES FOR DISTANCE TUNING OF RADIO SETS ARE REALLY SMALL TRANSMITTERS SENDING OUT WAVES AND INTERFERENCE.—(*Sci. News Letter*, 1st Oct. 1938, Vol. 34, No. 14, p. 223.) The suggested limit is that a field strength of 15 μV/m is not exceeded at a distance of $\lambda/2\pi$ (5 ft for a 10 m wave).

512. PECULIAR FAULTS IN RECEIVERS.—(*World-Radio*, 9th Dec. 1938, Vol. 27, p. 12.)

513. "WIRELESS SERVICING MANUAL: THIRD EDITION" [Book Review].—W. T. Cocking. (*Communications*, Sept. 1938, Vol. 18, No. 9, p. 24.)

514. CREATION OF A "SAFETY MARK" FOR BROADCAST APPARATUS [Mains-Driven].—U.S.E. (*Rev. Gén. de l'Élec.*, 24th Sept. 1938, Vol. 44, No. 12, p. 357.)

515. ON THE DESIGN OF [Low-Power] TRANSFORMERS AND COILS WITH IRON CORES.—N. I. Chistyakov. (*Izvestiya Elektroprom. Slab. Toka*, No. 10, 1938, pp. 45–48.)

The methods given by Starik for designing transformers for use with amplifiers having considerable power output (3877 of 1937) are here so modified as to make them applicable to the case of low-power transformers: in addition to the basic relationship between the various dimensions of the shell-type core, the maximum resistance of the winding wire is also fixed beforehand. Transformers with and without magnetising current are considered separately, and all the necessary formulae are given. To simplify the calculations, certain curves are plotted. A brief reference is also made to the design of choke coils, which are regarded as transformers without the secondary winding.

AERIALS AND AERIAL SYSTEMS

516. COAXIAL TRANSMISSION LINE [particularly the ¼ Inch Flexible Copper-Tube Sealed Line with Spiral Glass Braiding round Inner Conductor].—J. L. Bernard. (*Electronics*, Oct. 1938, Vol. 11, No. 10, p. 70.) Successfully used on 300 w at 60 Mc/s, and very satisfactory in long lengths for receiving installations.

517. AERIAL COUPLING SYSTEMS FOR TELEVISION [Analysis of Band-Pass Coupling, with Simplifying Assumptions: Design for Standard Vision Frequency Band: a Note on Loh's "Unequal Circuits": Effect of Self-Inductance of Leads: etc.].—W. E. Benham. (*Wireless Engineer*, Oct. 1938, Vol. 15, No. 181, pp. 555–561.) *See* also 459, above.

518. THE CHOICE BETWEEN HORIZONTAL AND VERTICAL DIPOLES WHEN MINIMUM EARTH ABSORPTION IS REQUIRED, FOR GIVEN EARTH AND WAVELENGTH.—K. F. Niessen. (*Ann. der Physik*, Series 5, No. 5, Vol. 33, 1938, pp. 404–418.)

For previous work *see* 3836 (*also* 2311) of 1938. The expressions there given for T, the energy absorbed in the earth, are here evaluated for horizontal and vertical dipoles at a height of at least two wavelengths above the earth, and emitting total energy at the same rate. Fig. 1 shows T as a function of the earth's refractive index for a horizontal, Fig. 2 for a vertical dipole. Fig. 3 is the superposition of these figures. If minimum earth absorption is required, a horizontal dipole is to be chosen when T is greater for the vertical than for the horizontal aerial. It is found that in general the horizontal dipole is to be preferred for large absolute values of the refractive index, but the reverse is the case for small values of the argument and absolute value of the refractive index. The quantity $1 - T$ is termed the "yield" [Rendement] of the dipole. Fig. 5 (§ 4) gives T as a function of wavelength for one special type of earth.

519. The Calculation of the Radiation Resistance of Transmitting Aerials.—B. P. Afanas'ev. (*Izvestiya Elektroprom. Slab. Toka*, No. 10, 1938, pp. 26–36.)

The object of this investigation is to derive a general formula which could be used for determining the radiation resistance of any flat aerial consisting of linear elements, with no restrictions as to their number, length, relative position, and phase displacement. Two separate conductors I and II arranged arbitrarily in the same plane are considered, and formulae (17) and (25) are derived determining respectively the field intensity at any point on II and the total power in II, as induced by I. From this the radiation resistance induced in II by I can be calculated, but owing to the extremely complicated nature of the calculations involved only the final solution is quoted (27), which is followed by an explanatory list of the symbols used. This is the required general formula. When applied to particular cases, such as two parallel half-wave radiators (Fig. 4), two perpendicular half-wave radiators (Fig. 5), or two radiators connected at an angle to each other (Fig. 6), it reduces to the well-known formulae.

520. Wire for Receiving Aerials [with Tabulated Data: Gauge and Material Far Less Important than Usually Supposed, even for Short Waves].—F. R. W. Strafford. (*Wireless World*, 8th Dec. 1938, Vol. 43, pp. 503–504.)

521. Simplified Discussion of Antennas and Antenna Feed Systems [for Amateur Stations].—T. M. Ferrill, Jr. (*QST*, Nov. 1938, Vol. 22, No. 11, pp. 23–27 and 59: to be contd.)

522. Some Thoughts on Rotary Beam Antennas: a Lightweight and Inexpensive Supporting Frame adaptable to Several Types of Arrays.—A. H. Lynch. (*QST*, Oct. 1938, Vol. 22, No. 10, pp. 45–48 and 118.)

523. An Elaborate and Effective Amateur Rotary Beam Aerial [at GM6RG, Galashiels].—G. Grammer. (*QST*, Nov. 1938, Vol. 22, No. 11, p. 55.)

524. Modern Mast Equipment for Radio Stations.—K. Ljungberg. (*Teknisk Tidskrift*, 3rd Dec. 1938, Vol. 68, No. 48, pp. 567–575: in Swedish.)

VALVES AND THERMIONICS

525. Deflection Valves for Ultra-Short and Decimetre Waves [Author's 1931/1934 Work & Its Conclusions: Necessity for Abandonment of Oscillograph "Electron Gun" and for a Concentration on "Flat Blade" Form for Jet: Necessity for Uniformity of Delay: etc.].—U. Tiberio. (*Wireless Engineer*, Nov. 1938, Vol. 15, No. 182, pp. 612–613.) Prompted by the article and letter dealt with in 3212 of 1938 (Colebrook, Harries). For the writer's paper *see* 1388 (not 1348, as printed in his letter) of 1936.

526. Ultra-Short-Wave Generator Valves [with Dipole Anode (fed at Central Node, and Tuneable by Sliding Magnetic Ends) and Concentrating Curved Screen behind Cathode: Other Devices].—H. E. Hollmann. (German Patent 594 261: *Funktech. Monatshefte*, Oct. 1938, No. 10, pp. 319–320.)

Or the anode may be made to oscillate to a harmonic, the nodal feeding-point then being one-third of the way along it: in this case the cathode is divided into three separate parts, facing different parts of the anode.

527. Radio Valves: Consideration in the Design of Transmitting and High Power Units [including CAT 15 for Max. Input of 2 kW at 2 m Wavelength, and DET 12 for Wavelengths down to 900 cm].—General Electric Company. (*Electrician*, 9th Dec. 1938, Vol. 121, p. 707.)

528. Variation of the Amplification Factor of Thermionic Valves in a Magnetic Field [Factor increased (for Certain Plate & Grid Potentials) from 19 to 23 as Field was raised from Zero to 73.2 Gauss: then decreased continuously to 18 for 209.8 Gauss].—R. D. Joshi. (*Sci. & Culture*, Calcutta, Nov. 1938, Vol. 4, No. 5, p. 302.)

529. Operating and Limiting Values of Receiving Valves, and Their Significance in Practice.—F. Neulen. (*Telefunken-Röhre*, Aug. 1938, Special Valve Number, Supp. to No. 13, pp. 126–134.)

A short general discussion prompted by the belief that "the new chapter in the development of receiving valves introduced by the 'Steel' series of valves provides a good opportunity of extending the technical foundations of valves so as to attain as nearly as possible to various wished-for qualities." In future, valve data will be given separately as "operating values" (Betriebswerte) and "limiting values." Thus the new term "operating anode voltage" will be the sum of the actual working voltage, measured between the cathode and the anode, and the voltage drop at the ohmic resistance: it corresponds to the once-used term "battery voltage."

530. A New Form of the Electromagnetic Energy Equation when Free Charged Particles are Present [useful for discussing Energy Relations in Electron Beam Tubes].—L. Tonks. (*Phys. Review*, 15th Nov. 1938, Series 2, Vol. 54, No. 10, p. 863.)

531. Positive-Grid Characteristics of Triodes [Modification of Usual Plate-Current Equation to take Account of Division of Current between Plate and Positive Grid].—R. W. Porter. (*Elec. Engineering*, Dec. 1938, Vol. 57, No. 12, Sec. 1, pp. 693–696.)

532. Sharp Cut-Off in Vacuum Tubes [Discussion of Equation for High-Vacuum Diode: an Empirical Equation].—G. H. Fett: Aiken & Birdsall. (*Elec. Engineering*, Oct. 1938, Vol. 57, No. 10, pp. 432–433.) Prompted by the paper dealt with in 2491 of 1938.

533. Regulating Valves [Variable-Mu, for AVC] with "Sliding" Screen-Grid Voltage, Type EF 11 [giving Reduced H.F. Distortion].—R. Schiffel. (*Telefunken-Röhre*, Aug. 1938, Special Valve Number, Supp. to No. 13, pp. 41–49.)

This is the paper referred to in 167 of January. "Hitherto it has been sought to avoid these difficulties [modulation distortion, cross modulation, etc., under varying conditions of signal strength] by building-up the complete regulating characteristic out of several parts (Fig. 3). It has already been shown [p. 43] that for small regulating voltages the chief enemy is cross modulation. In this case u_T can be small and lie in the region of 2.5 v [u_T occurs in the equation for the exponential characteristic, near top of p. 44: the larger it is, the more gentle the slope of the I_a/V_g curve]. In such a form of composite regulating characteristic the transition points cause much trouble: their sharp angles produce very strong distortions and interference by cross modulation, mixing of two signals, and hum modulation.

"The requirement, at first sight impossible to fulfil, was thus faced: that for high regulating voltages the curve should be of gentle slope, to keep down the modulation distortion, while for small regulating voltages the curve should be rather steeper (to give the necessary slope and amplification at small anode current) and free from sharp bends or points of discontinuity. These demands can be satisfied if the value of u_T can be made to increase regularly along the length of the regulating characteristic. For this a curve field is necessary which is built up of lines along each of which u_T is constant but increases uniformly from one line to the next. Such a curve field is obtained if the I_a/V_{g1} curves are plotted for different values of s.g. voltage. All that is then necessary is to arrange the connection between regulating voltage and s.g. voltage in such a way that for every regulating condition the modulation occurs along the most favourable curve [Scheel's paper, 534, below, is here referred to].

"Such a process of regulation . . . is attained by the principle of the 'sliding s.g. voltage.' For this purpose the s.g. voltage is generated across a potentiometer of small current consumption or across a series resistance. If the regulating voltage, *i.e.* the negative bias, is increased, the s.g. current decreases. This causes the p.d. across the s.g. series resistance to fall, and the voltage on the screen-grid itself to rise. But as Fig. 4 shows, a rising s.g. voltage means an increasing slope of the linear-logarithmic characteristic, a decrease in distortion, and a simultaneous widening of the regulation range." In terms of the Taylor's series (p. 42) this is expressed by saying that with increasing r.f. voltage, producing increasing regulating voltage, the s.g. voltage rises and the factor u/s becomes smaller: s being the first derivative, representing the slope of the anode-current characteristic, and u being the third, representing the variation of its curvature. Under the conditions of the example discussed in the final paragraphs, the "sliding" s.g. voltage circuit gives a u_T rising to about 7, compared with the value of 4 with a fixed s.g. voltage. For the same modulation distortion this means a maximum input voltage of 2.0 v instead of 1.1 v.

534. The Low-Frequency Regulating [Variable-Mu, for AVC] Valve with Tuning Indicator, Type EFM 11 [with "Sliding" Screen-Grid Voltage].—J. E. Scheel. (*Telefunken-Röhre*, Aug. 1938, Special Valve Number, Supp. to No. 13, pp. 72–100.)

"With the EFM 11 there appears in the new valve series for the first time a composite valve, whose special characteristic is its low-frequency a.v.c. properties." The reasons for combining the a.v.c. system with the tuning-indicator system, using a common cathode, are discussed on pp. 72–74: unlike the corresponding r.f. valves such as the EF 11 (*see* Schiffel, 533, above), this valve has limits for the "sliding" s.g. voltage which fit in well with the requirements of the tuning indicator or "magic eye": the lower limit may be about 30 v compared with the 100 v for the r.f. valve. The grid of the indicator part of the EFM 11 is connected inside the bulb to the cathode, not led out separately as in the AM 2 indicator; the possibility of double control of the luminous sector is therefore abandoned and only a single control used, by an extension of the screen grid of the l.f. system. This is all that is necessary (bottom of p. 73), and the plan considerably simplifies and improves the design of the valve.

535. The Mixing Valve ECH 11 with "Sliding" Screen-Grid Voltage.—R. Schiffel. (*Telefunken-Röhre*, Aug. 1938, Special Valve Number, Supp. to No. 13, pp. 101–104.)

The extension of the "sliding" s.g. voltage technique to the frequency-changing valve, for the improvement of a.v.c. (elimination of h.f. distortions, etc.), meets with the difficulty that as the s.g. voltage "slides" upwards to higher values, the effectiveness of the a.v.c. diminishes. Consideration of this effect (p. 102) has led to the design of the ECH 11, in which it is reduced to negligible proportions by making the third grid with a variable pitch corresponding to that of the variable-mu first grid.

536. The Low-Noise Regulating [Variable-Mu] Pentode EF 13 [specially for Use as H.F. Pre-Amplifier in High-Grade Superheterodyne Receivers, to decrease Background Noise and improve AVC].—L. Ratheiser. (*Telefunken-Röhre*, Aug. 1938, Special Valve Number, Supp. to No. 13, pp. 50–71.)

Section 3 discusses the internal design. Rothe & Engbert (1427 of 1938) give about 1 : 10 as the limit to which the "current-sharing" ratio can usefully be pushed in order to decrease valve-noise. In the EF 13 a ratio of 1 : 7.5 has been attained (compared with 1 : 2.5 for the AF 3) by careful design of the screen grid, which is wound of very thin wire, at a comparatively large distance from the control grid, and has a varying pitch which matches the varying pitch of the control grid. With this sharing-ratio, the s.g. current is about 0.6 mA for an anode current of 4.5 mA. This s.g. design tends to influence unfavourably the grid/anode capacity and the internal resistance of the valve. To get over this difficulty, the suppressor grid is also given a variable pitch to suit the various space-charge densities at different points along it; thus all three grids are of varying pitch. By this plan, and by the provision of screening plates (*see* Figs. 6 and 7), an internal resistance of 0.5 megohms has been obtained, with a grid/anode capacity less than 0.005 picofarad. This resistance is sufficiently high for the purposes of the valve, since it is not intended for use in i.f. circuits. The writer concludes by pointing out that the separate leading-out of the suppressor grid makes the EF 13 useful in special circuits, where this grid can be made use of for additional control (retroaction, etc.). All the other h.f. valves in the "Harmonic Series" have the suppressor grid connected inside the bulb to the cathode, for the sake of simplicity.

537. NOISE OF FREQUENCY-CHANGER VALVES [Observed Absence of Additional Noise from Heterodyning of R.F. Noise Components is *Not* Due to Small Percentage (Rothe & Engbert): Actually about 50%: Explanation based on Noise from I.F. Shot-Noise Components being Smaller for Fast than for Slow Oscillations: a Useful Graphical Method of Investigation].—E. Lukács, F. Preisach, & Z. Szepesi. (*Wireless Engineer*, Nov. 1938, Vol. 15, No. 182, pp. 611–612.) For the German work referred to *see* 1427 of 1938.

538. THE IMPULSIVE THEORY OF THE HEXODE FREQUENCY CHANGER [Results in Accordance with Those of Sinusoidal Theory: Physically Instructive View-Point yielded by Impulsive Treatment: Its Potential General Utility].—L. H. Bedford. (*Wireless Engineer*, Nov. 1938, Vol. 15, No. 182, pp. 596–599.)

539. EFFECT OF SPACE CHARGE AND TRANSIT TIME ON THE SHOT NOISE IN DIODES [Valve Noise equivalent to Thermal-Resistance Noise of Plate Resistance at 0.644 Times the Cathode Temperature, for Non-Planar as well as Planar Diodes: Transit Time produces Same H.F. Modification for both Thermal and Shot Valve Noise: Treatment by Method of Average Velocities].—A. J. Rack. (*Bell S. Tech. Journ.*, Oct. 1938, Vol. 17, No. 4, pp. 592–619.)

540. ON THE EFFECT OF THE SPACE CHARGE IN A VALVE ON THE VELOCITY OF ELECTRONS.—G. A. Zeitlenok. (*Izvestiya Elektroprom. Slab. Toka*, No. 8/9, 1938, pp. 5–14.)

Considering first a triode with flat electrodes, equations 3 & 6 are derived for the time taken by an electron in travelling from the cathode to the grid, (a) in the absence and (b) in the presence of a space charge. For each of the above cases curves are also plotted (Figs. 2 & 3) showing the distribution of potential, electron velocity, and duration of travel between the cathode and the grid. A similar analysis is applied to a triode with cylindrical electrodes, and a general formula is derived for calculating the electron velocity at any point between the cathode and the grid, as determined by the potential of that point (first equation on p. 13).

541. THE OUTPUT STAGE IN CAR RECEIVERS WITH THE VALVES EBC 11 AND EDD 11.—J. E. Scheel. (*Telefunken-Röhre*, Aug. 1938, Special Valve Number, Supp. to No. 13, pp. 113–125.)

The EDD 11 is a push-pull class B output valve of the new Steel Series, with two single-grid systems each with its indirectly heated cathode. In order to obtain as large as possible a ratio of anode current to grid current in the critical region of the characteristic ("full modulation") two auxiliary electrodes (*HH* of Fig. 1) are introduced into the grid/cathode space of each triode system: these are connected inside the valve to the cathode tubes (to which they are parallel) and have a focusing and screening action. Special advantages in the reduction of non-linear distortion are obtained by the choice of the grid bias as 6.3, so that the high current-yielding capacity and small internal resistance of the car accumulator can be taken advantage of for this purpose (section 2, p. 115). The EBC 11 is a duo-diode-triode whose triode part is specially designed to act as driver valve for the EDD 11: the duo-diode part is of normal construction.

542. FREQUENCY THROW-OUTS OF THE OSCILLATOR IN THE MIXING STAGE [Comparison of Hexode-Triodes and Octodes].—Kettel. (*See* 483.)

543. THE MULTI-ELECTRODE VALVE AND ITS APPLICATION IN SCIENTIFIC INSTRUMENTS.—W. B. Lewis. (*Journ. Scient. Instr.*, Nov. 1938, Vol. 15, No. 11, pp. 353–360.)

544. "MODERNE MEHRGITTER-ELEKTRONENRÖHREN" [Multi-Grid Valves: Vol. 2—Electrophysical Foundations: Book Notice].—M. J. O. Strutt. (*Journ. Scient. Instr.*, Nov. 1398, Vol. 15, No. 11, p. 386.) For Vol. 1 *see* 1438 of 1938.

545. NEW TRANSMITTING [and Other] TUBES [including Raytheon QY-4 (now RK-62) Gas-Filled Valve].—(*QST*, Nov. 1938, Vol. 22, No. 11, pp. 57–58.) For other references to this gas-filled valve *see* 3531 of 1938, and 829, below.

546. "SINGLE-ENDED" R.F. RECEIVING TUBES [Types 1852 & 1853 (primarily for Television Receivers), 6SJ7, & others].—(*QST*, Nov. 1938, Vol. 22, No. 11, pp. 55 and 57.) *See* also p. 56, and 164 of January. Also *Wireless World*, 8th Dec. 1938, Vol. 43, pp. 509–510.

547. New Metal for Grids [Nickel/Molybdenum/Iron Alloys, Hastelloy A & B (Moly Alloy & Moly Alloy Type HB)].—R. K. Kennedy. (*Electronics*, Sept. 1938, Vol. 11, No. 9, p. 54.)

548. Carbonised Nickel for Radio Tubes.—T. W. Briggs. (*Metals & Alloys*, Nov. 1938, Vol. 9, No. 11, pp. 303–307.) Describing, "for the first time outside of the patent literature, the blackening of nickel by 'carbonising,' now firmly established as the best black-coating process yet developed."

549. Secondary Electron Emission: Part II—Absorption of Secondary Electrons: Part III—Secondary Electron Emission caused by Bombardment with Slow Primary Electrons.—H. Bruining. (*Physica*, Dec. 1938, Vol. 5, No. 10, pp. 901–912: pp. 913–917.)

For Part I *see* 982 of 1938. (1) Experiments confirming that the absorption of secondary electrons is probably the cause of the fact that, with perpendicularly incident primary electrons, the secondary emission of metals with a large atomic volume is lower than that of metals with a small atomic volume. (2) On bombardment with very slow electrons (voltages about 10 v) the electropositive elements (barium) have a higher s.e. emission than metals such as silver. The coefficient of elastic reflection of barium is less than that of silver. Compounds of the electropositive elements have a high capacity for secondary emission and for reflection.

550. The Measurement of Secondary Emission in Valves, *and* S.E. Coefficients of Caesium-Oxide Surfaces.—Treloar. (*See* 660 & 661.)

551. The Surface Migration of Barium [Electron-Microscopic and Thermionic Experiments].—Benjamin & Jenkins. (*Phil. Mag.*, Dec. 1938, Series 7, Vol. 26, No. 179, pp. 1049–1062.) An abstract was dealt with in 153 of January.

552. The Contact Difference of Potential between Barium and Magnesium.—Anderson. (*See* 664.)

553. The Adsorption of Oxygen and Hydrogen on Platinum and the Removal of These Gases by Positive-Ion Bombardment [deduced from Measurements of Contact Potential Difference between Tungsten Filament and Platinum Anode after Various Treatments: Structure of Mixed Layers].—C. W. Oatley. (*Proc. Roy. Soc.*, Series A, 7th Nov. 1938, Vol. 168, No. 934, p. S 127: abstract only.)

554. The Formation of Negative Ions by Positive-Ion Impact on Surfaces [Experiments: Double Mass Spectrograph].—Sloane & Press. (*Proc. Roy. Soc.*, Series A, 25th Oct. 1938, Vol. 168, No. 933, pp. 284–301.) An abstract was referred to in 159 of January.

DIRECTIONAL WIRELESS

555. On Calculating the Sensitivity of a Radio Direction Finder.—E. N. Khesin. (*Izvestiya Elektroprom. Slab. Toka*, No. 10, 1938, pp. 37–41.)

It has been found experimentally that for a modulating frequency of 1000 c/s the received signal in a direction finder is distinguishable above background noise if the signal voltage U_{T1} is 5 times the background noise voltage U_{T2}. On the basis of this information, formulae 21 and 22 are derived determining respectively the coefficient of sensitivity of a direction finder and the swing necessary to take a bearing (angle at silence) in terms of U_{T1}, U_{T2}, signal field strength E, effective length of the frame l_{e}, efficiency of the input circuit of the direction-finder η, and amplification factor k of the receiver. The accuracy of these formulae has been confirmed experimentally.

556. New Data on Direction of [Short-] Wave Propagation [Deviations as Great as 90° from Great Circle Path].—C. B. Feldman. (*QST*, Oct. 1938, Vol. 22, No. 10, p. 109.) A column on the I.R.E. Convention paper: *see* also 3456 of 1938. For Barfield & Ross's paper on lateral deviation *see* 3970 of 1938.

557. Aircraft Direction Finding [Device for Air-Line Dispatchers].—Aeronautical Radio Company. (*Communications*, Oct. 1938, Vol. 18, No. 10, p. 33.) *See* also 181 of January.

558. Remark on the Paper: "Reflection and Absorption of Decimetre Waves at Plane Dielectric Strata" [Correction of Errors in Formulae].—W. Dällenbach & W. Kleinsteuber. (*Hochf:tech. u. Elek:akus.*, Oct. 1938, Vol. 52, No. 4, p. 147.) *See* 3097 of 1938.

559. Reflection and Absorption of Electromagnetic Waves by Dielectric Strata [of Special Interest for Aircraft Altimeters].—G.W.O.H.: Dällenbach & Kleinsteuber: Pfister & Roth. (*Wireless Engineer*, Nov. 1938, Vol. 15, No. 182, pp. 593–595.) Editorial prompted by the German work dealt with in 3097 of 1938 and back reference, and in 558, above.

560. The Principle of the [Modulated Micro-Wave] Echo Altimeter.—A. T. & T. Company. (*Science*, 11th Nov. 1938, Vol. 88, Supp. pp. 8 and 10.) Development by Sandretto (United Air Lines) and Newhouse (Western Electric).

561. Radio Altimeter [Bell Laboratories' Ultra-Short-Wave Apparatus: Demonstration by Western Electric and United Air Lines].—(*Communications*, Oct. 1938, Vol. 18, No. 10, p. 34.)

562. Automatic Position Finder for Airplanes [Demonstration at Hamble, England].—Roberts & McGillivray. (*Science*, 18th Nov. 1938, Vol. 88, Supp. p. 10.) The Sperry-RCA arrangement is also mentioned (*see* 563, below).

563. An Automatic Direction Finder [Sperry-RCA], *and* The "Flightray" Multiple Indicator.—Sperry Gyroscope Company. (*Communications*, Oct. 1938, Vol. 18, No. 10, pp. 10–11 : pp. 22 and 30.)

ACOUSTICS AND AUDIO-FREQUENCIES

564. Piezoelectric Crystal Elements for Electroacoustical Purposes [including Bimorph Rochelle-Salt Systems : Equivalent Circuits and Quantitative Results].—P. Beerwald & H. Keller. (*Funktech. Monatshefte*, Nov. 1938, No. 11, pp. 345–348.)

565. A D'Arsonval Reproducer for Lateral Recordings [Duralumin Cone (6 mm Diam.) with Coil round Base and Permanent-Point Stylus in Apex : Tensioned Ribbon Suspension].—G. W. Downs, Jr., & W. Miller. (*Communications*, Oct. 1938, Vol. 18, No. 10, pp. 19 and 35.) From the Lansing Mfg. Company.

566. Simple Phonograph Oscillator [Negative-Conductance Oscillator modulated by Pick-Up and giving Signals on about 540 kc/s for reproduction by Broadcast Receiver].—H. C. Kiehne. (*Electronics*, Oct. 1938, Vol. 11, No. 10, pp. 54 and 56.)

567. Idea in Disc Labels [embodying Stroboscopic Disc].—Aerogram Corporation. (*Communications*, Oct. 1938, Vol. 18, No. 10, p. 31.)

568. On Methods for Testing Glow-Discharge Tubes used in Sound Recording.—N. A. Illarionova. (*Izvestiya Elektroprom. Slab. Toka*, No. 8/9, 1938, pp. 51–55.)

The performance of glow-discharge tubes has been investigated by taking photographs of the electrodes under various conditions. The theory of the method is discussed and the conditions necessary to ensure satisfactory operation of the tube are established.

569. AVC by Applause [Automatic Regulation of Loudspeaker Volume to allow for Auditorium Noise].—(*Wireless World*, 4th Aug. 1938, Vol. 43, p. 92.) Note on a British patent.

570. Internal Friction of Wood [Measurements of Logarithmic Decrement of Oscillation Attenuation for Transverse and Longitudinal Oscillations at Audio-Frequencies for Various Kinds of Wood : Most Suitable Woods for Musical Instruments].—F. Krüger & E. Rohloff. (*Zeitschr. f. Physik*, No. 1/2, Vol. 110, 1938, pp. 58–68.)

571. Acoustical Properties of the Violin [Modern German Copy of Old Master compared with Original].—F. A. Saunders : Koch. (*Science*, 25th Nov. 1938, Vol. 88, Supp. p. 10.)

572. Notes on the Theory of the Elastic Pianoforte Hammer.—M. M. Ghosh. (*Science & Culture*, Calcutta, Oct. 1938, Vol. 4, No. 4, pp. 252–253.)

573. Acoustic Spectra of Organ Pipes.—C. P. Boner. (*Journ. Acoust. Soc. Am.*, July 1938, Vol. 10, No. 1, pp. 32–40.)

574. Transitions of Sound in the Organ.—Trendelenburg & others. (*Journ. Acoust. Soc. Am.*, July 1938, Vol. 10, No. 1, pp. 76–77.) Long summary of the German paper dealt with in 1939 of 1938.

575. The Tuning of Beating-Reed Organ Pipes considered as a Relaxation Phenomenon [Experimental Curve of Frequency as Function of Vibrating Length of Tongue].—L. Auger. (*Comptes Rendus*, 18th July 1938, Vol. 207, No. 3, pp. 216–217.)

576. An Improved Quality Commercial Telephone Receiver.—J. S. P. Roberton. (*Elec. Communication*, Oct. 1938, Vol. 17, No. 2, pp. 116–123.)

577. Amplitude-Range Control, *and* Devices for controlling Amplitude Characteristics of Telephonic Signals.—Wright: Norwine. (*See* 792.)

578. Reply to Discussions on "Modern Systems of Multi-Channel Telephony on Cables."—Angwin & Mack. (*Journ. I.E.E.*, Oct. 1938, Vol. 83, No. 502, pp. 576–579.) *See* 4039 of 1938.

579. Non-Linear Distortion and Cross-Talk Frequency Groups in Multiplex Carrier Transmission.—S. Yonezawa. (*Nippon Elec. Comm. Eng.*, Sept. 1938, No. 12, pp. 329–335.)

580. The Measurement of Harmonic Distortion [including B.B.C. Research Department's Apparatus].—H. D. Ellis & C. G. Mayo. (*World-Radio*, 16th Dec. 1938, Vol. 27, pp. 14–15.)

581. Acoustic Literature in Journals of the Year 1937 [Classified List of Titles].—K. Patermann. (*Akust. Zeitschr.*, July 1938, Vol. 3, No. 4, pp. 232–239.) Concluded from previous issues.

582. "The Amplification and Distribution of Sound" [Book Review].—A. E. Greenlees. (*Electrician*, 16th Dec. 1938, Vol. 121, p. 726.)

583. Stabilised Regenerative Amplifier [suitable for A.F. Measurements].—S. Roberts. (*Review Scient. Instr.*, Dec. 1938, Vol. 9, No. 12, p. 429.)

584. Measurement of Acoustic Reverberation Time [using Microphone and Amplifier together with System of Differential Measurement : Linear and Logarithmic Amplification : Logarithmic Amplifier with Fluxmeter].—P. Chavasse. (*Comptes Rendus*, 21st Nov. 1938, Vol. 207, No. 21, pp. 979–981.)

585. Recent Results in Room and Architectural Acoustics [Survey].—K. Schuster, (*Zeitschr. V.D.I.*, 6th Aug. 1938, Vol. 82. No. 32, pp. 921–927.)

586. On the Influence of a Resonator upon the Field of Sound.—K. Sato & K. Kubo. (*Aeron. Res. Inst. of Tokio*, Report No. 163, April 1938.)

587. Effects of Cylindrical Pillars in a Reverberation Chamber.—P. E. Sabine. (*Journ. Acoust. Soc. Am.*, July 1938, Vol. 10, No. 1, pp. 1–5.)

588. The Diffraction produced by Cylindrical and Cubical Obstacles and by Circular and Square Plates.—Muller, Black, & Davis. (*Journ. Acoust. Soc. Am.*, July 1938, Vol. 10, No. 1, pp. 6–13.)

589. The Reduction of Structure-Borne Noise by Vibration-Attenuating Supports.—A. J. King. (*Engineering*, 29th July 1938, Vol. 146, pp. 124–126 : to be contd.)

590. The Insulation of Air-Borne Sound : the Application of Laboratory Results to Practical Building Problems.—C. J. Morreau. (*Journ. Acoust. Soc. Am.*, July 1938, Vol. 10, No. 1, pp. 45–49.)

591. The Damping of Sound in Tubes with Absorbing Walls.—A. Belov. (*Journ. of Tech. Phys.* [in Russian], No. 8, Vol. 8, 1938, pp. 752–755.)

592. "Richtlinien für die Lärmabwehr in der Lüftungstechnik" [Defence against Noise in Ventilation Engineering : Book Review].—Gröber & others. (*Akust. Zeitschr.*, Sept. 1938, Vol. 3, No. 5, pp. 316–317.)

593. Some Physical Problems in Noise Measurement [with Particular Reference to Automobile Noise].—P. Huber. (*Journ. of Applied Physics*, July 1938, Vol. 9, No. 7, pp. 452–456.)

594. Some Acoustic Problems of the Automotive Fan [Reduction of Noise produced by Car Cooling-Fan].—B. B. Cary. (*Journ. Acoust. Soc. Am.*, July 1938, Vol. 10, No. 1, pp. 63–67.)

595. The War against Noise in Electrical Machines and Appliances.—E. Lübcke. (*E.T.Z.*, 21st July 1938, Vol. 59, No. 29, pp. 765–770.)

596. Oscillations of the Outer Casing of D.C. Machines as the Cause of Magnetic Noise.—K. Schmidt. (*Arch. f. Elektrot.*, 15th Aug. 1938, Vol. 32, No. 8, pp. 487–514.)

A d.c. machine is here used as an example of the theoretical and experimental investigation of problems connected with the whole phenomena of the production of magnetic noise by electrical machines. Author's summary :—"Oscillation of the outer casing of electrical machines are particularly fitted to cause a considerable amount of magnetic noise, since the natural frequencies of the stator ring are of the same order of magnitude as the slot frequency and the radiation resistance of the casing attains relatively large values. It is shown how to calculate approximately the oscillation amplitude and the power radiated as noise for a d.c. machine ; values calculated for a practical example are compared with the result of measurements of oscillation and acoustic intensity on the same machine. Measures for reducing the magnetic noise are deduced ; their effect may be quantitatively estimated."

597. The Damping of the Noise from a Shooting Range [so as not to Interfere with Sound-Film Recording].—G. Buchmann & L. Keidel. (*Akust. Zeitschr.*, July 1938, Vol. 3, No. 4, pp. 216–217.)

598. The Acoustic Auscultation of Structures in Concrete or Metal [Vibrating Cord Method, with Remote Observation].—Coyne. (*Génie Civil*, 1st Oct. 1938, Vol. 113, No. 14, pp. 286–288.)

599. The Influence of Acoustic Stimuli upon the Limits of Visual Fields for Different Colours.—P. A. Yakovlev. (*Journ. Opt. Soc. Am.*, Aug. 1938, Vol. 28, No. 8, pp. 286–289.)

600. The Scale of Loudness [Editorial on Wagner's Proposed "Everyday-Life" Scale, with a "Wien" as Unit].—G.W.O.H : Wagner. (*Wireless Engineer*, Oct. 1938, Vol. 15, No. 181, pp. 533–534.) *See* 4013 of 1938.

601. A New Method for Determining the Uniaural Differential Threshold.—J. W. Hughes. (*Phil. Mag.*, Nov. 1938, Series 7, Vol. 26, No. 177, pp. 635–650.)

602. The Mechanism of Hearing as revealed through Experiment on the Masking Effect of Thermal Noise.—H. Fletcher. (*Proc. Nat. Acad. Sci.*, July 1938, Vol. 24, No. 7, pp. 265–274.)

603. About the Origin of the Distance Impression in Hearing, *and* On Sound Localisation [and the Necessary Part played by Head Movement].—von Békésy : Wallach. (*Journ. Acoust. Soc. Am.*, July 1938, Vol. 10, No. 1, pp. 77–78 : p. 83.) Summaries only : the first is of the German paper referred to in 1937 of 1938.

604. "Hearing : Its Psychology and Physiology" [Book Review].—S. S. Stevens & H. Davis. (*Review Scient. Instr.*, Oct. 1938, Vol. 9, No. 10, pp. 302–303.)

605. An Analysis of Perceptible Overtones in the Voice.—Lewis & Lichte. (*Journ. Acoust. Soc. Am.*, July 1938, Vol. 10, No. 1, p. 83 : summary only.)

606. Vowel Vibration and Vowel Production [Vowel Vibration Tracks have Characteristic Profiles and Logarithmic Decrements : Vibrations are not Forced].—E. W. Scripture : R. A. S. Paget. (*Nature*, 1st Oct. 1938, Vol. 142, p. 619.) For Paget's letter, opposing Scripture's conclusions, and maintaining the human vowel sound to be essentially a resonance effect, see *ibid.*, 26th Nov. 1938, p. 957.

607. Acoustic Effects of Humidity in Gases [Possible Cause of Reported Critical Frequency in "Dry" CO_2], *and* Theory of Acoustic Effects of Humidity in CO_2.—W. H. Pielemeier: H. L. Saxton. (*Journ. Acoust. Soc. Am.*, July 1938, Vol. 10, No. 1, p. 87: p. 87: summaries only.)

608. Absorption of Sound in Carbon Dioxide and in Carbon Disulphide [Experimental Confirmation of Collision Theory of Anomalous Absorption].—V. O. Knudsen & E. Fricke. (*Phys. Review*, 1st Aug. 1938, Series 2, Vol. 54, No. 3, p. 238: abstract only.)

609. Acoustic Absorption and Reflection Coefficients in Gases by Supersonic Interferometry.—R. S. Alleman. (*Journ. Acoust. Soc. Am.*, July 1938, Vol. 10, No. 1, p. 88: summary only.)

610. Ultrasonic Reflection Losses in Air, Helium, and CO_2 [Recalculation of Values shows Agreement with Herzfeld's Theory].—R. S. Alleman & J. C. Hubbard. (*Phys. Review*, 15th Aug. 1938, Series 2, Vol. 54, No. 4, p. 313: abstract only.)

611. Velocity of Sound in Liquid Helium.—H. J. Groenewold. (*Nature*, 26th Nov. 1938, Vol. 142, pp. 956–957.)

612. The Velocity of Sound in Liquid Nitrogen [measured by Method using Diffraction of Light by Supersonic Waves].—E. Hirschlaff. (*Proc. Camb. Phil. Soc.*, April 1938, Vol. 34, Part 2, pp. 296–298.)

613. Debye Heat Waves in Highly Viscous Liquids [Hydrodynamic Viscosity has Little Influence on Propagation of Thermal Sound Waves of Very High Frequencies].—C. V. Raman & C. S. Venkateswaran. (*Nature*, 29th Oct. 1938, Vol. 142, p. 791.)

614. Absorption of Supersonic Waves in Electrolytes [as Function of Frequency (up to 37 Mc/s) and Concentration].—P. Bazulin. (*Comptes Rendus (Doklady) de l'Acad. des Sci. de l'URSS*, No. 3, Vol. 19, 1938, pp. 153–156: in German.) Using the apparatus described in a previous paper (227 of 1936).

615. The Determination of the Rigidity Modulus of Nickel and Some of its Alloys in the Annealed and Unannealed States [using Theory of Torsional Vibration of Bars in Form of Thin Strips of Rectangular Cross-Section].—D. H. Landon & R. M. Davies. (*Phil. Mag.*, Nov. 1938, Series 7, Vol. 26, Supp. No. 178, pp. 816–840.)

616. A New Method of Measuring the Elastic Constants of Transparent Isotropic Solid Bodies [using Supersonic Standing-Wave Lattice].—K. H. Hoesch. (*Zeitschr. f. Physik*, No. 9/10, Vol. 109, 1938, pp. 606–624.)

617. Note on Velocity of Sound in Copper [Direct Determination of Frequency of Rod Vibrating Longitudinally, Fixed at Middle: Effect of Hardening Processes, etc.].—G. E. Allan. (*Phil. Mag.*, Oct. 1938, Series 7, Vol. 26, No. 176, pp. 609–614.)

618. The Damping of the Lateral Vibration of a Mild Steel Bar [Decrease of Internal Friction Constant with Decrease in Amplitude].—Ockleston. (*Phil. Mag.*, Nov. 1938, Series 7, Vol. 26, No. 177, pp. 705–712.)

619. The Internal Friction of Metallic Crystals [less for Single Crystals than for Polycrystalline Material: Observations on Cu, Pb, Sn].—T. A. Read. (*Phys. Review*, 1st Sept. 1938, Series 2, Vol. 54, No. 5, p. 389.)

620. "Transverse" Acoustic Waves in Rigid Tubes [Apparatus & Methods for Production of Lower-Ordered Acoustic Waves: Agreement with Theoretical Results].—H. E. Hartig & C. E. Swanson. (*Phys. Review*, 15th Oct. 1938, Series 2, Vol. 54, No. 8, pp. 618–626.)

621. The Propagation of Supersonics in Capillary Tubes [Measurements of Velocity and Attenuation Constants: Absorption Greater than Theoretical Value].—J. May. (*Proc. Phys. Soc.*, 1st July 1938, Vol. 50, Part 4, No. 280, pp. 553–559: Discussion pp. 559–560.)

622. Thermal Dilatation of Liquids [Its Relation to Viscosity and the Longitudinal and Transverse Viscous Vibrations].—R. Lucas. (*Comptes Rendus*, 14th Nov. 1938, Vol. 207, No. 20, pp. 900–901.)

623. Dust Figures of Standing Supersonic Waves in Liquids [by Use of Herapathite Crystals in Hexane].—M. von Ardenne. (*Funktech. Monatshefte*, Aug. 1938, No. 8, p. 248.)

624. On the Interference between Two Plane Supersonic Waves: Application of This Phenomenon to a New Method of Measuring the Velocity of Sound [from the Spaces between Stationary Ripples formed on the Surface of Water, Mercury, etc.].—J. P. Cance. (*Journ. de Phys. et le Radium*, July 1938, Series 7, Vol. 9, No. 7, pp. 309–312.)

625. The Application of Short-Focus Optics to the Study of Supersonic Fields in Liquids, *and* The Effect of Supersonic Waves on Supercooled Water.—I. Sokolov. (*Journ. of Tech. Phys.* [in Russian], No. 10, Vol. 8, 1938, pp. 898–900: pp. 901–902.)

626. Some Experiments on the Optics of Supersonic Waves [using Lenses, Reflectors, etc: Frequencies up to about 5 Mc/s].—A. Giacomini. (*Alta Frequenza*, Oct. 1938, Vol. 7, No. 10, pp. 660–674.)

627. THE ULTRASONIC RADIATION FIELD OF A QUARTZ DISC RADIATING INTO LIQUID MEDIA [Intensity Distribution measured by Radiation Pressure of Sound Waves on Spherical Obstacle: Disc Comparable to Plane Piston].—F. E. Fox & G. D. Rock. (*Phys. Review*, 1st Aug. 1938, Series 2, Vol. 54, No. 3, pp. 223–228.)

628. CHARGED COLLOID PARTICLES IN AN ULTRASONIC FIELD: II—PARTICLES SURROUNDED BY A THIN DOUBLE LAYER [Calculations of Potential Difference between Node and Antinode].—J. J. Hermans. (*Phil. Mag.*, Nov. 1938, Series 7, Vol. 26, No. 177, pp. 674–683.)

629. THE PHYSICO-CHEMICAL PROPERTIES OF HIGH-FREQUENCY ELASTIC WAVES: PHYSICAL CATALYSERS: ULTRA-FILTRATION AND THE SUPERSONIC CENTRIFUGE.—N. Marinesco. (*Génie Civil*, 15th Oct. 1938, Vol. 113, No. 16, pp. 317–322.)

630. A MOLECULAR REARRANGEMENT INDUCED BY ULTRASONIC WAVES [10–50 kc/s: about 12 Watts: Benzacide into Nitrogen & Phenyl Isocyanate].—Porter & Young. (*Journ. Am. Chem. Soc.*, June 1938, Vol. 60, No. 6, pp. 1497–1500.)

631. DISRUPTION OF SOLID SUBSTANCES BY SUPERSONIC WAVES [as Distinct from Dispersion of Pre-Formed Particles].—K. Söllner. (*Communications*, June 1938, Vol. 18, No. 6, p. 38.)

632. THE SOUNDING OF RIVERS BY SUPERSONIC MAGNETOSTRICTION APPARATUS [and Some Demonstrations on the Rhône].—(*Génie Civil*, 23rd July 1938, Vol. 113, No. 4, pp. 90–91.)

633. THE PRESENT POSITION OF RESEARCHES ON SUPERSONICS: CRITICAL ANALYSIS OF PAPERS APPEARING IN 1935 AND 1936.—E. Baumgardt. (*Revue d'Acoustique*, Sept./Dec. 1937, Vol. 6, Fasc. 5/6, pp. 178–209.)

634. "ULTRASONICS AND THEIR TECHNICAL APPLICATIONS" [Book Review].—L. Bergmann. (*Electrician*, 11th Nov. 1938, Vol. 121, p. 570.) English translation of the book referred to in 207 of 1938.

PHOTOTELEGRAPHY AND TELEVISION

635. ULTRA-SHORT-WAVE RADIO TRANSMITTERS AT THE MOSCOW TELEVISION CENTRE.—G. Z. Besidski. (*Izvestiya Elektroprom. Slab. Toka*, No. 8/9, 1938, pp. 37–48.)

A description is given, with photographs and circuit diagrams, of the two u.s.w. transmitters at the Moscow Television Centre, built by the RCA and used for transmission of vision and sound respectively. Each transmitter has four stages and delivers approximately 7.5 kw (unmodulated carrier power) to a common feeder. The vision transmitter uses grid modulation on the last stage, with a maximum depth of 65–70%, while for the sound transmitter class B anode modulation with a maximum depth of 60–65% is employed. The total power consumption of the two transmitters is of the order of 200 kw. The operating wavelengths are 6.01 m (vision) and 5.77 m (sound). The aerial is supported on a tower 148.3 m high and consists of three horizontal sections mounted one above the other, each section comprising three horizontal quarter-wave dipoles arranged in the form of an isosceles triangle.

636. TELEVISION [Notes on History: System at London Television Station].—N. Ashbridge. (*Nature*, 19th Nov. 1938, Vol. 142, pp. 923–924: summary of lecture to Inst. Mech. Eng.)

637. THE LONDON TELEVISION SERVICE, *and* THE MARCONI-E.M.I. TELEVISION SYSTEM.—Macnamara & Birkinshaw: Blumlein & others. (*Journ. I.E.E.*, Dec. 1938, Vol. 83, No. 504, pp. 729–757: pp. 758–792: Discussions pp. 793–801.) Long summaries were referred to in 2870 of 1938.

638. E.M.I. CATHODE-RAY TELEVISION TRANSMISSION TUBES [and Comparison of "Emitron" and "Super-Emitron" Types].—J. D. McGee & H. G. Lubszynski. (*Electrician*, 9th Dec. 1938, Vol. 121, p. 697: short summary of I.E.E. paper.)

639. TELEVISION AT THE LONDON AND PARIS RADIO EXHIBITIONS.—von Farnholz. (*Funktech. Monatshefte*, Oct. 1938, No. 10, Supp. pp. 77–79.)

640. THE WIRELESS EXHIBITION, 1938: A TECHNICAL SURVEY.—(*Wireless Engineer*, Oct. 1938, Vol. 15, No. 181, pp. 543–554.)

641. LONG FEEDERS FOR TRANSMITTING WIDE SIDEBANDS, WITH REFERENCE TO THE ALEXANDRA PALACE AERIAL-FEEDER SYSTEM.—E. C. Cork & J. L. Pawsey. (*Electrician*, 9th Dec. 1938, Vol. 121, p. 697: short summary of I.E.E. paper.)

642. AERIAL COUPLING SYSTEMS FOR TELEVISION, *and* A NOTE ON ASYMMETRIC SIDEBAND PHASE DISTORTION.—Benham. (*See* 517 & 503.)

643. TELEVISION TRANSMISSIONS OVER SHORT DISTANCES [from Camera (or Film Scanner) to Control Room, then on to Ultra-Short-Wave Transmitter: Line Transmission to Several Receivers (at Exhibitions): Some Practical Points].—K. Lipfert. (*Funktech. Monatshefte*, Nov. 1938, No. 11, pp. 85–86.)

644. REPLY TO DISCUSSIONS ON "MODERN SYSTEMS OF MULTI-CHANNEL TELEPHONY ON CABLES."—Angwin & Mack. (*Journ. I.E.E.*, Oct. 1938, Vol. 83, No. 502, pp. 576–579.) *See* 4039 of 1938.

645. NEW MECHANICAL FILM SCANNER [Fernseh Company, 1937, and Further Developed to the "Universal" Scanner, 1938].—K. Thöm. (*Funktech. Monatshefte*, Nov. 1938, No. 11, Supp. pp. 84–85.)

646. A NEW TELEVISION SYSTEM.—Braude. (*Funktech. Monatshefte*, Oct. 1938, No. 10, Supp. p. 79.) A long summary of the Russian paper dealt with in 592 of 1938.

647. The Control of Electron Beams, with Particular Reference to Television [and the Comparative Advantages of Electrostatic and Magnetostatic Methods].—D. J. Mynall. (*Electrician*, 9th Dec. 1938, Vol. 121, p. 697: short summary of I.E.E. Students' Section paper.)

648. Deflecting Arrangements for Television [Survey of Saw-Tooth Generator and Amplifier or Symmetry Circuits].—G. Faust. (*Funktech. Monatshefte*, Oct. & Nov. 1938, Nos. 10 & 11, Supp. pp. 73–77 & 81–83.)

649. Cathode-Coupled Circuits.—Cocking. (*See* 464.)

650. The Need for Safety-of-Life Precautions in Amateur Transmitting Installations and Television Receiver Lay-Outs.—R. A. Hull: Warner. (*See* Warner's obituary article on Ross Hull, 802, below.)

651. A Practical Television Receiver for the Amateur.—C. C. Shumard. (*QST*, Dec. 1938, Vol. 22, No. 12, pp. 21–25 and 72 . . 76.)

652. Building Television Receivers with Standard Cathode-Ray Tubes [One, Two, and Three-Inch Tubes].—J. B. Sherman. (*QST*, Oct. 1938, Vol. 22, No. 10, pp. 21–25.)

653. "Testing Television Sets" [Book Review].—J. H. Reyner. (*Electrician*, 9th Dec. 1938, Vol. 121, p. 696.)

654. "Principes et État actuel de la Photo-télégraphie" [Book Review].—Chr. Caenepenne. (*Rev. Gén. de l'Élec.*, 5th Nov. 1938, Vol. 44, No. 18, pp. 565–568.)

655. Scattered Light from Polaroid Plates.—H. W. Farwell. (*Journ. Opt. Soc. Am.*, Nov. 1938, Vol. 28, No. 11, pp. 460–461.)

656. Electronic Conduction in Insulating Crystals under Very High Field Strength [Current/Voltage Characteristics and Photoelectric Response: Phenomena observed Acoustically make Crystalline Type of Light-Counter feasible].—A. von Hippel. (*Phys. Review*, 15th Nov. 1938, Series 2, Vol. 54, No. 10, p. 867: abstract only.)

657. A New Sensitive Light - Counter. — R. Tzschaschel. (*Zeitschr. f. Physik*, No. 3/4, Vol. 111, 1938, pp. 215–231.)

Author's summary:—"A light counter is developed which has the property of registering every emitted photoelectron. The primary electrons are accelerated in a homogeneous field and amplified by impact ionisation. The electrons of the resulting avalanche pass in part through a grid in the counting field of a point counter and cause it to respond. The counting properties of this apparatus are investigated and discussed with regard to darkness effect, resolving power, and self-excitation. The relative yield, *i.e.* the ratio of the impulses counted to the electrons primarily produced, is a function of the field strength. A saturation value of 0.25 is found; that is to say, every fourth photoelectron is counted."

658. The Photoelectric Properties of Alkali Films of Atomic Thickness on Carrier Metals of High Work Function: II—Caesium and Potassium on Tungsten and Platinum.—H. Mayer. (*Ann. der Physik*, Series 5, No. 5, Vol. 33, 1938, pp. 419–444.)

For I *see* 3079 of 1937. Here the change in photoelectric yield per unit incident energy is measured for a series of wavelengths between 8000 and 2400 AU and increasing film thickness. The results obtained are:—"(1) Determination of the optimum film thickness, for which the photoelectric yield passes through a first maximum; (2) experimental proof that this maximum occurs at the same thickness for both photoelectric and thermionic emission; (3) photoelectric determination of variation of work function with thickness, and comparison with thermionic measurements; (4) proof of occurrence of weak selective effect at thicknesses smaller than the optimum; photoelectrons originate from carrier metal up to optimum thickness; (5) proof that the second selective effect, usually observed, begins to develop immediately the optimum thickness is passed, and that the corresponding electrons come from the alkali atoms; (6) determination of the film thickness for which the yield of this selective effect passes through a maximum."

659. The Photoelectric Excitation of Composite Photocathodes at Low Temperatures.—R. Suhrmann & A. Mittmann. (*Zeitschr. f. Physik*, No. 3/4, Vol. 111, 1938, pp. 137–151.)

For previous work on composite photocathodes at low temperatures *see* 220 of January. In the present paper it is found that "an excitation, shown by a drop in sensitivity, occurs for all cathodes only on irradiation with the light of a spectral maximum. Irradiation of an excited cathode with long-wave light causes the emission of additional electrons, whose energy should arise from the excitation energy; current/voltage curves for long-wave light are therefore measured in the normal state and after excitation. It is found in fact that the maximum potential of the electrons liberated by long-wave light is higher for the excited state than that for the normal state by the value of the excitation energy. The sensitivity curve of an excited K/KH/K cathode shows a spectral maximum in the infra-red which is not present in the normal state and which must therefore be ascribed to an absorption band of the excited centres."

660. The Measurement of Secondary Emission in Valves [Critical Survey of Previous Methods, leading to Description of "Suppressor-Grid" Method: Application to Study of Various Caesium-Oxide Surfaces].—L. R. G. Treloar. (*Wireless Engineer*, Oct. 1938, Vol. 15, No. 181, pp. 535–542.)

661. Secondary-Emission Coefficients of Caesium-Oxide Surfaces are Independent of Nature of Metal dispersed through Coating.—Treloar. (In paper dealt with in 660, above.)

"This is a particularly interesting result because it has been suggested by Timofeew & Pyatnitski [1050 *bis* of 1937] that it is the silver particles embedded in the oxide that are responsible for the initiation of the s.e. process in the normal caesium-oxide film."

662. SECONDARY ELECTRON EMISSION.—Bruining. (*See* 549.)

663. THE PASSAGE AND DIFFUSION OF CORPUSCLES ACROSS BARRIERS OF COULOMBIAN POTENTIAL [General Theoretical Solution].—G. Badarau. (*Comptes Rendus*, 28th Nov. 1938, Vol. 207, No. 22, pp. 1030–1032.)

664. THE CONTACT DIFFERENCE OF POTENTIAL BETWEEN BARIUM AND MAGNESIUM [Measurements of Volta Potential compared with Recent Photoelectric Results: Work Function of Magnesium: Possible Variation with Nature of Surface].—P. A. Anderson. (*Phys. Review*, 1st Nov. 1938, Series 2, Vol. 54, No. 9, pp. 753–757.)

665. ADDITIONAL ELECTRONS DUE TO PHOTOELECTRIC EFFECT IN A NON-INDEPENDENT HYDROGEN DISCHARGE [explain Rapid Increase of Current above That given by Ionisation by Collision].—Costa & Raether. (*Naturwiss.*, 9th Sept. 1938, Vol. 26, No. 36, p. 593.)

666. THE SCATTERING AND PHOTOELECTRIC ABSORPTION OF HIGH-VOLTAGE X-RAYS IN NITROGEN.—Trueblood & Loughbridge. (*Phys. Review*, 15th Oct. 1938, Series 2, Vol. 54, No. 8, pp. 545–554.) *See* also 4490 of 1938.

MEASUREMENTS AND STANDARDS

667. A FIELD-STRENGTH MEASURING SET FOR ULTRA-SHORT WAVES.—V. B. Binshtok. (*Izvestiya Elektroprom. Slab. Toka*, No. 8/9, 1938, pp. 20–27.)

A description is given of a portable set developed in the USSR for field-strength measurements on wavelengths between 3 and 12 m. The set uses the comparison method and its circuit consists essentially of the following stages: local oscillator, first detector and beating oscillator, variable attenuator (capacity potentiometer), two stages of i.f. amplification, second detector, and two stages of l.f. amplification. The various errors introduced in these measurements are discussed, and means are suggested for increasing the accuracy of the set. A full circuit diagram and two photographs of the set are included.

668. HIGH-FREQUENCY AMMETER EMPLOYS PHOTO-TUBE INDICATOR [Electrodynamic Ammeter accurate within 1% in Range 5–42 Mc/s].—General Elec. Company. (*Electronics*, Sept. 1938, Vol. 11, No. 9, pp. 44 and 46.) *See* Meahl, 3724 of 1938.

669. MODERN SHORT-WAVE RECEIVING [and Measuring] TECHNIQUE.—Strutt. (*See* 480.)

670. A VALVE VOLTMETER WITH FOUR RANGES.—R. M. Shevchuk. (*Izvestiya Elektroprom. Slab. Toka*, No. 8/9, 1938, pp. 56–59.)

Developed in the USSR. Automatic grid biasing and a separate compensating valve make it suitable for operation from a.c. mains. Its four ranges are 0–3, 0–10, 0–30, and 0–100 volts, and it can be used at frequencies up to at least 2000 kc/s.

671. MINIATURE VALVE VOLTMETER [Type 105 X, using Small Valve with Filament Current from 3 V Torch Battery].—Salford Elec. Instr. Company. (*Journ. Scient. Instr.*, Nov. 1938, Vol. 15, No. 11, p. 381.)

672. VALVES WITH SHARP BENDS IN THEIR ANODE-CURRENT/GRID-VOLTAGE CHARACTERISTICS, FOR VALVE-VOLTMETERS.—(*E.T.Z.*, 24th Nov. 1938, Vol. 59, No. 47, pp. 1268–1269.) Based on the paper by Aiken & Birdsall (2491 of 1938).

673. DIRECT-READING INDUCTOMETERS AND CAPACITY METERS BASED ON CERTAIN PROPERTIES OF OSCILLATORY CIRCUITS.—Rutelli. (*See* 449.)

674. MEASUREMENT OF THE PARAMETERS OF QUARTZ PLATES.—A. Arkhangel'skaya. (*Izvestiya Elektroprom. Slab. Toka*, No. 8/9, 1938, pp. 28–35.)

It is pointed out that in designing crystal-controlled oscillators it is desirable to know not only the natural frequency and temperature coefficient of a crystal plate but also its decrement d_q, inductance L_q, capacity C_q and resistance R_q. In the present paper two alternative methods are suggested for measuring d_q. The first method consists in measuring the amplitude of the crystal oscillator at two different intervals after the excitation voltage has been removed from the crystal, while in the second method a resonance curve of the crystal is plotted and from this d_q is calculated. In order to determine R_q, L_q, and C_q, an additional resistance is connected in series with the crystal and the new d_q is measured; from this the required values can be calculated.

Circuits suitable for the above measurements are described and their accuracy discussed. A table is given showing results obtained with a number of crystal plates at frequencies from 100 to 2000 kc/s.

675. X-RAY EVIDENCE ON THE NATURE OF THE SURFACE LAYERS OF THIN GROUND QUARTZ CRYSTALS SECURED WITH THE CAUCHOIS SPECTROGRAPH [suggests Recrystallisation of Displaced Atoms on Underlying Crystal Foundation].—F. R. Hirsh & J. W. M. DuMond. (*Phys. Review*, 15th Nov. 1938, Series 2, Vol. 54, No. 10, pp. 789–792.)

676. MAINTENANCE OF MOTION OF A PENDULUM BY MEANS OF AN ALTERNATING CURRENT OF FREQUENCY HIGH COMPARED WITH ITS NATURAL FREQUENCY [Theory].—J. Béthenod. (*Comptes Rendus*, 7th Nov. 1938, Vol. 207, No. 19, pp. 847–849.)

677. ON THE REVISION OF THE VDE RULES FOR MEASURING INSTRUMENTS, *and* RULES FOR MEASURING INSTRUMENTS.—N. Lieber: VDE. (*E.T.Z.*, 10th Nov. 1938, Vol. 59, No. 45, pp. 1209–1211: pp. 1211–1212.)

678. "RADIO-FREQUENCY ELECTRICAL MEASUREMENTS: SECOND EDITION" [Book Review].—H. A. Brown. (*Proc. Inst. Rad. Eng.*, Sept. 1938, Vol. 26, No. 9, p. 1175.)

679. On the Use of Mechanical Oscillographs in the Production of Measuring Apparatus.—A. M. Damski & N. I. Voskoboynikov. (*Izvestiya Elektroprom. Slab. Toka*, No. 8/9, 1938, pp. 48–51.)

Methods are indicated for determining various constants (natural frequency, logarithmic decrement, etc.) of the moving parts of meters, by attaching a small mirror to the parts in question and recording the movement photographically.

680. Mechanical Elimination of Brownian and Other Fortuitous Deviations in Measurements.—L. S. Ornstein & J. M. W. Milatz. (*Physica*, Dec. 1938, Vol. 5, No. 10, pp. 971–976 : in English.)

681. Artificial Modification of Certain Galvanometer Constants [Galvanometer in Circuit of Photocell illuminated by Light Beam regulated by Galvanometer Mirror : Methods for Increase of Galvanometer Sensitivity and Realisation of Constant Luminous Flux.]—E. Hochard. (*Comptes Rendus*, 21st Nov. 1938, Vol. 207, No. 21, pp. 981–983.)

682. Filament Currents of D.C. Valves : Method of eliminating Variations [in D.C. Amplifier primarily for Measurement of Photoelectric Currents].—Bedeau & Herman. (*Electrician*, 14th Oct. 1938, Vol. 121, p. 438.) Based on two French papers, one of which was dealt with in 2013 of 1938.

683. Nomograms for Calculating the Resistance of Cable Conductors, with Allowance for Skin Effect and Proximity Effect.—Kh. I. Cherne. (*Izvestiya Elektroprom. Slab. Toka*, No. 7, 1938, pp. 60–62.)

684. Universal Abac for the Graphical Solution of Problems of Rheostatic Control [*e.g.* Calculation of Potentiometers for Radio Grid Bias].—A. Fouillé. (*Rév. Gén. de l'Élec.*, 22nd Oct. 1938, Vol. 44, No. 16, pp. 518–523.)

685. Photoelectrically Balanced Recording Potentiometer [free from "Hunting"].—Fairchild & Parsegian. (*Review Scient. Instr.*, Dec. 1938, Vol. 9, No. 12, pp. 422–425.) A summary was referred to in 3323 of 1938.

686. Sharp Cut-Off in Vacuum Tubes.—Fett : Aiken & Birdsall. (*See* 532.)

687. "Direct and Alternating Current Potentiometer Measurements" [Book Review].—D. C. Gall. (*Wireless Engineer*, Nov. 1938, Vol. 15, No. 182, pp. 613–614.) *See* also 3324 of 1938.

688. Precision Inductance [and Capacitance] Bridge, *and* A.C. Measuring Bridge.—H. W. Sullivan Ltd : Mullard W. Service Company. (*Journ. Scient. Instr.*, Nov. 1938, Vol. 15, No. 11, pp. 378–379 : pp. 383–384.)

689. A Cathode-Ray Null Indicator [Type 913 Oscilloscope with Filter].—E. B. McNulty. (*Electronics*, Sept. 1938, Vol. 11, No. 9, pp. 36 . . 44.)

690. Alternating-Current Measuring Instruments with Dry-Plate Rectifiers [for Commercial and Audio Frequencies, including a Comparison with Moving-Iron Meters].—H. Boekels & A. Brosch. (*E.T.Z.*, 17th Nov. 1938, Vol. 59, No. 46, pp. 1229–1231.)

691. Curve-Form Error in the Ideal Rectifying Instrument.—F. Klutke. (*E.N.T.*, Oct. 1938, Vol. 15, No. 10, pp. 295–296.)

An example is first given to illustrate the errors which may arise in calculations of non-linear systems by neglecting the effect of the relative phases of Fourier components. The set of functions given by Jordan (2136 of 1938) is then used to calculate the curve-form error of a rectifying meter with a bent characteristic (Fig. 2). Fig. 3 shows the error of the instrument-reading as a function of the curve form.

692. A New D.C.-Voltage Instrument Transformer for the Measurement of High D.C. Voltages [avoiding the Disadvantages of the Usual M.C. Meter with Series Resistance : Magnetic Saturation Principle, using Ring-Shaped Cores].—W. Krämer. (*E.T.Z.*, 1st Dec. 1938, Vol. 59, No. 48, pp. 1295–1298.) Extension of the work on the d.c. current-transformer (1141 of 1938) to voltage transformation.

693. A New Method of Curve Measurement at High Voltages [up to 500 kV : Capacity Potentiometer and Resonant Circuit tuned to Fundamental used to show Overtones on Cathode-Ray Screen as Function of Fundamental Voltage].—H. E. Linckh. (*Physik. Zeitschr.*, 1st Nov. 1938, Vol. 39, No. 21, pp. 727–735.)

694. A New Light-Beam Electrostatic Voltmeter [Full-Scale Ratings 3 to 20 kV].—Bialou & Malpica. (*Gen. Elec. Review*, Oct. 1938, Vol. 41, No. 10, pp. 446–447.)

695. Use of the Dark Pre-Discharge Current in Air between Point and Cylinder for the Measurement of L.F. Alternating Voltages [between 12.5 & 200 kV, 50 c/s].—E. Hess. (*Arch. f. Elektrot.*, 14th Oct. 1938, Vol. 32, No. 10, pp. 688–690.)

696. Optical Measurement of Very Intense Continuous Currents [using Magnetic Rotation due to Current Field] : *and* New Procedure for the Measurement of Intense Currents.—A. Cotton : B. Tsaï. (*Comptes Rendus*, 7th Nov. 1938, Vol. 207, No. 19, pp. 820–822 : pp. 850–851.)

697. Suitability of a Diamagnetic Crystal for the Measurement of Magnetic Fields.—R. G. Stansfield. (*Proc. Camb. Phil. Soc.*, Oct. 1938, Vol. 34, Part 4, pp. 625–633.)

698. A New Simple Magnetometer for Medium to Very Strong Fields.—A. Deubner. (*Physik. Zeitschr.*, 15th Oct. 1938, Vol. 39, No. 20, pp. 716–718.)

699. A PORTABLE DIRECT-READING MAGNETOMETER.—Turney & Cousins. (*Journ. Scient. Inst.*, Nov. 1938, Vol. 15, No. 11, pp. 360–367.) Development of Harrison & Rowe's instrument (2103 of 1938) to measure *absolute* values.

700. CURRENT BALANCE FOR MEASURING MAGNETIC FIELDS AND SUSCEPTIBILITIES.—A. R. Kaufmann. (*Review Scient. Instr.*, Nov. 1938, Vol. 9, No. 11, pp. 369–371.)

701. REMARKS ON THE "CURIE" SCALE OF TEMPERATURE [defined by Susceptibility Measurements].—N. Kürti & F. Simon. (*Phil. Mag.*, Nov. 1938, Series 7, Vol. 26, Supp. No. 178, pp. 849–854.)

702. VARIATION WITH FIELD-STRENGTH OF THE DIELECTRIC CONSTANTS OF THE *p*-AZOXYANISOLS [Effect analogous to That of Longitudinal Magnetic Field].—W. Maier. (*Ann. der Physik*, Series 5, No. 3, Vol. 33, 1938, pp. 210–225.)

703. FRICTIONAL DISPERSION OF THE DIELECTRIC CONSTANTS OF ORGANIC LIQUIDS.—E. Plötze. (*Ann. der Physik*, Series 5, No. 3, Vol. 33, 1938, pp. 226–242.) A preliminary letter was referred to in 4210 of 1938.

704. ROTATION OF DIPOLES IN SOLUTION [Effect of Non-Polar Molecules of Diluting Medium deduced from Dispersion and Absorption Curves].—P. Girard & P. Abadie. (*Physik. Zeitschr.*, 1st Oct. 1938, Vol. 39, No. 19, pp. 691–692.)

SUBSIDIARY APPARATUS AND MATERIALS

705. ULTRADYNAMIC OVERCONTROL OF CATHODE-RAY TUBES.—Hollmann. (*Hochf:tech. u. Elek:akus.*, Oct. 1938, Vol. 52, No. 4, pp. 125–129.)

"It is known that the deflections of the beam of a cathode-ray tube are limited by the fact that, when a critical plate voltage is passed, the beam strikes the plates and is extinguished." This phenomenon is here theoretically investigated for ultradynamic frequencies, starting from known inversion equations for the deflection (*see* also 274 of January, and back references). Fig. 2 shows ultradynamic electron paths in the tube, and illustrates the asymmetrical cut-off zones; Fig. 3 gives a case where cut-off occurs in the middle of the trace on the screen. Fig. 4 shows the critical over-control voltages for ultradynamic working and for stationary deflections, as a function of anode voltage. Fig. 6 gives calculated and observed cut-off zones. The exchange of energy on contact between the electron beam and the plates is also discussed.

706. NEW INVESTIGATIONS ON CATHODE-RAY OSCILLOGRAPHS: I—THE STATIC SENSITIVITY OF THE BRAUN TUBE TAKING INTO ACCOUNT THE STRAY FIELDS: II—THE SENSITIVITY AT HIGH FREQUENCIES AND FOR A HOMOGENEOUS PLATE FIELD.—Thoma. (*Funktech. Monatshefte*, Oct. & Nov. 1938, Nos. 10 & 11, pp. 313–316 & 329–331.)

The course of the stray-field strength in the mid-zone of the deflecting space: the static sensitivity for "triangular" stray fields (Hintenberger, 3120 of 1937: for further work *see* 4190 of 1937): closer approximation by assumption of cubic parabolic fields (Hollmann & Thoma, 3687 of 1938); the most commonly occurring case, where the stray field through which the ray *enters* the deflecting space is limited by an earthed anode and can therefore be treated as approximately triangular, whereas the stray field through which the ray *leaves* the deflecting space is represented best by a cubic parabola. The equivalent uniform field is then given by $F_{eq} = F_p + 0.8$, where F_p is the ratio of the length of the deflecting plates to the distance between them.

707. THE USE OF THE HIGH-VACUUM CATHODE-RAY TUBE FOR RECORDING HIGH-SPEED TRANSIENT PHENOMENA, *and* RECURRENT-SURGE OSCILLOGRAPHS, AND THEIR APPLICATION TO SHORT-TIME TRANSIENT PHENOMENA.—McGillewie: Wilkinson. (*Journ. I.E.E.*, Nov. 1938, Vol. 83, No. 503, pp. 657–662: pp. 663–672: Discussions pp. 673–680.) Already referred to (except the Discussions) in 281 of January and 2514 of 1938, respectively.

708. THE DETERMINATION OF PHASE ANGLE BY CATHODE-RAY OSCILLOGRAPH, *and* THE DETERMINATION OF SYMMETRICAL COMPONENTS [of a Varying Rotating Flux] BY MULTIPLE MAGNETIC DEFLECTION OF A CATHODE-RAY BEAM.—Chard. (*Journ. I.E.E.*, Nov. 1938, Vol. 83, No. 503, pp. 681–684: pp. 684–687.)

709. REMARKS ON PAPERS RELATING TO ELECTRON MICROSCOPES.—Beischer: Ruska, Krause. (*See* 850 & 851.)

710. THE IMAGE ERRORS OF THE ELECTRON MICROSCOPE CAUSED BY ELECTRON SCATTERING IN THE OBJECT, AND THEIR MUTUAL RELATIONS.—von Ardenne. (*Zeitschr. f. Physik*, No. 3/4, Vol. 111, 1938, pp. 152–157.)

For previous work on the investigation of the internal strata of an object by electron beams *see* 3739 of 1938 and the reference to it in 4076 of 1938. In the present paper "the importance of the spatial scattering of the electrons is first discussed; the relation between the resolving power and the recognisability of contrast, and thus the depth of the object planes, is then investigated. The errors due to scattering are compared with the chromatic errors (Figs. 3–5); the field of application of the electron 'raster' miscroscope (4076 of 1938—also 376 of January) is defined from this comparison."

711. THE NEW HARVARD SUPER-MICROSCOPE [not Electronic: "Useful" Magnifications of 6000 Diameters, "Empty" Magnifications of 50 000 Diamaters].—Graton. (*Sci. News Letter*, 1st Oct. 1938, Vol. 34, No. 14, pp. 218–220.)

712. Remark on the Summary of the Paper "Theoretical Foundations of the Electron 'Raster' Microscope" [Table of Resolving Powers was Calculated, Not Experimentally Determined].—von Ardenne. (*E.T.Z.*, 10th Nov. 1938, Vol. 59, No. 45, p. 1226.) A note on an *E.T.Z.* summary of the paper dealt with in 4076 of 1938.

713. Electron-Optical Spectrum Analysis of H.F. Oscillations.—Hollmann. (*Naturwiss.*, 11th Nov. 1938, Vol. 26, No. 45, p. 742.) Further application of the inversion spectrograph dealt with in 274 of January.

714. The Focusing of Charged Particles by a Spherical Condenser [Theory: Calculations of Velocity Dispersion and Reduced Velocity Dispersion: Relativistic Modification for High-Speed Particles: Description of Practical Electron Analyser of Very Large Aperture].—Purcell. (*Phys. Review*, 15th Nov. 1938, Series 2, Vol. 54, No. 10, pp. 818–826.)

715. The Paths of Ions in the Cyclotron [Theory]: I—Orbits in the Magnetic Field: II—Paths in the Combined Electric and Magnetic Fields.—Thomas. (*Phys. Review*, 15th Oct. 1938, Series 2, Vol. 54, No. 8, pp. 580–588 and 588–598.)

716. "Recherches sur l'Optique Électronique" [Book Review].—Cotte. (*Rev. Gén. de l'Élec.*, 5th Nov. 1938, Vol. 44, No. 18, p. 558.)

717. The Optics of Electrical Charges [Comprehensive Survey of Undulatory Properties, the New Methods of Calculation, and the Principal Applications of the New Knowledge].—Bricout. (*Rev. Gén. de l'Élec.*, 1st & 8th Oct. 1938, Vol. 44, Nos. 13 & 14, pp. 405–423 & 439–451.)

718. A New Form of the Electromagnetic Energy Equation when Free Charged Particles are Present [useful for discussing Energy Relations in Electron Beam Tubes].—Tonks. (*Phys. Review*, 15th Nov. 1938, Series 2, Vol. 54, No. 10, p. 863.)

719. The Oscilloperturbograph [for recording Short-Time Phenomena on Distribution Systems].—Masson. (*Rev. Gén. de l'Élec.*, 22nd Oct. 1938, Vol. 44, No. 16, pp. 523–524.)

720. A Timer for Use with a Westinghouse Four-Unit Moving-Coil Oscillograph [to avoid monopolising One Element for Time Marking].—Sontag & Huff. (*Science*, 11th Nov. 1938, Vol. 88, pp. 459–460.)

721. Photoconductivity in Willemite [Spectral Response Curves: Correlation between Luminescence and Photoconductivity].—Hofstadter. (*Phys. Review*, 15th Nov. 1938, Series 2, Vol. 54, No. 10, p. 864.)

722. The Fundamental Principles of Fluorescence.—Fonda. (*Elec. Engineering*, Dec. 1938, Vol. 57, No. 12, Sec. 1, pp. 677–681.)

723. A Memory Attachment for Oscilloscopes ["Memnoscope," primarily for Arc-Back Study: using Rotating Capacitor Network].—Pakala. (*Elec. Engineering*, Dec. 1938, Vol. 57, No. 12, Sec. 1, pp. 682–684.)

724. A Magazine Plate Camera for Photography in Vacuum [primarily for Use with Electron Microscope].—Fitzsimmons. (*Journ. Opt. Soc. Am.*, Nov. 1938, Vol. 28, No. 11, pp. 437–439.)

725. A High-Voltage Discharge Tube for 3 Million Volts.—Sinelnikov & others. (*Tech. Phys. of USSR*, No. 7, Vol. 5, 1938, pp. 481–490: in English.)

726. A Radiometer-Type Vacuum Gauge.—Lockenvitz. (*Review Scient. Instr.*, Dec. 1938, Vol. 9, No. 12, pp. 417–420.)

727. Greaseless Vacuum Valves.—Townes. (*Review Scient. Instr.*, Dec. 1938, Vol. 9, No. 12, pp. 428–429.)

728. A Device to protect Large Vacuum Systems against Accidental Interruptions of the Mechanical Pump.—Youtz. (*Review Scient. Instr.*, Dec. 1938, Vol. 9, No. 12, pp. 420–421.)

729. Simple Protective Device for Water-Cooled Apparatus.—Stephenson. (*Review Scient. Instr.*, Dec. 1938, Vol. 9, No. 12, p. 430.)

730. Recent Progress in Power Rectifiers and Their Applications.—Thompson. (*Journ. I.E.E.*, Oct. 1938, Vol. 83, No. 502, pp. 437–455: Discussions pp. 456–473.)

731. Breakdown Voltage in Mercury Vapour.—Klarfeld & Gusjeva. (*Tech. Phys. of USSR*, No. 6, Vol. 5, 1938, pp. 425–430: in English.)

732. The Rate of Vaporisation of Mercury from an Anchored Cathode Spot [Measurements].—Tonks. (*Phys. Review*, 15th Oct. 1938, Series 2, Vol. 54, No. 8, pp. 634–639.)

733. Ion-Convection Generators.—Tschescherin & Babat. (*E.T.Z.*, 17th Nov. 1938, Vol. 59, No. 46, p. 1245: summary only.) *Cf.* 395 of 1937.

734. "Negative Ions" [Book Review].—Massey. (*Wireless Engineer*, Nov. 1938, Vol. 15, No. 182, p. 615.) Including their formation in glow discharges and in the upper atmosphere.

735. Collector Electrode Currents in Discharges of Different Current Density [Failure of Collector to indicate True Drift-Current Magnitudes].—Rusk. (*Phys. Review*, 15th Nov. 1938, Series 2, Vol. 54, No. 10, p. 865: abstract only.)

736. Arcs of Various Metals in Capillary Tubes [Observed Spectra].—Voss. (*Phil. Mag.*, Dec. 1938, Series 7, Vol. 26, No. 179, pp. 1000–1006.)

737. The Counting Losses [due to Finite Recovery Time] in Geiger-Müller Counter Circuits and Recorders.—Lifschutz & Duffendack. (*Phys. Review*, 1st Nov. 1938, Series 2, Vol. 54, No. 9, pp. 714–725.)

738. A Crystalline Type of Light-Counter, *and* A New Sensitive Light-Counter.—von Hippel: Tzschaschel. (*See* 656 & 657.)

739. A Dual-Range Potential Source for Field Use with Electroscopes and G-M Counters [Battery with Hand-Driven Condenser-Type D.C. Multiplier].—Bosch. (*Review Scient. Instr.*, Oct. 1938, Vol. 9, No. 10, pp. 308–309.)

740. A Static Constant-Current Circuit [Iron-Core Reactor and Condenser: for Valve Filament Circuits, etc.].—Summers. (*Elec. Engineering*, Nov. 1938, Vol. 57, No. 11, pp. 636–639.)

741. Electromagnetic Voltage Regulators.—Kovalevskaya. (*Izvestiya Elektroprom. Slab. Toka*, No. 8/9, 1938, pp. 67–74.)

Various types of voltage regulator are discussed and a detailed description is given of a regulator with a transformer and condenser (Fig. 13) developed in the USSR.

742. Vibrator Power Supplies.—Hall. (*Wireless World*, 22nd Dec. 1938, Vol. 43, pp. 553–556.) Based on a Sydney World Radio Convention paper.

743. The Wound-Core Distribution Transformer.—Treanor. (*Elec. Engineering*, Nov. 1938, Vol. 57, No. 11, pp. 622–626.)

744. "A.C. Motors of Fractional Horse Power" [Book Review].—Jones. (*Electrician*, 18th Nov. 1938, Vol. 121, p. 594.)

745. Current Rating and Impedance of Cables in Buildings and Ships, *and* Current Rating of Cables for Transmission and Distribution.—Booth, Hutchings, & Whitehead: Whitehead & Hutchings. (*Journ. I.E.E.*, Oct. 1938, Vol. 83, No. 502, pp. 497–516: pp. 517–557: Discussions pp. 557–565.) British E.R.A. Reports.

746. Current-Carrying Capacity [of Various Gauges of Wire, in Free Air and in Transformer Windings].—Partridge. (*Wireless World*, 15th Dec. 1938, Vol. 43, pp. 529–530.)

747. Some Electronic Switching Circuits [Continuation of Discussion].—Shumard. (*Elec. Engineering*, Nov. 1938, Vol. 57, No. 11, p. 467.) *See* 4089 of 1938.

748. Bridge Grid Circuits [Regulating Circuits using Electronic or Ionic Valves].—Vartel'ski. (*See* 446.)

749. A Possible Use of a Selector Switch.—Petrishshev & Shupta. (*Izvestiya Elektroprom. Slab. Toka*, No. 8/9, 1938, pp. 61–62.)

It is suggested that a selector switch could be used as a means of making a circuit only when a certain sequence of impulses is received, any other sequence causing the switch to move to "dead" contacts. The switch would thus serve as a safeguard against the unauthorised use of the line. It is desirable that a switch so employed should have the lowest possible value of $p = 1/b$, where b is the total number of possible impulse combinations. With this object in view a switch was developed by the author, briefly described in this paper, in which impulses of opposite polarity are used and which has $p = 6 \times 10^{-8}$.

750. Low-Voltage Paper Condensers with Halowax Impregnation.—Walther & Inge. (*Izvestiya Elektroprom. Slab. Toka*, No. 3, 1938, pp. 57–61.)

In a previous paper (338 of 1938: for later work *see* 2062 of 1938) it was shown that the boiling-out of condensers in halowax results in a considerable reduction of the breakdown voltage as compared with paraffin-impregnated condensers. An improvement was obtained when condensers were boiled out in vacuum, and accordingly an additional investigation of the latter process was carried out. A detailed report on this investigation ends with the conclusion that under proper conditions it is possible to manufacture condensers with electrical characteristics as good as those of paraffin-impregnated condensers and with a higher thermal stability, together with smaller overall dimensions for a given capacity.

751. Fabricated-Plate Capacitors [" FP " Electrolytic Condensers using Aluminium sprayed on Fabric, instead of Etched Plate].—Peck. (*Electronics*, Sept. 1938, Vol. 11, No. 9, p. 60.)

752. A Nomogram for calculating Losses in Electrolytic Condensers.—Nelepets. (*Izvestiya Elektroprom. Slab. Toka*, No. 8/9, 1938, pp. 60–61.)

753. The Dynamic Forming of Aluminium for Electrolytic Condensers.—Zakheim & Nikolaeva. (*Izvestiya Elektroprom. Slab. Toka*, No. 7, 1938, pp. 57–59.) Report on an experimental investigation of the effect of the dynamic forming of aluminium electrodes (in which aluminium foil is moved through the forming bath) on the properties of electrolytic condensers.

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760. Plastics and Electrical Insulation.—Hartshorn, Megson, & Rushton. (*Journ. I.E.E.*, Oct. 1938, Vol. 83, No. 502, pp. 474–487: Discussion pp. 488–496.)

761. Plastic Materials: Phenol-Aniline Resins [including Some Data from German Patents for Moulding Materials without any Filler].—(*Electrician*, 9th Dec. 1938, Vol. 121, p. 694.)

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765. Tests on Oil-Impregnated Paper: III—Fluid Flow.—Race. (*Elec. Engineering*, Oct. 1938, Vol. 57, No. 10, pp. 573–579.)

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768. Chemistry and High-Voltage Dielectrics.—Clark. (*Elec. Engineering*, Dec. 1938, Vol. 57, No. 12, Sec. 1, pp. 489–492.)

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771. Reciprocal Action of Conduction Electrons and Interference Positions in the Electronic Semiconductor: Voltage Effect, Frequency Effect.—Müller. (*Naturwiss.*, 11th Nov. 1938, Vol. 26, No. 45, pp. 739–740.)

772. Electronic Conduction in Insulating Crystals under Very High Field Strength.—von Hippel. (*See* 656.)

773. An Investigation of the Amorphous State: XIII—Viscosity, Electrical Conductivity, and Dielectric Losses in Alcohols and Glycerol.—Kobeko, Kuvshinski, & Shishkin. (*Tech. Phys. of USSR*, No. 6, Vol. 5, 1938, pp. 413–424: in English.)

774. On the Design of [Low-Power] Transformers and Coils with Iron Cores.—Chistyakov. (*See* 515.)

775. Magnetic Quality of Iron Wire as Influenced by the Diameter.—Wall. (*Nature*, 12th Nov. 1938, Vol. 142, pp. 875–876.) For previous work *see* 1623 of 1938 (and, for other work on nickel & iron wires, 3157 & 3880 of 1937 and 3389 & 3776 of 1938).

776. Rotational Hysteresis Loss in Electrical Sheet Steels [measured by New Method eliminating Eddy-Current Losses: Magnetic Anisotropy: Discovery of Sharp Increase in Loss near Knee of Magnetisation Curve: etc.].—Brailsford. (*Journ. I.E.E.*, Oct. 1938, Vol. 83, No. 502, pp. 566–575.)

777. An X-Ray Test of Superstructure in $FeNi_3$ [Negative Result].—Haworth. (*Phys. Review*, 1st Nov. 1938, Series 2, Vol. 54, No. 9, pp. 693–698.)

778. The Production and Industrial Uses of Titanium—a Correlated Abstract: Part II [including Magnetic Alloys].—Comstock. (*Metals & Alloys*, Nov. 1938, Vol. 9, No. 11, pp. 314–318.)

779. H.F. Cores of Magnetite.—Evseev. (*Izvestiya Elektroprom. Slab. Toka*, No. 6, 1938, pp. 53–56.)

Experiments were carried out with magnetite cores prepared from the ore obtained in the Ural mountains. The effect of these cores on the self-inductance and Q-value of coils at frequencies from approximately 500 to 1000 kc/s was investigated, and a number of curves taken for coils with and without the cores are shown. One of the main conclusions reached in this investigation is that the Q-value of a coil is greatly affected by the shape of the core and the type of Litz wire used. The self-inductance has been found to increase from 1.5 to 5 times, depending on the shape of the coil, and appears unaffected by a temperature rise from approximately 15° C to 80° C.

780. SOME FUNDAMENTAL FACTORS IN THE DESIGN OF PERMANENT MAGNETS.—(*P.O. Engineering Dept., Library Circular* No. 5, Vol. 15, 1938, Informative Summary No. 19, pp. 1–6.)

781. THE DESIGN OF WINDINGS FOR ELECTROMAGNETS OF HIGH FIELD STRENGTH.—Kanter. (*E.T.Z.*, 1st Dec. 1938, Vol. 59, No. 48, p. 1307 : summary only.)

782. THE CRYSTALLINE DIAMAGNETISM OF THALLIUM [with Small Admixtures of Other Metals : Measurements].—Rao & Narayanaswami. (*Phil. Mag.*, Dec. 1938, Series 7, Vol. 26, No. 179, pp. 1018–1030.)

783. THE MAGNETIC PROPERTIES OF BISMUTH : III—FURTHER MEASUREMENTS ON THE DE HAAS–VAN ALPHEN EFFECT.—Schoenberg. (*Proc. Roy. Soc.*, Series A, 25th Nov. 1938, Vol. 168, No. 935, pp. S 134–S 135 : abstract only.)

784. COLLECTIVE ELECTRON FERROMAGNETISM : II—ENERGY AND SPECIFIC HEAT.—Stoner. (*Proc. Roy. Soc.*, Series A, 25th Nov. 1938, Vol. 168, No. 935, p. S 138 : abstract only.)

785. THE PARAMAGNETIC SUSCEPTIBILITY OF COPPER/NICKEL AND ZINC/NICKEL ALLOYS.—Wheeler. (*Phys. Review*, 15th Nov. 1938, Series 2, Vol. 54, No. 10, p. 867 : abstract only.)

786. MAGNETIC PROPERTIES OF SUPERCONDUCTORS.—Shoenberg. (*Nature*, 12th Nov. 1938, Vol. 142, pp. 874–875.)

787. STABILITY OF THE VISCOSE TYPE OF OZAPHANE PHOTOGRAPHIC FILM [and Its Special Suitability as Record Material].—Sookne & Weber. (*Journ. of Res. of Nat. Bur. of Stds.*, Sept. 1938, Vol. 21, No. 3, pp. 347–353.)

788. THE PHOTOGRAPHIC PRODUCTION OF LARGE PRECISION SCALES AND GRATICULES.—Burmistrov. (*Tech. Phys. of USSR*, No. 6, Vol. 5, 1938, pp. 431–436 : in English.)

STATIONS, DESIGN AND OPERATION

789. CROSS-CHANNEL ULTRA-SHORT-WAVE RADIO LINK.—(*Electrician*, 16th Dec. 1938, Vol. 121, p. 716.) Paragraph on the placing of a joint order by G.P.O. and the French P.T.T.

790. NON-LINEAR CROSS-TALK IN MULTIPLE SYSTEMS WITH TRANSMITTED CARRIERS [*e.g.* in H.F. Wire Broadcasting].—Hölzler. (*Hochf:tech. u. Elek:akus.*, Oct. 1938, Vol. 52, No. 4, pp. 137–142.)

The work of Strecker (2939 of 1937) for cross-talk between one modulated and one unmodulated carrier is here extended to systems with several modulated carriers (arrangement of frequencies Fig. 1). Those combination tones which give comprehensible cross-talk are picked out from the many possible combinations ; § II shows how the non-linear cross-talk depends on the number of channels, for cross-talk of the second and third degree. In § III the connection between cross-talk attenuation and "klirr" attenuation for two channels is determined as a measurable quantity, so that the least required "klirr" attenuation can be determined as a function of the number of conversations under given conditions for the cross-talk (§ IV). It is found that if a noise distance is prescribed for each channel, the required "klirr" attenuation varies only slightly with the number of conversations, since the increased number of cross-talk possibilities is approximately balanced by the smaller modulation of energy per conversation.

791. ON THE POSSIBILITY OF TWO-CHANNEL COMMUNICATION WITH A SINGLE CARRIER WAVE.—Anitov & Kenigsen. (*Izvestiya Elektroprom. Slab. Toka*, No. 8/9, 1938, pp. 14–20.)

It is shown that if two separate amplifiers, each with its own modulator, are excited by a common oscillator and operate into a common aerial, and if the frequencies of the amplifiers are displaced in phase, then by the use of a suitable detecting circuit in the receiver (Fig. 1) the two signals can be separated. It is also shown that the common carrier frequency, or one of the sidebands in each channel, can be suppressed. Furthermore it appears that the width of the band transmitted remains the same whether the carrier frequency is modulated by one only or by two signals simultaneously. Practical transmitting and receiving circuits operating on the above principle are discussed.

792. AMPLITUDE-RANGE CONTROL [Discussion and Classification of Special Characteristics, for Vogads, Compressors, Vodas, etc.], *and* DEVICES FOR CONTROLLING AMPLITUDE CHARACTERISTICS OF TELEPHONIC SIGNALS.—S. B. Wright : A. C. Norwine. (*Bell S. Tech. Journ.*, Oct. 1938, Vol. 17, No. 4, pp. 520–538 : pp. 539–554.)

793. "MIXING" AND "CUEING" AT OUTSIDE BROADCAST POINTS.—Williams. (*World-Radio*, 9th Dec. 1938, Vol. 27, pp. 14–15.)

794. NEW F.C.C. [Amateur] RULES EFFECTIVE 1ST DEC : MANY IMPORTANT CHANGES IN APPARATUS REQUIREMENTS, OPERATING PRACTICES, AND LICENSING PROCEDURE.—Warner. (*QST*, Dec. 1938, Vol. 22, No. 12, pp. 11–16 and 62 . . 72.) For a preliminary communication see *ibid.*, Nov. 1938, No. 11, p. 27.

GENERAL PHYSICAL ARTICLES

795. INITIAL RECOMBINATION OF IONS [Computation of Probability from Laws of Brownian Movement].—Onsager. (*Phys. Review*, 15th Oct. 1938, Series 2, Vol. 54, No. 8, pp. 554–557.)

796. SOME REMARKS ON THE THEORY OF BROWNIAN MOVEMENT.—Niessen & Bakker. (*Physica*, Dec. 1938, Vol. 5, No. 10, pp. 977–985 : in German.)

797. THE PASSAGE AND DIFFUSION OF CORPUSCLES ACROSS BARRIERS OF COULOMBIAN POTENTIAL [General Theoretical Solution].—Badarau. (*Comptes Rendus*, 28th Nov. 1938, Vol. 207, No. 22, pp. 1030–1032.)

798. On a Method of Solving the Fundamental Problem of Electrostatics and Related Problems [by Determination of Density of "Free" Charges induced on Surfaces separating Dissimilar Media].—Grünberg. (*Tech. Phys. of USSR*, No. 7, Vol. 5, 1938, pp. 525–560: in English.)

799. High-Altitude Research at 14 200 Feet leads to Identification of the "Neutretto", Another Atomic Particle.—Shonka. (*Science*, 2nd Dec. 1938, Vol. 88, Supp. p. 10.)

800. A Determination of *e/m* from the Refraction of X-Rays in a Diamond Prism.—Bearden. (*Phys. Review*, 1st Nov. 1938, Series 2, Vol. 54, No. 9, pp. 698–703.)

801. "Electromagnetics: a Discussion of Fundamentals" [Book Review].—O'Rahilly: G.W.O.H. (*Electrician*, 18th Nov. 1938, Vol. 121, pp. 593–594.) *See* also *ibid.*, 2nd Dec. 1938, p. 665.

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802. The Death of Ross A. Hull.—Warner. (*QST*, Nov. 1938, Vol. 22, No. 11, pp. 7–10 and 64.)

803. The Differential Analyser and Its Applications in Electrical Engineering [to Study of Loud-speakers, Resonant Electrical Circuits, Potential Distribution in Valves, etc.], *and* The Application of the Differential Analyser to Transients on a Distortionless Transmission Line.—Hartree & Nuttall: Hartree & Porter. (*Journ. I.E.E.*, Nov. 1938, Vol. 83, No. 503, pp. 643–647: pp. 648–656.)

804. Statistical Laws of Nature [Kelvin Lecture].—Born. (*Journ. I.E.E.*, Dec. 1938, Vol. 83, No. 504, pp. 802–813.)

805. A [Statistical] Test for the Adequacy of Theory in the Light of Experiment.—Beth. (*Phys. Review*, 15th Nov. 1938, Series 2, Vol. 54, No. 10, pp. 865–866: abstract only.)

806. A General Graduation Formula for the Smoothing of Time Series.—Schumann. (*Phil. Mag.*, Dec. 1938, Series 7, Vol. 26, No. 179, pp. 970–983.)

807. A Method of calculating Fluctuations [for Problems Not Governed by Poisson Law: System of Differential Equations satisfied by Probabilities: Determination of Generating Function from which Standard Deviation, etc., can be Derived].—Ellickson. (*Phys. Review*, 15th Oct. 1938, Series 2, Vol. 54, No. 8, pp. 572–579.)

808. Relaxation Methods applied to Engineering Problems: III—Problems involving Two Independent Variables [Poisson's Equation: Application to Problems including Magnetic Induction in Field containing Triangular Prism of Iron].—Christopherson & Southwell. (*Proc. Roy. Soc.*, Series A, 7th Nov. 1938, Vol. 168, No. 934, pp. 317–350.)

809. The General Theory of Relaxation Methods applied to Linear Systems.—Temple. (*Proc. Roy. Soc.*, Series A, 25th Nov. 1938, Vol. 168, No. 935, p. S 134: abstract only.)

810. Symmetrical-Component Impedance Notation.—Kimbark. (*Elec. Engineering*, Oct. 1938, Vol. 57, No. 10, p. 431.)

811. Graphics in the Solution of Complex Quantities.—Goodale. (*Elec. Engineering*, Nov. 1938, Vol. 57, No. 11, pp. 453–454.)

812. "Lectures on the Mathematical Theory of Electricity" [Book Review].—Pidduck. (*Science*, 2nd Dec. 1938, Vol. 88, p. 529.)

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814. "Standards on Electronics—1938" [Book Notice].—Institute of Radio Engineers. (*Electronics*, Oct. 1938, Vol. 11, No. 10, p. 58.)

815. Some Comments on the Recommendations of the International Electrotechnical Commission concerning Radio Apparatus in Common Use.—Zilitinkevich. (*Izvestiya Elektroprom. Slab. Toka*, No. 8/9, 1938, pp. 35–37.)

816. Conference of the Technical Advisory Committees of the CCIF in Oslo [Notes on Recommendations for Telephone Cables, Non-Linear Distortion of Broadcast Transmissions, Wireless Telephony, Telephone Acoustics, Protection of Cables against High-Power Cables & Electrolytic Corrosion, etc.].—Oehlen. (*E.N.T.*, Oct. 1938, Vol. 15, No. 10, pp. 320–323.)

817. On the Consumption of Electrical Energy by Broadcasting Stations [Estimates based on German Data].—Dennhardt. (*E.T.Z.*, 24th Nov. 1938, Vol. 59, No. 47, pp. 1279–1280: summary only.) *Cf.* 3827 of 1938.

818. Current Articles on Electronics and Related Subjects [Bibliography].—Sperling. (*Electronics*, Oct. 1938, Vol. 11, No. 10, pp. 58, 60, 61, 62.)

819. "Radio Laboratory Handbook" [Book Review].—Scroggie. (*Electrician*, 16th Dec. 1938, Vol. 121, p. 726.)

820. "Encyclopédie de l'Électricité et de la T.S.F. à Bord des Avions modernes" [Book Review].—Lanoy. (*Rev. Gén. de l'Élec.*, 8th Oct. 1938, Vol. 44, No. 4, pp. 429–430.)

821. "Problems in Radio Engineering: 3rd Edition" [Examination Questions and Notes: Book Review].—Rapson. (*Electrician*, 19th Aug. 1938, Vol. 121, p. 205.)

822. "Radiotecnica: Vol. 3—Pratica di Radiotrasmissione e Ricezione" [Book Review].—Hoepli. (*Wireless Engineer*, Aug. 1938, Vol. 15, No. 179, p. 431.)

823. "Fundamentals of Radio" [Book Review].—Terman. (*Wireless Engineer*, Sept. 1938, Vol. 15, No. 180, p. 479.)

824. "Van Nostrand's Scientific Encyclopedia" [Book Review].—(*Review Scient. Instr.*, Oct. 1938, Vol. 9, No. 10, p. 290.)

825. A Consultant talks about Electronics [as a Profession].—McDill. (*Electronics*, Sept. 1938, Vol. 11, No. 9, pp. 11–12 and 52.)

826. A Museum of Electronic Apparatus [Valves, Cathode-Ray Tubes, and Photoelectric Cells].—Weston. (*Elec. Communication*, Oct. 1938, Vol. 17, No. 2, pp. 133–142.)

827. The Wireless Exhibition, 1938: a Technical Survey.—(*Wireless Engineer*, Oct. 1938, Vol. 15, No. 181, pp. 543–554.)

828. The Novelties on View at the Paris Broadcasting Salon, Sept. 1938.—Adam. (*Génie Civil*, 8th Oct. 1938, Vol. 113, No. 15, pp. 301–305.)

829. Radio Control of Powered Models [Model Aeroplanes: Four Receivers (Each using One RK-62 Valve) on 8-Inch Square Chassis].—De Soto. (*QST*, Oct. 1938, Vol. 22, No. 10, pp. 42–44.) For this "gas-triode detector-thyratron" valve (known in its experimental state as Raytheon QY-4) *see* also Hull, 3531 of 1938: also 545, above.

830. A New Method of Connection of a Multi-Grid Valve for D.C. Amplification [for Various Automatic-Control & Other Purposes].—Boucke. (*See* 445.)

831. The Multi-Electrode Valve and Its Application in Scientific Instruments.—Lewis. (*Journ. Scient. Instr.*, Nov. 1938, Vol. 15, No. 11, pp. 353–360.)

832. A New Method: Remote Transmission of Instrument Readings [Pneumatic Telemetering System].—Moore. (*Technique*, Montreal, Nov. 1938, Vol. 13, No. 9, pp. 446–451.)

833. Viewpoints for the Choice of Remote-Control [and Telemetering] Systems and of the Transmission Channel.—Venzke. (*E.T.Z.*, 24th Nov. & 1st Dec. 1938, Vol. 59, Nos. 47 & 48, pp. 1253–1257 & 1292–1294.)

834. On the Theory of Telemetering.—Zukkerman. (*Izvestiya Elektroprom. Slab. Toka*, No. 10, 1938, pp. 55–58.) Continuation of the work referred to in 369 of January.

835. The Position in Optical Telephony.—Köhler. (*E.T.Z.*, 1st Dec. 1938, Vol. 59, No. 48, pp. 1285–1289.) For previous work by the same author *see* 433 of 1937 and 3828 of 1938.

836. Temperature Fluctuations of Tungsten Filaments heated by Alternating Current.—Elenbaas. (*Physica*, Dec. 1938, Vol. 5, No. 10, pp. 929–937: in German.)

837. The Increase of X-Ray Reflection from Quartz due to a Strong Electric Field.—Kakiuchi. (*Phys. Review*, 1st Nov. 1938, Series 2, Vol. 54, No. 9, p. 772.)

838. Eddy-Current Oven roasts Coffee.—(*Electronics*, Sept. 1938, Vol. 11, No. 9, p. 46.)

839. The Surface Hardening of Steel by Heating by means of High-Frequency Currents.—Babat & Losinsky. (*Rev. Gén. de l'Élec.*, 22nd Oct. 1938, Vol. 44, No. 16, pp. 495–510.) *See* also 4186 of 1938.

840. Electro-Magnetic Measurement of the Longitudinal Displacement of Turbine Shafts during Running.—Kelch. (*Zeitschr. V.D.I.*, 17th Sept. 1938, Vol. 82, No. 38, p. 1121.)

841. The Electric Strain Gauge [with Varying Magnetic Air Gap Head, Balancing Unit, etc: for Static or Oscillatory Strains].—Rusher & Mershon. (*Elec. Engineering*, Nov. 1938, Vol. 57, No. 11, pp. 645–648.)

842. Measuring Millionths of an Inch in the Gauge Room [General Electric Electric Tailstock Gauge Head].—Coffman & Borneman. (*Gen. Elec. Review*, Nov. 1938, Vol. 41, No. 11, pp. 502–503: *see* also p. 469.)

843. Cathode - Ray - Oscillograph Auxiliary Pressure Recording Apparatus [for Indicator Diagrams of Internal-Combustion Engines].—Cossor Ltd. (*Journ. Scient. Instr.*, Nov. 1938, Vol. 15, No. 11, pp. 382–383.)

844. Combined Thyratron and Tachometer Speed Control of Small Motors.—Williams. (*Elec. Engineering*, Oct. 1938, Vol. 57, No. 10, pp. 565–568.)

845. Induction Pick-Up regulates Temperature directly from Indicator Pointer [Aluminium Vane on Pointer passes between Small R.F. Coils (at Desired Point on Scale): Change of Oscillation Frequency operates Relay: No Force between Coils and Vane].—(*Electronics*, Oct. 1938, Vol. 11, No. 10, p. 34.)

846. Electrodeless Neon Tubes excited by Radio-Frequency Energy [New System of Tube Lighting].—(*Electronics*, Oct. 1938, Vol. 11, No. 10, pp. 34 and 52.)

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849. PHYSICS IN PHARMACY [Use of Spectroscopy, X-Rays, Polarisation, Photoelectricity, etc.].—McFarlan. (*Electronics*, Oct. 1938, Vol. 11, No. 10, pp. 67–69: summary only.)

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851. REMARKS ON THE PAPER BY F. KRAUSE:—"THE MAGNETIC ELECTRON MICROSCOPE AND ITS BIOLOGICAL APPLICATION": REPLY [Resolving Power: Photometric Measurements: etc.].—Ruska: Krause. (*Naturwiss.*, 18th Nov. 1938, Vol. 26, No. 46, pp. 759–760.) For Krause's paper *see* 1274 of 1938.

852. THE HEATING OF BIOLOGICAL CELL MATTER AND FLUIDS BY VERY RAPID ELECTRICAL OSCILLATIONS (1.25×10^7 to 1.67×10^9 c/s) AND ITS APPLICABILITY FOR MEDICAL PURPOSES [including Use of Parabolic Mirrors for focusing Rays].—Spiller. (*Hochf:tech. u. Elek:akus.*, Oct. 1938, Vol. 52, No. 4, pp. 129–137.)

853. THE POLARITY POTENTIAL OF THE HUMAN EYE [Measurements with Valve Microvoltmeter].—Miles. (*Science*, 11th Nov. 1938, Vol. 88, p. 437: summary only.) *Cf.* Halstead, 4681 of 1938.

854. STERILISATION BY ULTRA-VIOLET RADIATION.—Hibben & Blackburn. (*Elec. Engineering*, Nov. 1938, Vol. 57, No. 11, pp. 455–459.)

855. PHOTOELECTRIC COUNTERS AND THEIR APPLICATIONS [and the Detection of Powers around 10^{-12} Erg per Second].—Audubert. (*Rev. Gén. de l'Élec.*, 19th Nov. 1938, Vol. 44, No. 20, p. 622: summary only.) Applications include the detection of u.v. radiations emitted in the course of chemical reactions and biological processes such as nerve excitation. For other papers on counters *see* 656 & 657, above.

856. INCREASING THE SENSITIVITY OF A PHOTOTUBE RELAY [by reducing Lag of Mechanical Relay by Interposition of Thyratron Circuit].—Sturtevant. (*Review Scient. Instr.*, Oct. 1938, Vol. 9, No. 10, p. 331.)

857. PHOTOELECTRIC MEASURING APPARATUS FOR THE TESTING OF AGRICULTURAL SOILS [for Rapid Determination of Potash and Phosphate Content].—Jaekel: Neubauer. (*Zeitschr. V.D.I.*, 29th Oct. 1938, Vol. 82, No. 44, pp. 1275–1276.)

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859. ELECTRONIC RECORDING ANALYTICAL BALANCE [with Photocell Scanning of Pointer].—Muller & Garman. (*Journ. Scient. Instr.*, Oct. 1938, Vol. 15, No. 10, p. 352: summary only.)

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862. PHOTOTUBE INDICATES SOFTNESS OF WATER.—Pick: Permutit Company. (*Electronics*, Oct. 1938, Vol. 11, No. 10, p. 34.)

863. A PHYSICAL DENSITY COMPARATOR [Densitometer to "surmount Shortcomings of Existing Commercial Types": using Polaroid Plates and "Photronic" Cell].—Sweet. (*Journ. Opt. Soc. Am.*, Sept. 1938, Vol. 28, No. 9, pp. 349–353.)

864. "PHOTOELECTRIC CELL APPLICATIONS: THIRD EDITION" [Book Review].—Walker & Lance. (*Electronics*, Sept. 1938, Vol. 11, No. 9, pp. 80–81.)

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866. GOVERNMENTAL SUPPORT OF RESEARCH IN FRANCE.—(*Science*, 4th Nov. 1938, Vol. 88, pp. 425–426.)

867. THE IMPORTANCE OF RESEARCH AND DEVELOPMENT IN MAINTAINING TECHNICAL PROGRESS.—Smith. (*Elec. Engineering*, Dec. 1938, Vol. 57, No. 12, Sec. 1, pp. 484–488.)

868. DISPERSION AND RELAXATION [Notes on Acoustic Relaxation Phenomena, Relaxation and Electrical Properties, Paramagnetic Dispersion and Absorption, etc.].—K. Wirtz. (*Naturwiss.*, 25th Nov. 1938, Vol. 26, No. 47, pp. 771–772: notes on the Baden-Baden meeting of the German Physical Society, Sept. 1938.)

869. ENGINEERING AND THE LAW.—Appleton. (*Elec. Engineering*, Dec. 1938, Vol. 57, No. 12, Sec. 1, p. 477–479.)

870. GERMAN ELECTRICAL IMPORTS AND EXPORTS, JAN./SEPT. 1938.—(*E.T.Z.*, 24th Nov. 1938, Vol. 59, No. 47, pp. 1281–1282.)

871. FRENCH IMPORTS AND EXPORTS DURING THE FIRST SIX MONTHS OF 1938.—Reyval. (*Rev. Gén. de l'Élec.*, 5th Nov. 1938, Vol. 44, No. 18, pp. 577–588.)

Some Recent Patents

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

493 253.—Oscillation-generator, for frequencies up to 10,000 cycles, controlled by back-coupling through a resonant reed.

Marconi's W.T. Co. (assignees of J. N. Whitaker). Convention date (U.S.A.) 28th January, 1937.

DIRECTIONAL WIRELESS

492 455.—Directional system in which the signals received on a pair of spaced aerials are combined through variable-mu amplifiers.

Rediffusion and S. H. Grove. Application date 12th April, 1937.

492 643.—Direction-finder with amplified adjustments for ascertaining the correct "sense" of the bearings.

Telefunken Co. Convention date (Germany) 7th April, 1937.

492 927.—Directive wireless system for automatically steering or piloting an aeroplane or like moving craft.

Standard Telephones and Cables (assignees of Le Matériel Téléphonique Soc. Anon.). Convention date (France) 4th November, 1936.

493 027.—Direction-finding system in which three or more crossed frames are each coupled to separate radiogoniometers (addition to 467 785).

Telefunken Co. Convention date (Germany) 7th April, 1937.

493 393.—Direction-finder or "homing" device which automatically "sets" itself towards a distant transmitting station.

Telefunken Co. Convention date (Germany) 9th September, 1936.

494 697.—Reducing "night effect" in direction-finding by the use of frequency-moderated signals.

Marconi's W.T. Co. and G. M. Wright. Application date 30th April, 1937.

RECEIVING CIRCUITS AND APPARATUS

(*See also under Television*)

492 408.—Automatic tuning circuit in which any out-of-tune condition varies the mutual conductance of a screen-grid valve in a compensating sense.

The General Electric Co. and L. C. Stenning. Application date 10th June, 1937.

492 624.—Means for preventing the tendency of the A.V.C. voltage to detune the circuits of a wireless receiver.

E. K. Cole. Convention date (Sweden) 15th May, 1937.

492 635.—Automatic tuning control system in which provision is made for readjusting the tuning of the preselector circuits independently of the local oscillator.

Fabrica Italiana Magneti Marelli. Convention date (Italy) 22nd January, 1937.

492 646.—Receiver of the super-regenerative type in which the local "quenching" frequency is applied to the split-anodes of a magnetron valve.

Marconi's W.T. Co. and E. W. B. Gill. Application date 23rd March, 1937.

493 056.—Tuning system in which the luminous "pointer" of a cathode-ray visual indicator is brought into line with a frequency indicator at resonance.

Marconi's W.T. Co. (assignees of W. La V. Carlson and J. E. Albright). Convention date (U.S.A.) 28th March, 1936.

439 102.—All-wave receiver in which different tuned circuits are housed as separate units in compartments inside a rotating drum, which forms the wave-change switch.

(Mrs.) H. Dent and C. E. Osmond. Application date 30th March, 1937.

493 256.—Two-speed driving-gear for the tuning-control of a wireless set.

Standard Telephones and Cables (assignees of Bell Telephone Manufacturing Co.). Convention date (U.S.A.) 7th April, 1937.

493 297.—Masking-device for the tuning indicator of a wireless set.

Electric and Musical Industries. Convention date (Germany) 4th April, 1936.

493 346.—Mounting of a tuning-coil assembly with powdered-iron cores.

Ferrolyte S.A.R.L. and A. Kaufman. Application date 6th February, 1937.

493 370.—Automatic gain control particularly for a receiving circuit comprising a detector valve with variable back-coupling.

Marconi's W.T. Co. and R. B. Armstrong. Application date 6th April, 1937.

493 477.—Controlling the quality of reproduction in a wireless receiver by varying the depth of modulation of the incoming signal in a relatively non-selective part of the circuit.

Hazeltine Corpn. (assignees of A. V. Loughren). Convention date (U.S.A.) 13th August, 1936.

493 511.—Automatic frequency control system for a superhet receiver with a minimum number of I.F. stages.

Marconi's W.T. Co. (addition to 489 094). Convention date (U.S.A.) 3rd April, 1936.

493 542.—Correlating the automatic tuning control and the noise-suppressing circuits in a wireless receiver, particularly to prevent the latter from coming into operation if the signal fades.

Johnson Laboratories Inc. (assignees of S. Y. White). Convention date (U.S.A.) 22nd July, 1936.

494 577.—Wireless receiver with automatic tuning which depends upon the production of local "control" oscillations independently of the received signals.

J. Robinson. Application date 24th March, 11th May, and 27th August, 1937.

TELEVISION CIRCUITS AND APPARATUS

For Transmission and Reception

492 278.—Saw-toothed oscillation-generator in which the discharge condenser is in the form of a gas-filled tube fitted with two pairs of discharge electrodes.

Marconi's W.T. Co. and D. J. Fewings. Application date 16th March, 1937.

492 284.—Television tubes in which a photo-electric cathode is associated with a grid developing charges proportional to the picture intensity, and an anode located on the side of the grid remote from the cathode.

Baird Television and V. A. Jones. Application date 16th March, 1937.

492 302.—Television system in which the picture is scanned from its centre radially outwards in all directions by a single vibrating mirror.

J. W. Garside. Convention date (U.S.A.) 21st March, 1936.

492 337.—Rectifying circuit for suppressing the carrier-wave component when receiving television signals.

Radio-Akt. D. S. Loewe. Convention date (Germany) 19th March, 1936.

492 398.—Receiver in which two local oscillations are applied to the same valve in order to separate two sets of signals, particularly sound and vision in a television receiver.

Ferranti and G. M. Tomlin. Application date 24th April, 1937.

492 442.—Method of forming the light-sensitive surface of a mosaic-cell electrode as used in a cathode-ray television transmitter.

E. E. Thomson; and H. Miller. Application date 20th March, 1937.

492 468.—Light-modulating device of the kind in which a liquid such as pentane is set into supersonic vibration by a piezo-electric crystal.

Scophony and J. H. Jeffree. Application date 10th June, 1937.

492 469.—Light modulating cell in which waves of supersonic frequency are set up in a liquid by a piezo-electric crystal.

Scophony; J. H. Jeffree; and J. Sieger. Application date 10th June, 1937.

492 662.—Television transmitter in which the electron camera is automatically thrown out of action during the "flyback" period of scanning.

Baird Television and V. A. Jones (addition to 470 785). Application date 23rd March, 1937.

492 665.—Double power-pack arrangement for a cathode-ray television receiver.

Baird Television and L. R. Merdler. Application date 23rd March, 1937.

492 753.—Timing of the synchronizing impulses to ensure accurate positioning of the two sets of frames in television systems using interlaced scanning.

Telefunken Co. Convention date (Germany) 25th February, 1936.

493 026.—Anti-fading system in which a signal is radiated on three different frequencies, two of which are carrier-waves and the third consists of side-bands.

Marconi's W.T. Co. (assignees of Amalgamated Wireless [Australasia]). Convention date (Australia) 3rd April, 1937.

493 007.—Developing television signals from a cinema film by means of infra-red rays.

Farnsworth Television Inc. Convention date (U.S.A.) 18th August, 1936.

493 048.—Producing television signals by applying carrier-wave potentials to the electrodes of an electron multiplier associated with an image-dissector.

Baird Television and T. C. Nuttall. Application date 30th March, 1937.

493 049.—Method of separating the frame and line synchronizing impulses in interlaced systems of scanning.

Baird Television; P. W. Willans; and T. C. Nuttall. Application date 30th March, 1937.

493 050.—Balanced modulating circuit for amplifying television signals "down to zero."

Baird Television and P. W. Willans. Application date 30th March, 1937.

493 043.—Cathode-ray tube combined with an electron-multiplier for use as a television transmitter.

Radio-Akt. D. S. Loewe. Convention dates (Germany) 29th January and 4th April, 1936.

493 142.—"Overcoupled" screen-grid valve for producing scanning-oscillations of substantially-constant slope.

Ferranti and M. K. Taylor. Application date 24th February, 1937.

493 232.—Television transmitter tube in which scanning is effected partly by an electron stream and partly by moving the image to and fro over an aperture in the anode of the tube.

F. B. Dehn (communicated by Zeiss Ikon Akt.). Application date 21st September, 1937.

493 279.—Applying the synchronizing-impulses to television signals by means of a valve of the secondary-emission type.

Baird Television and T. C. Nuttall. Application date 20th January, 1938.

493 289.—Gain-control system, particularly for television, in which the amplification of one signal is governed by a second signal.

Philco Radio and Television Corpn. Convention date (U.S.A.) 14th May, 1936.

493 303.—Construction and arrangement of the mosaic-cell screen used in television transmitters of the Iconoscope type.

Telefunken Co. Convention date (Germany) 4th April, 1936.

493 304.—Television system in which the carrier level is restored to "picture black" before and after each synchronizing impulse.

Baird Television; E. D. McConnell; and H. G. Bruce. Application date 6th April, 1937.

493 543.—Arrangement of the focusing and other control electrodes in a cathode-ray tube so that they do not "shadow" the photo-electric screen.

Radio-Akt. D. S. Loewe. Convention date (Germany) 11th January, 1936.

493 790.—Supporting and aligning the "lens system" and other electrodes of cathode-ray tubes as used in television.

The British Thomson-Houston Co.; D. Gabor; and L. Rushforth. Application date 30th April, 1937.

493 885.—Double scanning arrangement for securing "interlaced" lines from a continuously-moving cinema film.

S. L. Clothier and H. C. Hogencamp. Convention date (U.S.A.) 9th May, 1936.

494 145.—Television receiver in which an electric image is first formed on a "mosaic" screen which is then scanned point by point to secure a higher light-intensity.

Radio-Akt. D. S. Loewe. Convention dates (Germany) various between 21st January and 24th April, 1936.

495 185.—Electron-optical arrangement for focusing and controlling the scanning stream in a cathode-ray tube.

Radio-Akt. D. S. Loewe. Convention date (Germany) 11th February, 1936.

TRANSMITTING CIRCUITS AND APPARATUS

(*See also under Television*)

492 610.—Short-wave generator with tuned Lecher-wire resonators which oscillate at a single natural frequency.

The General Electric Co. and E. C. S. Megaw. Application date 22nd March, 1937.

493 010.—Cathode-ray tube used as a "constant-frequency-variable-dot" modulator for carrier-wave signalling.

Marconi's W.T. Co. (assignees of R. E. Shelby). Convention date (U.S.A.) 14th September, 1936.

493 369.—Frequency-multiplying circuit for driving a radio transmitter from a low-frequency source controlled by a tuning-fork or similar device.

Marconi's W.T. Co. and W. S. Mortley. Application date 6th April, 1937.

493 966.—Lecher-wire arrangement for stabilizing the frequency of a short-wave valve generator.

Standard Telephones and Cables (assignees of R. A. Heising). Convention date (U.S.A.) 2nd September, 1936.

494 722.—Electron discharge tube containing small rod oscillators for producing a beam of waves of the order of millimetres.

Telefunken Co. Convention date (Germany) 27th April, 1936.

494 814.—Short-wave valve-generator in which the cathode stream is deflected to one side or other of a curved anode acting as a dipole oscillator.

Marconi's W.T. Co. (assignees of C. W. Hansell). Convention date (U.S.A.) 13th March, 1937.

CONSTRUCTION OF ELECTRONIC-DISCHARGE DEVICES

492 604.—Spacing device for the lead-in wires in a thermionic valve of the all-metal type.

Marconi's W.T. Co. Convention date (U.S.A.) 21st March, 1936.

492 698.—Electron multiplier in which a cathode with a "monocrystal" coating of copper is used to give straight-line amplification over a wide range of frequencies.

G. Weiss. Convention date (Germany) 31st March, 1936.

493 217.—Electron-multiplier with two symmetrical sets of electrodes acting in push-pull.

Standard Telephones and Cables (assignees of A. M. Skellett). Convention date (U.S.A.) 31st July, 1936.

493 296.—Electrode design and arrangement for an electron-multiplier.

Fernseh Akt. Convention date (Germany) 3rd April, 1936.

493 487.—Titanium-magnesium-nickel alloy, for making valve electrodes, the tensile strength and stiffness of which is increased by the usual heat-treatment.

British Driver-Harris Co. Convention date (U.S.A.) 3rd February, 1937.

493 614.—Electrode arrangement of a thermionic valve producing a jet or beam as distinct from a diffused stream of electrons.

Marconi's W.T. Co.; N. M. Rust; and G. F. Brett (addition to 467 573). Application date 11th February, 1937.

493 801.—Electron multiplier in which the electrons oscillate between two parallel sets of target electrodes separated by an open-work accelerating-anode.

Farnsworth Television Inc. Convention date (U.S.A.) 18th July, 1936.

SUBSIDIARY APPARATUS AND MATERIALS

492 843.—Gas-filled discharge tube for converting X-rays and ultra-violet rays into visible light.

Philips' Lamp Co. Convention date (Germany) 3rd September, 1936.

493 235.—H.F. transmission line giving no attenuation for waves of a given frequency whilst attenuating others, though the phase of the given frequency may be controlled.

Standard Telephones and Cables (assignees of A. Alford). Convention date (U.S.A.) 7th November, 1936.

493 527.—Hexode valve circuit arranged to simulate a negative impedance, including capacity, inductance, and resistance.

A. C. Cossor (Holdings) and L. Jofeh. Application date 6th April, 1937.

493 704.—Detecting the presence of a distant object by its reflecting action on a transmitted beam of ultra-short waves.

E. G. H. Mobsby and G. Nicholson. Application date 9th April, 1937.