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Editorial

The Naming of Instruments

UNDER this title an article appeared in the May number of the *Journal of Scientific Instruments*, written by Mr. J. W. Williamson, the former Secretary of the British Scientific Instrument Research Association, who states that he frequently received requests for information about instruments of which only the name was given and this frequently gave no clue whatever to its character or purpose. We were not aware that about twenty years ago a dictionary of British scientific instruments was published, in the preface to which it was stated that " the nomenclature of a science is one of the most important portions of its structure," but as Mr. Williamson very rightly remarks, the manufacture of instruments can hardly be called *per se* a science, although it involves a number of sciences at almost every stage. It is maintained that for the furtherance of the scientific industry of instrument manufacture a good nomenclature for the products is most desirable, if not essential ; and that, to assist in providing such a nomenclature, some fundamental principles should be commonly agreed on as a basis. The difficulties facing such a scheme are enormous ; one only has to think of the range and variety of apparatus covered by the word " instrument " and the vagueness of the borderline between apparatus that can be correctly so described and that which cannot. One is apt to think only of the instruments concerned in one's own branch of science and forget that there are other branches about which one knows practically nothing. Mr. Williamson gives a list of instruments culled from current catalogues or from advertisements in scientific journals : Avometer, Q-meter—most of our readers will have got on very well so far, but—lanameter, thixotrometer, gelometer, dia-box, steeloscope, uviares, barocyclonometer and trouble-shooting-gear. Except that the first two are known to many radio engineers, it is probably true to say that the average electrical engineer, even although he may be engaged in the instrumental side of the profession, will have no idea of the character or purpose of any of these instruments. As Mr. Williamson says, the name "steeloscope" conveys not the slightest hint of the nature or construction or purpose of the instrument, even to those steeped in the steel industry. He propounds three questions : (1) Should the naming of an instrument be left solely to the inventor or manufacturer or should there be some authoritative body to which the proposed name could be submitted for approval ? (2) What should be the composition of such a body ? and (3) what basic principles of nomenclature should it adopt ? There would probably be general agreement about such word-endings as meter, scope, and graph, but it has to be remembered that the names of instruments are in a very different

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category from those of concepts and units. Instruments are made and named by commercial concerns the continued existence of which depends on profits which again depend on sales and it is generally recognised that a certain amount of goodwill attaches to a distinctive well advertised, but not necessarily very logical, name.

A great amount of discussion has taken place about the introduction of such terms as resistor, reactor, impedor, and capacitor, and they are already used to some extent, but I doubt whether there is any maker of condensers—or condensors—who would not feel some surprise on receiving an order for a capacitor.

An effort was made a few years ago to replace converter by convertor and starter by startor, but most of the advocates of such a change hesitated to suggest the replacement of meter by metor. As the body concerned was associated with the electrical industry any such decision would not have affected the gas companies and the result would have been that many people would have had a metor standing side by side with a meter.

While one must agree with Mr. Williamson that the names given to scientific apparatus should be as explanatory as possible, one must remember that the scientific field is now so wide and so specialised that an expert in one branch is a layman in another, and we feel that he is asking for the impossible when he says that "the nomenclature of instruments should be such as to present no difficulties to those well versed in the use of instruments or familiar with the craft of their manufacture." G. W. O. H.

Cathode-Ray Oscillographs*

A Battery-Operated Power Unit

By R. E. Burgess, B.Sc.

(Radio Department, National Physical Laboratory)

Abstract.—Where electric mains are not available, the operating voltages for a cathode-ray oscillograph can be obtained by amplifying, transforming up and rectifying the audio-frequency voltages generated by a small-power valve oscillator. A suitable circuit is described in detail.

WHERE A.C. mains are not available, it is customary to use dry batteries to provide the accelerating voltages for cathode-ray oscillographs. This method has a number of obvious disadvantages which need not be detailed.

One method of providing the required high voltages is by means of a valve generator or "voltage multiplier." It can be operated from any batteries already available (e.g. for the receiver), or since the H.T. consumption is very small, it can be provided with its own (low capacity) batteries and thus made into a self-contained unit.

Description

The circuit of the power unit which was developed is given in Fig. 1. It consists essentially of an oscillator, an amplifier and a rectifier. The oscillator V_1 works at a low audio-frequency and provides grid excitation for the valve V_2, which is auto-biased beyond cut-off and so gives class-C amplification.

The transformer T_2 gives a voltage step-up from V_2 to the rectifier circuit. There is an optimum ratio corresponding to an impedance matching condition. It is necessary to try both senses of connection of the windings of T_2 in order to obtain maximum output; the difference probably arises from capacitive coupling or leakage between the windings.

A diode half-wave rectifier is used and the load resistance is the potential divider for the required operating voltages. (A metal rectifier can be used with economy of L.T. current, resulting in somewhat lower H.T. efficiency.) The steady p.d. across the load and C_3 corresponds to the voltage of the equivalent battery supply, although in both

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

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cases the accelerating voltage is that between the terminals Filament and A_3. The potential divider is designed for hard-tube operation and has a large total resistance (5 megohms) so that only a small output power is required and hence the power consumption is kept small. The potentiometer R_3 is of the smallest possible value consistent with good focus since the p.d. between the shield terminal and the negative end of C_3 is wasted.

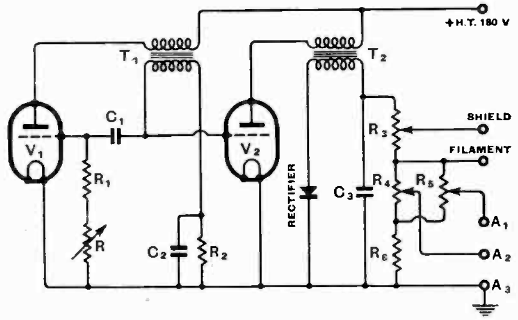

Fig. 1.—*Circuit diagram of the power unit.* R, 0.5 $M\Omega$; R_1, R_2, 50 $k\Omega$; R_3, 0.5 $M\Omega$; R_4, R_5, 5 $M\Omega$; R_6, 2 $M\Omega$; C_1, 0.01 μF; C_2, 1 μF; C_3, 2 μF (1,500 V.); T_1, 1/1 *output transformer*; T_2, 1/9 *output transformer*; V_1, *triode (anode resistance about* 10,000 *ohms, mutual conductance about* 2 *mA/V.)*; V_2, *L.F. amplifying triode (about* 5,000 *ohms,* 3.5 *mA/V.)*; *Rectifier, high-voltage, small current, half-wave, e.g. HVR1.*

The unit naturally has a bad regulation, but this is unimportant since it works into a fixed load, and gives the advantage of minimising the danger of shock, or of damage on short circuit.

By the suitable choice of circuit values, it has been possible to obtain a conversion efficiency of 40 per cent. The experimental model was designed to give an output of 1,000 V. but higher voltages can be obtained by the use of a different transformer for T_2 at approximately the same efficiency; similarly, a lower H.T. voltage can be used. A small range of adjustment of output is obtained by the variation of the oscillator grid leak (R).

Supplies: L.T. .. 2 volts;
H.T. .. 180 volts, at
2.0 mA to give 800 V.
2.5 mA ,, ,, 1,000 V.
4.0 mA ,, ,, 1,200 V.

Performance

Weight, excluding batteries .. 10½ lb.

When used to supply a hard cathode-ray tube, negligible ripple was observed on a 50 c/s trace, and the spot was completely stable. No long-period tests of reliability have been carried out, but the only source of trouble that can be foreseen is the breakdown of T_2.

Acknowledgment

The work described above was carried out as part of the programme of the Radio Research Board and is published by permission of the Department of Scientific and Industrial Research.

Correspondence

Inductor with Air-gapped Magnetic Circuit

To the Editor, The Wireless Engineer

Sir,—In connection with your Editorial of the April issue of this journal, which I read with much interest, I should like to bring some additional information which may be of interest.

In a study* of the magnetic circuit of a telephone receiver, I have pointed out that the very distributed path of the magnetic flux into the diaphragm is responsible for the existence of an optimum value for the distance between the diaphragm and the pole pieces (air-gap), corresponding to a maximum value for the self-induction of the receiver.

Starting from the assumption of a constant magnetic permeability and constant flux distribution along the magnetic circuit, an optimum value of air-gap is obtained, in close agreement with experimental results.

Direct experimental proof of the exactness of the above assumptions was obtained by replacing the circular membrane by a rectangular one, over which the path of the magnetic flux is not so distributed as over the circular membrane; there is then no optimum value for the air-gap to be found—the self-induction decreases gradually with increasing air-gap.

Although so far as quantitative results are concerned, the very simplified assumptions made in the above study may be open to criticism, the qualitative results are not thereby affected, and it may be stated that the predetermination of the optimum air-gap, in the case of a telephone receiver, requires, first of all, exact information on the distribution of magnetic flux, specially into the membrane.

Ing. Matei G. Marinesco

Bucharest, Roumania.

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* Contributions à l'étude du récepteur téléphonique, by M. G. Marinesco. *Ann. des. Postes T. et T.*, July, 1934.

The Stability of Regenerative Circuits*

By R. S. Rivlin, M.A.

(*Communication from the Staff of the Research Laboratories of The General Electric Company, Limited, Wembley, England*)

SUMMARY.—Nyquist's theorem on the stability of regenerative circuits is discussed and an alternative proof is given.

1. Introduction

IN general, any oscillator or amplifier can be represented by the four-terminal network N whose output is connected back to its input through a feedback network F, as shown in Fig. 1. The network N can transmit signals only in the direction of the arrow.

If we break the feedback path at a pair of points (XX', YY') we have a four terminal network consisting of N and F in tandem (see Fig. 2). We terminate this network at the input terminals X, Y in the impedance Z_a of the network looking into F at X', Y' and at the output terminals X', Y' in the impedance Z_b of the network looking into N at X, Y. We can then use this network to define the transfer constant $A(\omega)$.

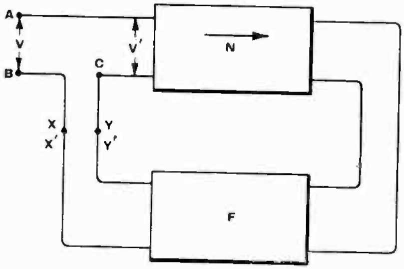

Fig. 1.

For an applied input potential $|V_1|e^{j\omega t}$, the output potential is $|V_2|e^{j(\omega t + \phi)}$, where $|V_2|$ and ϕ are real functions of the angular frequency ω. The transfer constant $A(\omega)$, a complex function of the angular frequency, is defined as the ratio of the output potential to the input potential, i.e. as $\dfrac{|V_2|e^{j\phi}}{|V_1|}$.

Since $A(\omega)$ is a complex quantity it can be plotted as a curve in an Argand diagram where each point on the curve corresponds to some value of ω and to each real value of ω there corresponds a point on the curve. We shall assume that $A(\omega)$ is a continuous function of ω. In most practical cases the value of $A(\omega)$ is zero for $\omega = 0$ and $\omega = \infty$. The curve representing $A(\omega)$ is then a closed curve passing through the origin.

Nyquist[1] gave complete criteria for the stability or instability of such a circuit which were verified experimentally by Peterson, Kreer and Ware[2]. The circuit is unstable if the loop representing $A(\omega)$ in the Argand diagram encircles the point (1, 0). Nyquist proved this theorem by considering the transient oscillations set up by an arbitrary disturbance due (say) to thermal effects. Such a disturbance can be expressed as a Fourier integral and the voltage resulting from the traverse of the closed circuit formed by N and F by the signal one, two, three . . . times can be found as an integral. The condition for the convergence of this integral gives the condition for stability of the circuit and the condition for divergence of the integral gives the condition for instability of the circuit. However, this proof involves somewhat difficult mathematical considerations whose physical significance is not always apparent. Attempts have therefore been made to give simpler proofs of Nyquist's theorem.

Reid[3], following, to some extent, some considerations of Peterson, Kreer and Ware, has solved the problem by considering the linear mesh equations of the network. Here, again, the condition for instability is that the transients resulting from the normal modes of oscillation of the circuit should build up infinitely. This occurs if the equation obtained by equating the discriminant of the mesh equations (which is a function of frequency) to zero, has solutions of the form $(\alpha + j\omega)$ where α is positive or zero. The network is stable if there are no

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solutions of this form. Reid shows that these conditions are equivalent to the criteria proved by Nyquist.

Brayshaw[4] has attempted to obviate the consideration of the transients set up by an arbitrary disturbance by assuming that the final value of the transfer constant is reached by increasing the transfer constant quasi-statically from zero to its final value, i.e. the building-up time of the transients is negligibly small compared with the rate of increase of the transfer constant. However, the complete criteria of Nyquist are not deduced by Brayshaw, whose analysis is, in any case, open to serious mathematical objections.

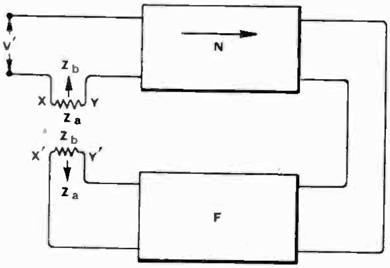

Fig. 2.

It is the object of this paper to show how Nyquist's criteria can be derived without considering the behaviour of the circuit as regards transients, by assuming that the value of the transfer constant considered has been attained by quasi-static increase from zero. The mathematical objections to Brayshaw's method are avoided and the complete criteria of Nyquist are deduced as distinct from the limited criteria of Brayshaw.

2. An Alternative Proof of Nyquist's Theorem

We have seen that when a voltage V_1 of angular frequency ω is applied to the input terminals of the network of Fig. 2, the voltage appearing between the output terminals is V_2 where

$$V_2 = A(\omega) \,.\, V_1$$

Now, referring to Fig. 1, when the circuit is stable, a voltage V applied to the input terminals AB gives rise, on account of the retroaction, to a voltage V' between the terminals AC, where

$$V' = V + AV'$$

Hence, when the circuit is stable, or in the limiting case of oscillation when $A = 1$,

$$V' = \frac{V}{1 - A} \quad \ldots \quad \ldots \quad \ldots \quad (1)$$

V' is finite unless $A = 1$. In this case we see that V' becomes infinite, which implies that the circuit is unstable.

If, when steady-state conditions have been reached, the transfer constant is increased by a small quantity ΔA (e.g. by varying slightly the electrical elements in the feed-back path F), the corresponding increase in voltage on the terminals AC is $\Delta V'$, given by differentiating equation (1) with respect to A, thus

$$\Delta V' = \frac{V \,.\, \Delta A}{(1 - A)^2} \quad \ldots \quad \ldots \quad (2)$$

Now, suppose the transfer constant is initially zero. The curve for $A(\omega)$ in the Argand diagram is a point circle at the origin and the circuit is certainly stable.

Let the transfer constant be increased quasi-statically so that at any time t it is given by the function $A(\omega, t)$, which is continuous for all values of ω and t. Let us denote $\underset{t \to \infty}{\mathrm{Lt}}\, A(\omega, t)$, which is the final value attained by the transfer constant, by $A(\omega, \infty)$. This is the value of transfer constant pertaining to the circuit whose stability we are investigating.

Excluding the case where the curve $A(\omega, \infty)$ has a double point (as shown, for example, in Fig. 3), we choose the function $A(\omega,t)$ to satisfy, in addition to the condition of continuity, the following conditions :—

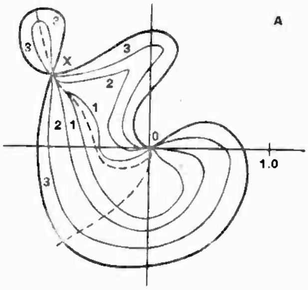

Fig. 3.

1. As the parameter t varies from 0 to ∞, it represents a family of curves ξ completely filling the area enclosed by the curve $A(\omega, \infty)$ in such a way that through every point of this area, except the origin (through which all the curves of the family ξ pass), there passes one and only one member of the family.

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2. As the parameter ω varies from 0 to ∞, it represents a family of curves η completely filling the area enclosed by the curve $A(\omega, \infty)$ in such a way that through every point of this area, except the origin (through which all of the curves of the family η pass), there passes one and only one member of the family.

3. No member of either of the families ξ and η has a double point.

These conditions can always be fulfilled if we allow positive and negative electrical elements which vary with frequency in any prescribed manner.

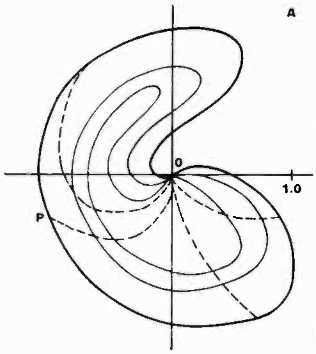

Fig. 4.

It will be seen from this that each member of the family ξ is a closed curve passing through the origin and that for $t > t_2$, the curve $A(\omega, t_1)$ encloses the curve $A(\omega, t_2)$.

Thus in Fig. 4 the full lines represent curves of the family ξ and the broken lines represent curves of the family η.

If the curve $A(\omega, \infty)$ has double points at some points $X, Y \ldots$ of the complex plane, as in Fig. 3, then the conditions, which have to be satisfied by $A(\omega, t)$, are the following :—

1. As the parameter t varies from 0 to ∞, it represents a family of curves ξ completely filling the area enclosed by $A(\omega, \infty)$ in such a way that through every point of the space, except the origin and the points $X, Y \ldots$, there passes one and only one member of the family.

2. As the parameter ω varies from 0 to ∞, it represents a family of curves η completely filling the area enclosed by the curve $A(\omega, \infty)$ in such a way that through every point of the space, except the origin and the points $X, Y \ldots$, there passes one and only one member of the family.

3. No member of either of the families ξ and η has a double point, except at the points $X, Y \ldots$ In Fig. 3 the full lines represent members of the family ξ and the broken lines represent the members of the family η.

In fact, it is possible to choose our families of curves ξ and η in a number of other ways which do not satisfy all the conditions given above, but to do so may make it difficult or impossible to determine definitely whether the circuit under consideration is stable or unstable. We are justified in choosing the method of attaining the final value of the transfer constant which is most convenient for the purposes of our mathematical analysis, as the final state of the circuit depends only on the final value of the transfer constant (i.e. on the final value of the circuit elements) and not on the way in which this final value has been reached.

In Fig. 4 let the curve OP be a typical member of the family η, corresponding to some angular frequency ω'.

Then, the value of the voltage V' appearing at the terminals AC when the applied voltage is V is given, from equation (2), by

$$V' = V + \int_{OP} \frac{V \, . \, dA}{(1 - A)^2} \quad \cdots \quad \cdots \quad (3)$$

Now, this integral has a finite value unless the integrand has a pole (becomes infinite) on the path of integration OP. Since the integrand has a pole only at $A = 1$, i.e. at the point (1, 0) of the complex plane, the integral is finite unless OP passes through the point (1, 0).

When OP passes through the point (1, 0) the integral is divergent (see Section 4 for a more rigorous discussion of this integral and the condition for instability).

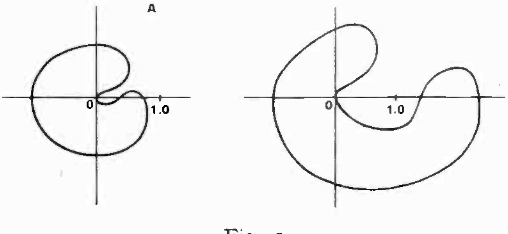

Fig. 5.

If the curve $A(\omega, \infty)$ does not enclose the point (1, 0), as shown in Fig. 5, then none of the integrals of the form (3) evaluated over the various members of the family of curves η can diverge, for none of the members of the family η can pass through (1, 0). Hence,

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in this case *the transfer constant can be increased quasi-statically from zero to its final value without the circuit springing into oscillation at any time.*

If the curve A (w, ∞) encloses the point (1, 0), as shown in Fig. 6, then one member and only one member of the family of curves η passes through this point. For all other curves of the family η the integral (3) is convergent, but for the curve passing through (1, 0) the integral is divergent and hence the circuit is unstable. In other words, if A (ω, ∞) surrounds the point (1, 0), we cannot increase the transfer constant quasi-statically from zero to its final value without one curve of the family ξ passing through (1, 0), i.e. without the circuit becoming unstable.

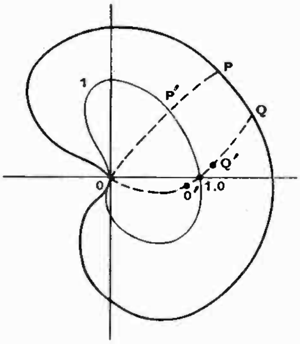

Fig. 6.

Any attempt to choose A (ω, t) in such a way that no member of either of the families ξ and η passes through (1, 0) would lead to the transfer constant being discontinuous for some value of t, which is physically inadmissible.

3. Natural Frequencies of the Circuit

In the argument of the previous section, it is evident that we cannot assign any particular significance to the frequency corresponding to the member of η for which the integral (3) is divergent, for by a suitable choice of A (ω, t) we could have made the member of the family η corresponding to any selected frequency between 0 and ∞ pass through (1, 0). This apparent anomaly that the circuit appears capable of oscillation for all frequencies is explained when we consider that we have throughout been discussing steady-state conditions in the circuit. The actual frequency at which the circuit oscillates is essentially a characteristic of the transient condition.

These natural frequencies of the circuit under consideration are obtained by solving the equation.

$$A\ (\omega, \infty) = 1$$

There always exist values of ω satisfying this equation but, unless the curve representing A (ω, ∞) passes through the point (1, 0), none of these values will be real.

The value of ω which is complex and of the form $(\beta - j\alpha)$, where α is positive, indicates that the angular frequency β is a natural frequency of the circuit and that the "build-up" factor $e^{\alpha t}$ which tends to infinity as t tends to infinity is associated with the oscillation at this angular frequency.

The formula (1) is applicable to the circuit when it is unstable as well as when it is stable, only if we recognise complex values of frequency.

By assuming that the transfer constant attains its final value by increasing quasi-statically from zero, we avoid the use of complex angular frequencies. Such angular frequencies have, of course, no meaning when applied to the steady-state conditions which obtain at all stages of our quasi-static increase of the transfer constant.

4. Appendix

In the proof of Nyquist's theorem given in Section 2 of this paper we have assumed that the integral $\int_{OP} \frac{V\,.\,dA}{(1 - A)^2}$ represents the change of voltage, of frequency corresponding to OP, on the terminals AC when the transfer constant is increased from zero to its final value at the point P, along the path OP, even when this path passes through the point (1, 0). So far, we are not really justified in making this assumption, for we have derived the formula from equation (1) which is only valid when the circuit is stable, or in the limiting case of instability when $A = 1$.

We can, however, avoid this difficulty, by using a reductio ad absurdum argument to prove that the circuit is unstable when its transfer constant curve encircles the point (1, 0).

Assume that for this final value of the transfer constant A (ω, ∞) the circuit is stable, and let V_P (ω) be the voltage appearing on the input terminals corresponding to an angular frequency ω. In Fig. 6 let P be the point on the curve A (ω, ∞) corresponding to the angular frequency ω. We then construct two families of curves ξ and η as described in Section 2. One member only of the family ξ and one member only of the family η will pass through the point (1, 0). We assume that the transfer constant is reduced quasi-statically from its value $A(\omega, \infty)$ to zero, following these curves. Until the circuit becomes unstable we can apply the formula (1) and hence, at any point P' on the curve OP, the voltage $V_{P'}$ appearing on the input terminals is given by the formula

$$V_{P'} = V_P + \int \frac{V dA}{(1 - A)^2} \qquad \dots \qquad \dots \qquad (4)$$

so long as the circuit is not unstable for any value of transfer constant between the value $A(\omega, \infty)$ and the value corresponding to the member of the family ξ passing through P'. We see from equation (4) that the circuit can only become unstable when the transfer constant has been so reduced that for some frequency, $A = 1$. That is, when the corresponding member of the family ξ passes through the point (1, 0). We have proved that if the point (1, 0) lies outside the transfer constant curve, the circuit is stable. Thus, we have shown that if we make the assumption that the circuit is stable when the transfer constant is $A(\omega, \infty)$, then the circuit is stable for all values of the transfer constant except for that value corresponding to ξ', the member of the family ξ passing through the point (1, 0). The formula (1), and consequently the formula (4), is then applicable at all points enclosed by the curve $A(\omega, \infty)$. Thus, when the transfer constant has its final value $A(\omega, \infty)$, we can apply equation (4) to determine the voltage corresponding to an angular frequency ω appearing on the input terminals when the path of integration passes through the point (1, 0).

Let this path be OQ and let Q', O' be points on this path adjacent to (1, 0) but lying between Q and (1, 0) and between O and (1, 0), respectively. Then,

$$V_Q = \int_{OQ} \frac{V \, . \, dA}{(1 - A)^2}$$

$$= \underset{O'Q' \to 0}{L^t} \left\{ \int_{OO'} \frac{V \, . \, dA}{(1 - A)^2} + \int_{Q'Q} \frac{V \, . \, dA}{(1 - A)^2} \right\}. \qquad \dots \qquad \dots \qquad (5)$$

From equation (5), we have

$$V_Q = \underset{O'Q' \to 0}{L^t} \left\{ \left[\frac{V}{1 - A} \right]_O^{O'} + \left[\frac{V}{1 - A} \right]_{Q'}^{Q} \right\} \qquad \dots \qquad \dots \qquad (7)$$

Now $\left[\frac{V}{1 - A} \right]_O$ and $\left[\frac{V}{1 - A} \right]_Q$ are both finite, since the circuit is stable for the transfer constant corresponding to each of the points O, Q.

Also, if $\left[\frac{V}{1 - A} \right]_{O'} \to \infty$ as $O' \to (1, 0)$ along the curve OQ, $\left[\frac{V}{1 - A} \right]_{Q'} \to -\infty$ as $Q' \to (1, 0)$ along the curve OQ, for O', Q' approach (1, 0) in opposite directions. Alternatively, if $\left[\frac{V}{1 - A} \right]_{O'} \to -\infty$ as $O' \to (1, 0)$ along the curve OQ, $\left[\frac{V}{1 - A} \right]_{Q'} \to \infty$ as $Q' \to (1, 0)$ along the curve OQ.

We thus obtain that the voltage appearing on the input terminals for the angular frequency corresponding to OQ is infinite when the transfer constant is $A(\omega, \infty)$. But, we have assumed that the circuit is stable, which means that this voltage must be finite. This contradiction, obtained by assuming the circuit to be stable, implies that the circuit is, in fact, unstable.

Hence, if the transfer constant curve encloses the point (1, 0), the circuit is unstable.

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3.—D. G. Reid. *Wireless Engineer.* Vol. 14, No. 588. (1937).
4.—G. S. Brayshaw. *Wireless Engineer.* Vol. 14, No. 597. (1937).

I.E.E. Wireless Section

NO nominations having been received other than those proposed by the Wireless Section Committee of the I.E.E. for the vacancies which occur on September 30th, the following have been duly elected for the year 1940–41; Chairman, Mr. W. J. Picken (Marconi's W.T. Co.); Vice-Chairman, Mr. T. E. Goldup (Mullard); ordinary members, Mr. L. W. Hayes (B.B.C.), Mr. T. H. Kinman (B.T.H.), Mr. R. P. Ross (Signals Experimental Establishment) and Dr. R. L. Smith-Rose (N.P.L.).

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Electro-Acoustic Reactions

By A. T. Starr, M.A., Ph.D., A.M.I.E.E.

(Concluded from page 256 of last month's issue.)

Effect of Plating on Response to Harmonics

THERE is a qualitative difference between the cases of full and partial plating, in that in the former the inductance of the crystal in the neighbourhood of a resonant frequency is independent of the harmonic order of the resonance (see equation 12(b)). In the latter case, however, the inductance to the $(2n - 1)$th harmonic is equal to

$$L_f \div \sin^2\left(\overline{n - \tfrac{1}{2}}\,\pi \frac{y_0}{y_1}\right)$$

and varies with the harmonic order. We could, therefore, eliminate some specially selected harmonic by the correct plating. Thus suppose we wish to avoid the resonance at the third harmonic, we should then put

$$\frac{3}{2}\pi\frac{y_0}{y_1} = \pi, \text{ i.e. } y_0 = \frac{2}{3}y_1.$$

In such a case

$$\left(L_p\right)_{\omega_1} = \frac{4}{3}L_f$$

and $$\left(L_p\right)_{\omega_3} = \infty$$

The response to the fundamental frequency would be not much decreased (by 33 per cent. only) whilst there would be no response to the third harmonic. The physical picture for this case is quite clear, and is shown in Fig. 10. The dotted curve shows the variation of stress (neglecting the constant term F_y) for a voltage application of third harmonic. By plating only two-thirds of the length, the electrodes pick up as much positive charge in the section P_2OP_3 as negative charge in the sections P_1P_2 and P_3P_4, so that the net reaction on the electrical system is zero. The responses to ω_1, ω_3, ω_5, ω_7, ω_9, are given by noting that the corresponding inductances are $\frac{4}{3}L_f$, ∞, $\frac{4}{3}L_f$, $\frac{4}{3}L_f$, ∞, ... respectively. This method therefore eliminates the responses to the third, ninth, harmonics, but leaves the others unaltered compared with the fundamental response.

We could, if we wished, decrease considerably any two selected harmonics, say the third and fifth. To do this we put $\theta = \frac{\pi}{2}\frac{y_0}{y_1}$, and find the value (or values) of θ which gives a good response to the fundamental and a weak response to the third and fifth harmonics. The best arrangement may well be that in which the responses to the third and fifth harmonics correspond to equal, high inductances. (It would not be difficult to find the plating factor for some other desired behaviour, say $\omega_3 L_3 = \omega_5 L_5$ and both as high as possible compared with $\omega_1 L_1$, $L_1 L_3 L_5$ being the inductance corresponding to 1st, 3rd, 5th harmonics respectively.) We have then

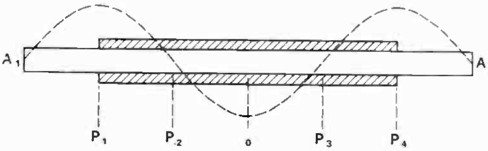

Fig. 10.—*Plating to avoid third harmonic.*

$$L_1 = \frac{L_f}{\sin^2\theta},\ L_3 = \frac{L_f}{\sin^2 3\theta},\ L_5 = \frac{L_f}{\sin^2 5\theta}.$$

Equating the last two we get

$$\sin^2 3\theta = \sin^2 5\theta, \text{ or } \cos 6\theta = \cos 10\theta$$

The solutions of this equation are

$$10\theta = 2m\pi \pm 6\theta$$

where m is a positive or negative integer. We need consider only positive integers, as we are concerned with values of θ between 0 and $\frac{\pi}{2}$. Thus we have

$$\theta = \frac{2m\pi}{10 \mp 6} = \frac{2m\pi}{4 \text{ or } 16}$$

The values corresponding to a denominator of 4 are included in those for which the

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denominator is 16, so we need only the solution

$$\theta = \frac{2m\pi}{16} = \frac{m\pi}{8},$$

so that $\theta = 22^\circ\ 30', 45^\circ, 67^\circ\ 30', 90^\circ$.

The value of 90° corresponds to full plating for which $L_1 = L_3 = L_5 = L_f$, and is of no interest. $\theta = 45^\circ$ corresponds to half plating, and then $L_1 = L_3 = L_5 = 2L_f$, and this solution also is of no interest. $\theta = 22^\circ\ 30'$ is quarter plating and we find

$$L_1 = 6.85\ L_f,\ L_3 = 1.17\ L_f,\ L_5 = 1.17 L_f$$

The response is thus equally powerful for the third and fifth harmonics and weak for the fundamental. The solution we require is thus $\theta = 67^\circ\ 30'$ corresponding to three-quarter plating. We then have

$$L_1 = 1.17\ L_f,\ L_3 = L_5 = 6.85\ L_f.$$

This is the arrangement we want; the response to the fundamental is diminished by less than 20 per cent., whilst the responses to the third and fifth harmonics are reduced to less than a sixth of the values for a fully plated crystal.

It is not usual that the harmonics of the fundamental are of importance, but the theory outlined above will be of great help in avoiding what are called "spurious" responses. These are due to harmonic responses of some unwanted, coupled mode of vibration. Suppose we wish to make an X – or – 18° cut crystal with a very low inductance at, say 400 kc/s. It will be necessary to make the z dimension greater than the y dimension. Spurious responses will occur due to harmonic responses of $\overset{\wedge}{yz}$ and $\overset{\wedge}{zz}$ vibrations. By proper arrangement of the plating, it is then possible to eliminate (or greatly diminish) the responses of harmonics of these motions in the neighbourhood of the fundamental response of the $\overset{\wedge}{yy}$ vibration.

The Activity Factor. *R*.

If the simple representation of a quartz vibrator, as shown in Fig. 1, is considered, r is defined as

$$r = \frac{Co}{C} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (14)$$

For a fully plated crystal, equations (10a) and (12c) give

$$(C_0)_f = \frac{ky_1z_1}{4\pi x_1} \text{ and } (C)_f = \frac{8\epsilon^2}{\pi^2 G}\,\frac{y_1z_1}{x_1}$$

so that

$$r_f = \frac{k\pi G}{32\epsilon^2} \quad \ldots \quad \ldots \quad \ldots \quad (14a)$$

The ratio r_f is independent of the dimensions of the vibrator, and depends only on the mechanical, electrical and piezo-electric properties, viz. G, k, ϵ respectively. Mason (^{3}) points out that "this ratio limitation is a consequence of a fixed electromechanical coupling between the electrical and mechanical systems of the crystal." The ratio can be considered as an "activity factor," the smaller r the more active the crystal; the importance of r was pointed out by Dye (^{4}).

Taking the values for quartz:—

$$k = 4.55$$
$$G = 7.85 \times 10^{11},$$
$$\epsilon = Gd_{12},$$

where d_{12} is the more usual piezo-electric constant, and is equal to -6.3×10^{-8} for an X-cut, we get,

$$r_f = \frac{4.55 \times \pi}{32 \times 7.85 \times 10^{11} \times 6.36^2 \times 10^{-16}} = 140.7$$

The reduction in C_0 due to the piezo-electric action will bring r_f down to about 140. It may be possible that by taking a perpendicularly cut crystal with other mechanical and z axes to reduce r_f substantially, and the variation of the activity ratio with a rotation of the plate about the X axis will be considered. Let the plate be rotated through an angle θ (a positive angle resulting in the new mechanical axis pointing towards a minor (z) face of the terminating pyramid). Then the new mechanical constants s^1_{22}, which is the reciprocal of the Young's modulus, is given by $s^1_{22} = s_{11} \cos^4\theta + s_{33} \sin^4\theta + 2\,s_{14} \cos^3\theta \sin\theta + (2s_{13} + s^{44}) \sin^2\theta \cos^2\theta$ and the new piezo-electric constant is

$$d^1_{12} = -\,d_{11} \cos^2\theta + d_{14} \sin\theta \cos\theta$$

The best known values of the s's and d's are

$$s_{11} = 127.2 \times 10^{-14},\ s_{33} = 97.2 \times 10^{-14},$$
$$s_{14} = -\,43.1 \times 10^{-14}$$
$$s_{13} = 15.2 \times 10^{-14},\ s_{44} = 200.5 \times 10^{-14},$$
$$d_{11} = -\,6.36 \times 10^{-8},\ d_{14} = 1.69 \times 10^{-8}.$$

The values of s^1_{22}, d^1_{12}, and the resulting r_f are plotted against θ in Fig. 11. It is seen that the crystal is most active, i.e. r_f is a minimum at about $\theta = +5^\circ$, for which cut r_f is just about 140. Values of r as low

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as 115 are claimed to have been measured, and certainly values of 125 are obtainable. There are errors of the order of about 3 per cent. in the measured mechanical and electrical constants, so that we might expect at most a 5 per cent. or 7 per cent. divergence from the theoretical minimum of 140, but definitely not a 20 per cent. difference.

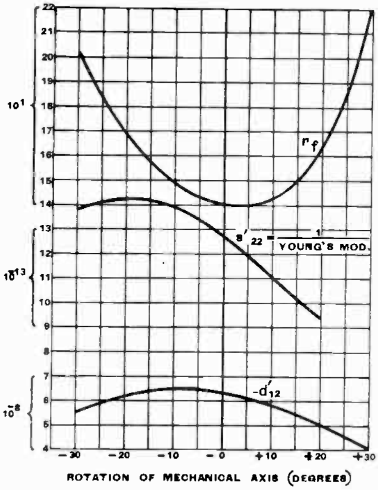

Fig. 11.—*Young's modulus, piezo-electric constant, and activity factor for a perpendicularly cut crystal.*

It is easy to show that almost the whole discrepancy is due to the neglect of partial plating. It may have been tacitly assumed by workers on quartz crystal vibrators that a partial plating must result in a diminished activity, and a consequently increased activity factor r. It will be shown, however, that this assumption is quite wrong, and that there exists an optimum arrangement of partial plating for which the activity factor is near 120.

Let us consider the approximate representation of a partially plated crystal in which

$$(C_0)_p = \frac{ky_0z_1}{\pi x_1} = \frac{y_0}{y_1}(C_0)_f$$

and $$(C)_p = C_f \times \sin^2\left(\frac{\pi y_0}{2 y_1}\right)$$

The activity factor is

$$r_p = r_f \times \left[\frac{\dfrac{y_0}{y_1}}{\sin^2\left(\dfrac{\pi}{2}\dfrac{y_0}{y_1}\right)}\right] \quad .. \quad (14b)$$

It is easily seen that r_p has a minimum value for a value of y_0 between 0 and y_1. Putting $\frac{y_0}{y_1} = x$, differentiating with respect to x, and equating to zero, we get for a minimum value the condition :—

$$\sin^2\left(\frac{\pi}{2}x\right) = x\,2\sin\left(\frac{\pi}{2}x\right)\cos\left(\frac{\pi}{2}x\right).\ \frac{\pi}{2}$$

$$= \pi x \sin\left(\frac{\pi}{2}x\right)\cos\left(\frac{\pi}{2}x\right)$$

One solution is given by $\sin\left(\frac{\pi}{2}x\right) = 0$, or $x = 0$, this clearly gives $r = \infty$, and corresponds to no plating at all. The other solution is given by

$$\sin\left(\frac{\pi}{2}x\right) = \pi x \cos\left(\frac{\pi}{2}x\right)$$

or $$\tan\left(\frac{\pi}{2}x\right) = \pi x = 2\left(\frac{\pi}{2}x\right)$$

This is Euler's well-known transcendental equation in the theory of vibrations, but the solution is found very simply by a graphical method or by looking up the tangent table of radian measure, we have merely to find the angle whose tangent is twice the angle.

We find $\frac{\pi}{2}x = 1.1655$, corresponding to a plating ratio of $\frac{y_0}{y_1} = 0.742$. The activity factor is then

$$r_p = 140\,x\,\frac{0.742}{\sin^2(1.1655)} = \frac{140 \times 0.742}{\sin^2(66^\circ\,47')}$$
$$= 123$$

The difference between this value and the minimum observed value of 115 can be easily accounted for by errors of measurement of G and ϵ, and by the neglect of coupled modes of vibration (although we might expect the latter to be deleterious), in addition the small effect of the piezo-electric action will reduce C_0 by about 1 per cent. and hence r_p to 122.

The physical reason for the greater activity of the three-quarter plated crystal is simple, the last quarter of plating does not collect much charge due to the piezo-electric action, but has its full quota of electrostatic charge, so that its omission results in an improved electromechanical coupling.

The activity factor, defined as $r = \frac{C_0}{C}$, has a meaning only in the approximate representation of the quartz vibrator. The general definition is obtained by considering r as a function of the resonant and neighbouring anti-resonant frequency. In both the approximate and exact representation ω, is the same, since L and C were chosen with this in mind. Fig. 12 shows diagrammatic plots of $\left(\omega L - \frac{1}{\omega C}\right)$ and (Z_2/j), the anti-resonant frequency is clearly given by the intersection of the dotted curve, representing $\frac{1}{\omega C_0}$ with the other curves. In the case of the approximate representation ω_a is given by

$$\omega L - \frac{1}{\omega C} = \frac{1}{\omega C_0},$$

or
$$\omega_a{}^2 LC = 1 + \frac{1}{r} = \frac{\omega_a{}^2}{\omega_1{}^2},$$

giving
$$r = \frac{\omega_1{}^2}{\omega_a{}^2 - \omega_1{}^2}$$

We can define r for the exact equivalent by

$$r = \frac{\omega_1{}^2}{\omega^1{}_a{}^2 - \omega_1{}^2}$$

This is not at all artificial, as r is found by this method in practice. It will be found with sufficient accuracy that

$$r = \frac{\omega_1}{2(\omega^1{}_a - \omega_1)}$$

It is seen from equations (1) and (11) that $\omega^1{}_a$ is given by $Y_1 + Y_2 = 0$

or
$$j\omega \frac{ky_0 z_1}{4\pi x_1} + j\omega \frac{2\epsilon^2 z_1 c}{G\omega x_1} \frac{\cos \frac{\omega}{2c}(y_1 - y_0)}{\cos\left(\frac{\omega}{2c} y_1\right)}$$

$$\sin\left(\frac{\omega}{2c} \cdot y_0\right) = 0$$

An exact solution of this equation is possible by graphical methods, without a great deal of labour, but a small amount of investigation simplifies the solution very much. It is clear from Fig. 12 that

$$\frac{\omega^1{}_a}{\omega} = 1 + \frac{1}{2r},$$

r being the value for the approximate equivalent. It is then seen that the numerator of Y_2 changes hardly at all in the region $\frac{\omega^1{}_a}{\omega} = 1 + \frac{1}{2r}$, we may therefore put $\omega = \omega_1$ in the numerator. Remembering also that $\omega_1 = \frac{\pi c}{y_1}$ we find that the equation for the exact value of r is

$$\frac{k\pi G}{32\epsilon^2} \times \frac{\frac{y_0}{y_1}}{\sin^2\left(\frac{\pi y_0}{2 y_1}\right)} + \frac{1}{\frac{4}{\pi}\frac{\omega}{\omega_1} \cos\left(\frac{\pi}{2}\frac{\omega}{\omega_1}\right)} = 0$$

or
$$\frac{4}{\pi}\frac{\omega}{\omega_1} \cos\left(\frac{\pi}{2}\frac{\omega}{\omega_1}\right) = -\frac{1}{r_p},$$

r_p being the value calculated above, viz., 123.

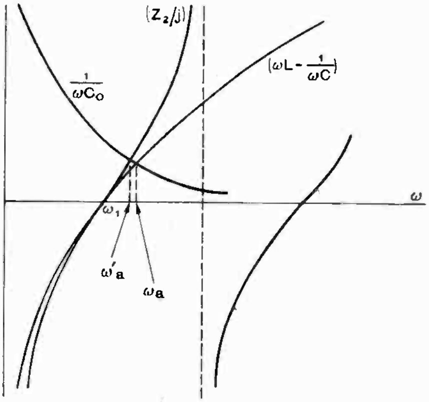

Fig. 12.—*Effect of network equivalent on anti-resonant frequency.*

It is quite good enough to put

$$\cos\left(\frac{\pi}{2}\frac{\omega}{\omega_1}\right) = -\frac{1}{\frac{4}{\pi}\left(1 + \frac{1}{2} r_p\right) r_p}$$

$$= -\frac{1}{\frac{4}{\pi}\left(r_p + \frac{1}{2}\right)}, = -0.00636$$

In the neighbourhood of such small values of sines, we have very closely

$$\frac{\pi}{2}\frac{\omega}{\omega_1} = \frac{\pi}{2} + \frac{1}{\frac{4}{\pi}\left(r_p + \frac{1}{2}\right)}.$$

or
$$\frac{\omega^1{}_a}{\omega_1} = 1 + \frac{1}{2r_p + 1}$$

This means that the correct value is $r_p + \frac{1}{2} = 123.5$. It appears, therefore, that the approximate equivalent is quite good enough to give a very close representation up to and including the anti-resonant frequency mainly because the anti-resonant frequency is within $\frac{1}{4}$ per cent. of the resonant frequency.

Matters should be quite different, however, in the design of a broad band filter, in which we are interested in a frequency range of about 15 per cent. (this includes the pass band and the important parts of the stop bands, where frequencies of infinite attenuation are located). The method just outlined is capable of giving a more accurate representation of a broad band filter using quartz crystals. It can be said definitely that if the cross overs in the pass band are correctly adjusted, the frequencies of infinite attenuation should not, in general, be where the simple theory says they are, the discrepancy will depend on the way in which the crystal inductances are obtained, and the relative values in the arms of the lattice structure.

Experimental Verification of Plating Formulae

The formulae are:

$$L_p = L_f \div \sin^2\left(\frac{\pi}{2}\frac{y_0}{y_1}\right)$$

and $$r_p = r_f \times \frac{\dfrac{y_0}{y_1}}{\sin^2\left(\dfrac{\pi}{2}\dfrac{y_0}{y_1}\right)}$$

A crystal, which was measured with various degrees of plating, was a − 18.5° cut with $x = 0.61$ mm, $y_1 = 31.3$ mm, $z_1 = 28.8$ mm. The measurements included the finding of the resonant and anti-resonant frequencies, and the crystal inductance by the use of a shunt coil of known inductance or by a bridge — T network method. The table below gives the results. Frequency differences were not measured to better than 10 cycles per second, so that a comparatively large error in r is possible. The inductance measurements were consistent, and probably accurate, to within about 2.0 per cent. In the third and fourth measurements it was not possible to get a good frequency calibration, but the frequency differences, being determined by a vernier condenser of the oscillator, were probably correct to within about 10 cycles.

It is seen that r follows the calculated values within the errors of observation, this does not preclude, however, the possibility that r_f differs considerably from 140, say by 10. What is shown up very vividly is that the − 18.5° cut has very small coupling to the shear mode, for the value of 140 corresponds to the assumption of plane wave motion; the x-cut with

$$\frac{z}{y} = \frac{28.5}{31.3} = 0.91 \text{ has } r_f = 180.$$

Plating	Resonant frequency	Anti-Resonant frequency	r	L (H)	Calculated r	Calculated L
Full	80.915	81.215	135	9.27 9.25 } 9.25 9.22	140 (assumed)	9.25 (assumed)
$\frac{y_0}{y_1} = \frac{23.7}{31.3}$	80.990	81.313	125	10.7 10.8 } 10.74 10.73 10.72	123	10.74
$\frac{y_0}{y_1} = \frac{17.3}{31.3}$	81.227	81.504	147	15.6 15.6 } 15.5 15.3	133	15.92
$\frac{y_0}{y_1} = \frac{13.3}{31.3}$	81.130	81.390	157	22.2 23.8 } 22.9 22.7	155	24.2
$\frac{y_0}{y_1} = \frac{10.5}{31.3}$	80.945	81.160	188	34.4 35.8 } 34.9 34.4	186	36.7

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The measured inductance values agree fairly well with the calculated values, except that the measured inductance is always lower than the calculated value (taking the measured value with full plating as the reference value). This progressive (although small) deviation can be explained satisfactorily in two ways. First we see that with a crystal of 0.61 mm. thick and plating surfaces 13 mm. × 28.5 mm., there is a sufficient fringing of the lines of electrostatic force to increase the effective plate area by a few per cent.; secondly, the effect of clamping the crystal may be to increase the charge collection under the contact wedges, but the mechanism for this is not physically clear although a certain simple assumption gives almost the exact correction.

Effect of Plating only Part of the Width

When only one part of the width of the crystal is plated, the piezo-electric force acts only at the edge of the plated area. We apply St. Venant's "principle of the elastic equivalence of statically equipollent systems of loads," even though the crystal is by no means a long narrow bar, for which the principle holds very closely. It will be found that the error is not great even for wide crystals and the result is that we can replace the actual force of $\epsilon\ (V/x_1)$ over a width of z_0 by a force of $\epsilon\ (V/x_1)\ (z_0/z_1)$ acting over a width of z_1. The result is to introduce a constant of (z_0/z_1) in all expressions of physical displacement and piezo-electric charge. As moreover the charge is collected over a width of z_0 (instead of z_1), the impedance is multiplied by $(z_0/z_1)^2$, i.e. the width factor is just (z_0/z_1).

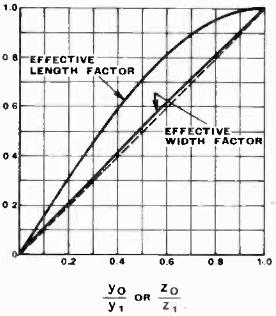

Fig. 13.—*Effective length and width factors for partial plating.*

This method is necessarily approximate in that St. Venant's principle has been assumed to hold, and also lateral motion has been ignored. To a very close degree of approximation this lateral motion was found to be negligible. Nevertheless a width factor was calculated on a simplified basis, assuming a Poisson's ratio of $\sigma = -0.1$. It is then found that for a plating width of z_0, the effective width factor is

$$\text{Effective}\left(\frac{z_0}{z_1}\right) = \frac{0.9\frac{z_0}{z_1} + 0.063\sin\left(\frac{\pi}{2}\frac{z_0}{z_1}\right)}{0.963}$$

$$= w, \text{ say} \quad .. \quad .. \quad (15a)$$

Similarly

$$\text{Effective}\left(\frac{y_c}{y_1}\right) = \sin\left(\frac{\pi}{2}\frac{y_0}{y_1}\right) = l, \text{ say} \quad .. \quad (15b)$$

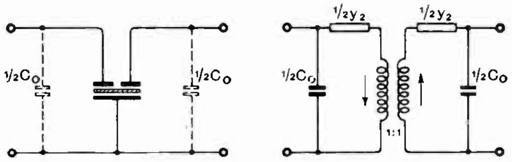

Fig. 14.—*Three-electrode crystal and its equivalent network.*

Fig. 13 shows these factors as functions of $\frac{z_0}{z_1}$ and $\frac{y_0}{y_1}$. The dotted line is drawn at 45° to the abscissa, and shows the slight divergence of the width factor from uniformity. The inductance should then be L_f/l^2w^2. This formula has been verified for a crystal plate, in which $l = 0.620$ and $w = 0.421$, to within 1.1 per cent. in this case L_f was 8.62H and L_p was 65.5H.

Verification by Three-Electrode Crystal

The application of St. Venant's principle receives striking confirmation in the case of the three-electrode crystal. The case was chosen in which the upper face is covered by two equal electrodes with the dividing line parallel to the axis of vibration.

The assumption of St. Venant's principle implies that the halves vibrate equally, so that each electrode receives the same current, i.e.

$$i_1 = i_2.$$

It may seem remarkable that this equation should hold even when one electrode is isolated, but in such a case the piezo-electric current will flow into the electro-static capacitance, which is therefore shown dotted in Fig. 14.

Secondly, if V_1 and V_2 are the potentials of the upper halves, the average force on the plate is that due to $\frac{1}{2}\ (V_1 + V_2)$, so that the total current is given by

$$i_1 + i_2 = \tfrac{1}{2}\ (V_1 + V_2)\ Y_2,$$

where Y_2 is the piezo-electric admittance of the crystal considered fully plated and as a whole. These two equations determine the action of the three-electrode crystal, considered as a three-terminal network, provided the static capacitances are put as shown in Fig. 14. It is easy to show that the right-hand network of Fig. 14 is an exact equivalent, the transformer being ideal of unity ratio and series aiding in the direction shown.

As a check we may measure the resonant and anti-resonant frequencies of the impedances of the whole crystal, between A and E with B open, and between A and E joined to B. It is seen that if the representation is correct, the resonant frequencies of the first and third should be the same, the anti-resonant frequencies of the first and second should be the same, whilst the resonant frequency of the second and the anti-resonant frequency of the third should be mid-way between the other frequencies. The following table gives the results of a test :—

	Resonant Frequency (kc/s).	Anti-Resonant Frequency (kc/s).
Whole crystal ..	80.000	80.189
AE, B open ..	80.090	80.194
A, EB	80.000	80.100

Having regard to the fact that the frequencies were only measured to within ± 5 cycles, the verification is within observational errors.

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"Television Receiving Equipment"

EVEN though the war has stopped active television development, the technique of the subject, and especially that of the cathode-ray tube, is still being applied in many fields. Further, to ensure that the television service progresses smoothly and rapidly when it re-starts, it is highly desirable that as many wireless technicians as possible should have a sound foundation of knowledge on the subject.

An opportunity to acquire this knowledge is now presented by the publication of "Television Receiving Equipment," a 300-page book by W. T. Cocking, A.M.I.E.E., of our sister journal, *The Wireless World*. The author assumes that the reader is familiar with "sound" broadcasting technique and does not deal with the transmitting side of television except in so far as is necessary to explain reception practice. Whilst the treatment of the subject is substantially non-mathematical, design formulae have been included where essential.

The book, which includes 167 illustrations and diagrams, is available, price 7s. 6d. net, or 7s. 10d. by post, from our publishers, Iliffe and Sons Ltd., Dorset House, Stamford Street, London, S.E.1.

Cathode-Ray Oscillographs

By J. H. REYNER. Pp. 177. Sir Isaac Pitman & Sons, Ltd., Parker Street, Kingsway, London, W.C.2. Price 8s. 6d.

The scope of this book is not ambitious and, we feel sure, is not intended as a text-book in any sense. The author has, however, many years experience of the use and design of oscillographs; the volume summarises this experience for the use of those less experienced but interested in the use of oscillographs.

The first third of the book treats of the elements of cathode-ray tubes, their type and peculiarities. It then proceeds to the discussion of oscillographs in general terms, covering both the magnetic and electrostatic systems, time bases, synchronisation, power supplies, the limitations of each arrangement and the precautions to be observed for each. The remainder of the book covers the use of the oscillograph for the investigation of phenomena which may be grouped under certain main headings. These include the examination of wave forms, both at high and low frequency, and of frequency response curves. The latter subject is treated mainly from the point of view of obtaining the response from high frequency tuned circuits by means of frequency modulation, but the audio frequency response of amplifiers is also mentioned. Also included is the delineation of characteristic curves (for valves, magnetic substances, etc.), the use of the oscillograph for frequency measurement by comparison with a standard source and finally a general chapter covering special applications such as the investigation of transients and the use of special time bases. A very necessary chapter is interpolated in this part of the book with regard to the amplification of deflection voltages.

The strength of the book as a whole lies, we feel, not so much in the fundamental principles which it describes as in the little hints and tips with regard to the eradication of difficulties which so often mar methods which are in principle sound and valuable. All through the book these hints are to be found and make the book useful to anyone engaged on oscillograph work. The first part of the book is perhaps rather less satisfactory than the latter portions, but even here a very adequate elementary picture of the ground work of the subject is conveyed. Printer's and other errors are very few. One on page 8, however, should be corrected. It is stated here that electrons "always try to move at right angles to the lines of electric force"; equipotential lines are obviously meant. F. M. W.

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.

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PROPAGATION OF WAVES

2502. Quantic Emission in Phase in the Region of Radioelectric Waves.—Jonescu. (*See* 2572.)

2503. An Ionospheric Investigation concerning the Lorentz Polarisation Correction.—H. G. Booker & L. V. Berkner. (*Hochf:tech. u. Elek:akus.*, Feb. 1940, Vol. 55, No. 2, pp. 60–63.) A four-page summary by Zenneck of the paper in *Terr. Mag. & Atmos. Elec.*, 1938, pp. 427–449: *see* also 2185 & 3123 of 1938.

2504. The Velocity of Propagation of Electrical Disturbances [Non-Mathematical Treatment of Basic Concepts—Group & Phase Velocities, Retardation: Propagation along Perfect Conductors and in Dissipative Media].—S. Ramo. (*Communications*, March 1940, Vol. 20, No. 3, pp. 9–12.)

2505. Pressure Waves and Boundary Surfaces in the Free Atmosphere [" Canal Wave " Theory on Assumptions that an Air Element keeps Its Volume Constant in Small Displacements, and that Horizontal Pressure Gradient is Independent of Height].—D. S. Subrahmanyam. (*Indian Journ. of Phys.*, Dec. 1939, Vol. 13, Part 6, pp. 419–437.)

The first assumption has already " led to a satisfactory explanation of the constant lapse rate in the free atmosphere " (3072 of 1939). The theory now developed leads, among other conclusions, to the following: the boundary surface corresponding to the travel of a wave along a great circle will be at a height of 21.85 km at all points on the globe and should be an isobaric surface; " this compares well with the observed fact that at 20 km height the pressure at all points of the globe and at all times of the year is the same ": the possibility is shown of the formation of other higher boundary surfaces, corresponding to the principal possible modes of oscillation; " the heights deduced for three of these are found to be very close to the heights of the E, F, and D layers."

2506. The Estimation of Wireless Transmission Data from Ionospheric Observations [Principles used in Estimating, assuming Flat Earth and neglecting Ionospheric Variations: Special Attention to Absorption (" D " and " N-D " Types—in " Deviating " and " Non-Deviating " Regions): Approximations for Spherical Earth: etc.].—F. W. G. White. (*New Zealand Journ. of Sci. & Tech.*, Nov. 1939, Vol. 21, No. 3B, pp. 114–127.)

" It is shown that a complete solution may be obtained provided the equivalent height of reflection . . . at vertical incidence on all frequencies, as well as measurements of absorption on some frequencies, are available."

2507. The Calculation of the Night Field Strength of Radio Broadcasting Stations.—V. P. Gulyaev. (*Journ. of Tech. Phys.* [in Russian], No. 19, Vol. 9, 1939, pp. 1697–1711.)

The existing methods of calculating the field strength of a radio broadcasting station are briefly criticised and a new method is proposed in which multiple reflection between the earth and the ionosphere is taken into account. The ionosphere is assumed to be uniform and the air/ionosphere boundary sharply defined. The field strength is calculated as the r.m.s. value of the fields due to separate rays; the only data required for this calculation are the height of the ionosphere and the coefficients of reflection from the earth's surface and the ionosphere. Tables and curves are given to facilitate the necessary calculations. A comparison between the calculated and experimental results shows a sufficiently close agreement. The method described is similar to that proposed by Kenrick (1928 Abstracts, p. 578) but is free from " certain erroneous assumptions," which are discussed.

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2508. The Influence of the Geomagnetic Activity on the Height and Concentration of the F Layer, and a Connection between Abnormal E Ionisation and Disturbances of the F Layer [Conclusion that there are Two Types of Abnormal E Layer].—Th. Netzer. (*Hochf:tech. u. Elek:akus.*, March 1940, Vol. 55, No. 3, pp. 86–94.)

These investigations were made at night throughout the winter of 1938/39, extending to May 1939. The method chosen (Appleton, 1931 Abstracts, p. 202: Gilliland, 1934 Abstracts, p. 86, l-h column) gives the effective heights as a function of frequency, and also the critical frequency and thus the maximum electron density. Relaxation-circuit pulses with a group frequency of 50 c/s were made to modulate a fixed-frequency emitter which combined with a variable-frequency emitter to give, in two stages (two fixed inductances with automatic switching) a frequency ranging from 1 to about 10 Mc/s in the mixing stage: as a rule, only up to 6 Mc/s was used. Agreement in tuning between transmitter and receiver was obtained by making the circuits of the 3rd and 2nd transmitter stages act as input and oscillatory circuits of the receiver h.f. stage; this was possible because the transmitting valves belonging to these circuits were blocked except during the duration of a pulse, when the receiver itself was strongly blocked.

As regards the first part of the title, the observations showed the general result that the effective height of the F layer was higher, the higher the geomagnetic figure. "The relation between the effective height and the magnetic activity is still more clearly shown when we use for this height not the 'minimum height' values [*see* section II.1a: the correlation is seen in Fig. 3] but the second criterion, defined on p. 88" [namely the apparent height for the extra-ordinary component at the moment when the ordinary component just penetrates: correlation seen in Fig. 4]. On the other hand, absolutely no correlation could be obtained between magnetic figures and maximum electron concentration (critical frequency: Fig. 6): since the results on effective heights had suggested that the phenomena leading to magnetic disturbances perhaps only affected the ionosphere after a certain delay, a comparison was made with the magnetic figure of the previous day—with, however, no better result (Fig. 7).

Coming now to the second part of the title, the writer recalls the various negative results in attempts to observe changes in the F layer resulting from the passage of the corpuscular radiation which is generally supposed to produce the "abnormal E" layer: they show, at any rate, that such changes cannot be large. But the method here employed lends itself to the examination of the F layer in conditions (during a layer rise) when even very slight disturbances can be detected by the behaviour of signals close around the critical frequency. The records shown in Figs. 8/10 illustrate such results: the figures at the top edge represent the frequency, increasing from 1 to 3 Mc/s to the right of the "*U*" (where the inductance switching takes place) and from 3 to 6 . . 10 Mc/s to the left of the same point. Fig. 8 shows one type of layer rise: "the curves representing the temporal course of the effective heights gradually rise, for both the wave-components, without appreciable alteration of their simple course." The second type is seen in Fig. 9: each of the two components, ordinary and extraordinary, shows a multiple (up to six-fold) splitting "which indicates a complex stratification of the F region." In a variant of this (Fig. 10) these sub-components are more or less unstable, so that a smudged thickening of the curves occurs as the heights tend upwards (Fig. 10); this variant, as well as the intermediate forms between Figs. 9 and 10, is classified as a "multiple-splitting" type.

It is a relation between the occurrence of this multiple splitting ("m.A")—which is described as "quite distinct from the normal (?) splitting into three components"—and the appearance of the abnormal E layer, that the writer seeks to establish from the data of table 7. The bottom line of totals shows that out of 511 (505 + 6) cases of multiple splitting, 505 also show the presence of an abnormal E layer. On the other hand, there are 505 + 678, that is, 1183 cases of abnormal E layer (given wrongly in the text as 891) and of these only 505 show also the multiple-splitting effect. Further examination of the records, however, leads the writer to conclude that the 678 cases of "abnormal E without multiple splitting" are composed of two types (about 77 of one and 601 of the other): the first is characterised by a weak, "smudgy" layer, often subdivided and usually at or over 150 km, more or less of the kind seen in Fig. 9 (reflections generally only up to 2Mc/s), while the more numerous second type has a very sharp layer giving a uniform effective height (about 100 km) over a much larger frequency range, as in Fig. 8. The first type gives a percentage of 86 (505 out of 505 + 77) with simultaneous multiple splitting (*see* footnote on p. 93, where alone it is stated that the 505 were found to be all of the "first type"); the second type is never accompanied by multiple splitting. It is concluded that the first type of abnormal E layer is produced by corpuscles which are partly absorbed in their passage through the F layer, the second type by more penetrating corpuscles of a very uniform character which pass through the F layer without any effect on it and cause a sharply defined layer at about 100 km: "this supposition loses all improbability when one remembers that Harang observed the formation of abnormal E layers, sometimes at heights considerably over 100 km, during the occurrence of aurora—that is, during a violent corpuscular bombardment."

2509. The Theory of Reflection of Very Long Wireless Waves from the Ionosphere.—M. V. Wilkes. (*Proc. Roy. Soc.*, Ser. A, 10th April 1940, Vol. 175, No. 961, pp. 143–163.) A summary was dealt with in 3884 of 1939: *see* also 2149 of June.

2510. Preferential and Initial Ionic Recombination in Gases [Theory considering Change of Energy Distribution of Electrons diffusing away from Parent Atom: Space Distribution of Negative Ions formed: Calculation of Final Volume Recombination].—N. E. Bradbury. (*Journ. of Applied Phys.*, April 1940, Vol. 11, No. 4, pp. 267–273.)

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2511. Monthly Tables of Ionospheric Data [Notice].—National Physical Laboratory. (*Wireless Engineer*, May 1940, Vol. 17, No. 200, p. 205.)

2512. The Ionosphere and Radio Transmission: Normal and Irregular Characteristics which affect Wave Propagation [Summary of Present Knowledge].—Nat. Bureau of Standards. (*QST*, March 1940, Vol. 24, No. 3, pp. 32–35 and 88..98.) From *Letter Circular* LC–575.

2513. Geiger-Counter Measurements in the Upper Atmosphere bearing upon the Nature of the Radiation from Solar Flares and Radio Fade-Outs.—T. H. Johnson & S. A. Korff. (*Journ. Franklin Inst.*, Feb. 1940, Vol. 229, No. 2, pp. 252–253.) Abstract of paper in *Terr. Mag. & Atmos. Elec.*, 1939, Vol. 44, p. 21.

2514. The Magnetic Storm of Easter Sunday, 1940 [Horizontal Intensity passed 1000 Gammas].—W. Davis. (*Science*, 5th April 1940, Vol. 91, Supp. p. 10.)

2515. The Magnetic Storm of 24th March 1940 [Data].—L. Eblé, G. Gibault, & É. Tabesse. (*Comptes Rendus*, 8th April 1940, Vol. 210, No. 15, pp. 542–543.)

2516. Aurora and Magnetic Storm of March 24/25 [and March 29/30: Data].—J. P. Rowland. (*Nature*, 20th April 1940, Vol. 145, pp. 625–626.)

2517. Unusual Solar Activity [in Spot Groups, Kodaikanal, Aug./Sept. 1939: Magnetic Records show No Corresponding Disturbances].—Md. Salaruddin & B. G. Narayan. (*Indian Journ. of Phys.*, Dec. 1939, Vol. 13, Part 6, pp. 451–454 and Plates.)

"It has not been possible to study the connection between these solar flares and the associated radio effects, as continuous series of daily records regarding the behaviour of the ionosphere are not available in India." Spectrophotographs indicate that the active agent producing both eruptions and terrestrial effects "originates in layers lower than the chromosphere, below the eruptive patch." "It would appear that the connection between the eruptions and the magnetic effects is not a simple one, and there is need for further careful studies of the diurnal variations accompanying solar outbursts."

2518. Extreme Ultra-Violet Absorption Spectrum of Nitrogen.—F. A. Jenkins & R. E. Worley. (*Phys. Review*, 1st Feb. 1940, Ser. 2, Vol. 57, No. 3, p. 252: abstract only.)

2519. Absorption of the Hydrogen Line 1215.7 AU by Air.—W. M. Preston. (*Nature*, 20th April 1940, Vol. 145, pp. 623–624.)

Discussion of discrepancies between the writer's results (3430 of 1939) and those of Williams (1317 of April). *See* also Martyn & others (6 of 1938) where it is suggested that this radiation from solar eruptive areas may be responsible for radio fade-outs.

2520. The Atmospheric Layer from which originates the Yellow Line in Twilight [lies in the Lower Part of the Auroral Region: Line due to Extra-Terrestrial Sodium].—L. Vegard. (*Nature*, 20th April 1940, Vol. 145, p. 623.)

2521. Sun and Sky Radiation on the Jungfraujoch during the International Polar Year 1932/33.—U. Chorus. (*Helvetica Phys. Acta*, Fasc. 6, Vol. 12, 1939, p. 537–552: in German.)

2522. The Diffraction of Radio Ranges by Hills [Theory: Calculations for Wavelengths about 1000 m: Plots of Signal Intensities].—W. R. Haseltine. (*Phys. Review*, 15th April 1940, Ser. 2, Vol. 57, No. 8, pp. 717–721.) A summary was dealt with in 2134 of June.

2523. Ground Wave Propagation Characteristics [Graphical Method of determining Field Intensity as Function of Ground Conductivity and Inductivity, Distance, Frequency, and Operating Power or Unattenuated Field Intensity at One Mile.].—C. E. Smith. (*Communications*, April 1940, Vol. 20, No. 4, pp. 7–10.) Using curves based on Norton's work (14 of 1937).

ATMOSPHERICS AND ATMOSPHERIC ELECTRICITY

2524. A Theory of Spark Discharge [Mechanism depending on Photo-Ionisation and Electron Multiplication in the Gas: Positive Space Charge a Conducting Plasma: Development of Long Sparks not dependent on Cathode Material: Equation for Breakdown: Self-Propagating Streamer Mechanism accounts for Pilot Streamer and "Stepping" in Lightning Discharges].—J. M. Meek. (*Phys. Review*, 15th April 1940, Ser. 2, Vol. 57, No. 8, pp. 722–728.) For previous work *see* 3067 & 3484 of 1939.

2525. Electrical Discharge on Liquid Surfaces [of Soap and Other Bubbles: Discharge Path follows Bubble Surface].—Snoddy, Henry, & Beams. (*Phys. Review*, 15th Feb. 1940, Ser. 2, Vol. 57, No. 4, p. 350: abstract only.) For previous work *see* 2692 of 1939.

2526. Recent Lightning Storms: II.—J. F. Shipley. (*Distribution of Electricity*, April 1940, Vol. 12, No. 138, pp. 361–365.) Some corrections to Part I (935 of March) are given at the end.

2527. The Development of the Cathode-Fall Lightning Arrester for High Voltages.—Geissler. (*E.T.Z.*, 7th March 1940, Vol. 61, No. 10, pp. 229–233.)

2528. "Lightning" Radiation [near Soft X-Ray Region], emitted from Lightning-Arrester Insulation, lowers Gap Resistance.—Berkey. (*Scient. American*, April 1940, Vol. 162, No. 4, p. 223.)

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PROPERTIES OF CIRCUITS

2529. Dielectric Losses in Radio Circuits [Comparison of Power-Factor/Frequency Curves of Coil and of Actual Complete Circuit: Dominant Influence of Dielectric Losses and Leakage in Various Components: Measurements of P.Fs of Valves (Base, Pinch) & Holders, Condensers: the " Rho-Meter": etc.].—A. G. Bogle. (*Wireless Engineer*, May 1940, Vol. 17, No. 200, pp. 198–202.)

" It appears that the best variable condensers available may easily have a power-factor comparable with that of the coil."

2530. The Wide-Band Amplifier: III—High-Frequency Correction by Auxiliary Valves.—H. Pieplow. (*Arch. f. Technisches Messen*, Jan. 1940, No. 103, double p. 12.)

" An absolute independence of frequency on the part of the amplification is impossible with purely passive circuit elements." Realisation of this has led to attempts to use " negative capacity " effects. Thus in Fig. 1 the amplifying valve V_1 has a compensating valve V_2 in parallel on the anode side; this valve is controlled, through another auxiliary valve V_3 (which serves only for phase reversal) and an a.c. voltage divider (C_s, R_s), by the anode voltage U_2, in such a way as to send through the anode-impedance network a compensation current J_2 which is as accurately as possible opposed to the capacitive current J_c. The vector diagram is examined to find the conditions for a (theoretically) complete independence of frequency, and this leads to the conclusion that another valve V_4 (Fig. 4) is necessary to provide an " internal capacity " C_i which will combine with the R_i of the frequency-independent voltage divider (Fig. 3b) to match the $R.C$ of its components. The conditions for frequency independence of Fig. 4, given in eqn. 8, can be fulfilled over a larger frequency range than in other correction methods. Numerous literature and patent references on the subject are given at the end.

2531. Shunt Peaking Compensation [Graphical Method for Wide-band Amplifiers].—W. H. Freeman. (*Electronics*, Jan. 1940, Vol. 13, No. 1, pp. 35–36.)

2532. Resistance Networks: Complete Design Tables.—C. D. Colchester & M. W. Gough. (*Wireless Engineer*, May 1940, Vol. 17, No. 200, pp. 206–215.)

From the Research and Development Department of the Marconi Company. " So far as is known, similar tables have not previously been published in Great Britain, though tables somewhat similar to those given in Figs. 1 and 14 have appeared elsewhere."

2533. On Temperature-Independent Electrical Resistances [Compensation Methods].—Hildebrandt. (*See* 2686.)

2534. Non-Linear Resistance Elements in Circuit Networks [treated by Graphical Methods].—P. I. Wold. (*Phys. Review*, 15th Feb. 1940, Ser. 2, Vol. 57, No. 4, p. 351: abstract only.)

2535. Non-Linear Resistances in A.C. Circuits [Experimental Investigation on Production of D. C. Components (22% when using Atmite) if Wave includes Even Harmonics].—T. A. Ledward. (*Electrical Times*, 11th April 1940, Vol 97, pp. 317–318.)

2536. Full-Wave Rectifier Analysis.—C. M. Wallis. (*Electronics*, March 1940, Vol. 13, No. 3, pp. 19–22.)

2537. The Instability of Linear and Non-Linear Oscillations [" Mitnahme "—Pull-In—Oscillations].—Wenke. (*See* 2626.)

2538. The Operation within the Pull-In Range of an Auto-Oscillating System of the Thomson Type examined from the Standpoint of the Energy Balance in the Circuit.—K. F. Teodorchik. (*Journ. of Tech. Phys* [in Russian], No. 16, Vol. 9, 1939, pp. 1481–1483.)

If an auto-oscillating system of the Thomson type, determined by equation (1), is subjected to the action of an external harmonic force, nearly harmonic oscillations (2) may appear within the pull-in range. A theoretical investigation of these oscillations using the method of " energy cycles " (1365 of April) is presented, and the results are applied to the case of an auto-oscillating system operating in the soft régime. Equations (13) and (14), similar to those of van der Pol, are derived showing the building-up of the oscillations, and also equations (15) and (16) for determining the steady-state oscillations.

2539. The Poisson Integral and Its Applications to the Theory of Linear Alternating-Current Circuits (Networks): Part I.—W. Cauer. (*E.N.T.*, Jan. 1940, Vol. 17, No. 1, pp. 17–30.)

" The most important application of the Poisson integral [to the theory of linear a.c. circuits] lies in the fact that it gives an analytical representation of all functions of frequency which can be realised as impedances or admittances . . . The practical field of application of the ' positive functions ' is not limited to rational functions. Irrational, but algebraically positive functions are, for instance, the surge-impedance or attenuation functions of finite reactance connections, meromorphic functions of dipole reactances of a cross-connected section equivalent to a length of loss-free homogeneous line. Similarly irrational are, for example, the impedances of Pupinised lines. All these functions are represented together by the Stieltjes integral dealt with later (eqn. 49), which covers all positive functions without any assumptions as to the limiting values . . . Particularly simple and practical is the relation between real and imaginary components (*cf.* Bayard, 2587 of 1935) given by formulae 24 & 25." The series development 26 is of special interest in connection with Wiener & Lee's dipole or quadripole combinations (U.S.A. patents).

2540. The Application of Matrix Calculation in Electrotechnics [Fundamental Rules: Simple Example from Network Theory].—F. Strecker. (*Arch. f. Elektrot.*, 15th March 1940, Vol. 34, No. 3, pp. 167–175.)

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2541. ENERGY CONSIDERATIONS APPLIED TO THE TELEGRAPH EQUATION [Mathematics of Electrical Oscillations and Transients on Conductors deduced from Theorem of Equality of Electric and Magnetic Energies].—A. Kneschke. (*Arch. f. Elektrot.*, 15th March 1940, Vol. 34, No. 3, pp. 175–180.)

TRANSMISSION

2542. QUESTIONS OF INTENSITY IN THE REGION OF VERY SHORT ELECTRIC WAVES [10 mm–0.1 mm].—H. Klumb. (*Zeitschr. f. Physik*, No. 5/6, Vol. 115, 1940, pp. 321–325.)

"Using known facts as to the intensities generated in the wavelength range $1–1 \times 10^{-2}$ cm and combining them with the laws of radiation, the probable course of the variation with wavelength of the radiation intensities which can be generated in the transition region [between infra-red waves and those produced by macroscopic oscillators such as magnetrons] is depicted. It is shown that the available observational material, combined with the radiation laws, leads to the assumption of the existence of an intermediate region, in which electromagnetic energy can be produced with only small intensities by the methods hitherto known." For the writer's work on the measurement of micro-waves *see* 2679, below.

2543. THE ACCELERATION OF CHARGED PARTICLES IN THE ELECTROMAGNETIC ALTERNATING-CURRENT FIELD [in the Magnetron: Theory].—G. Seibert. (*Arch. f. Elektrot.*, 10th Jan. 1940, Vol. 34, No. 1, pp. 31–42.)

"It is shown that, in the magnetron, in the absence of space charges or with Langmuir's space charge, there are no concentric circular paths for electrons on which they can be accelerated. It is further proved that, in an alternating magnetic field with a superposed static radial electric field, the electrons cannot be accelerated much beyond the velocity which corresponds to the imposed voltage." The results are opposed to those of Jassinsky (332 of 1937) but agree with the results obtained by Hull (in 1921) for constant fields.

2544. BALLISTIC MODELS OF VELOCITY-MODULATED TRANSIT-TIME DEVICES [Heil's "Two-Field" (Faraday Cage) Arrangement, leading to the Two-Field Arrangement with Cophasal Entrance and Exit Fields (and the Use of Galvanic Regeneration), and thence to the Klystron].—H. E. Hollmann. (*Hochf:tech. u. Elek:akus.*, March 1940, Vol. 55, No. 3, pp. 73–86.)

Further development of the work dealt with in 1376 of April. While these investigations were in progress the AEG Research Institute pointed out the usefulness of such representations by models, in the introductory paper mentioned in 2218 (*see* also 2221) of June. Author's summary:—"The paper describes ballistic models of velocity-modulated devices, provided with a stream of balls and mechanically moved see-saws and chutes: first, a model of the Heil two-field arrangement [3380 of 1935: *also* 2124 of 1936]; then, leading from this, a model of a transit-time generator with galvanic regeneration; and finally the model of a klystron.

"From the kinetic and potential energies which the balls have gained or lost at the instant of their exit from the models, the efficiency functions are calculated with attention to the path-time angle in the different fields, and also with the decompression cut out by the introduction of incidence-angle limitation; in simple cases the results are experimentally confirmed by the measurement of the changes in the logarithmic decrement occurring in various working conditions. The path-time compression is also shown oscillographically. By a static retardation of the compression process the efficiency of the Heil two-field model can be so far improved that self-excitation occurs. By phase-reversal of the exit field the Heil two-field device is transformed into a generator with path-time compression and galvanic regeneration. Finally, from this arrangement a model of the klystron is developed, and the action of this device as an amplifier and frequency-doubler is shown. The Webster theory [3950 of 1939: for a later paper *see* 968 of March] is extended by the introduction of the path-time angle in the control and working fields": the curves of Fig. 18 show how the maximum efficiency sinks rapidly with increasing path-time angles in these two fields, so that in practice the angles should be kept as small as possible. Consideration of the energy consumed by the modulating see-saw shows that the latter can be worked in regions where it either consumes no energy or actually delivers energy to the control circuit. "This case is particularly important for receiving and amplifying purposes, where appreciable control powers are not available. There is also the possibility of spontaneously exciting the control circuit through the negative internal resistance of the control system, and thus of dispensing completely with external control or external feedback." The static retardation of the compression process, mentioned above in connection with the Heil generator, is considered in connection with the klystron in section IIIc.

2545. VELOCITY-MODULATED BEAMS [Correction].—Kompfner: Tombs. (*Wireless Engineer*, May 1940, Vol. 17, No. 200, p. 202.) *See* 1806 of May: Kompfner finds that his formula for S requires multiplying by a correction factor when m is over 0.1. "For values of m which are likely to occur in practice" this factor is very nearly unity.

2546. VELOCITY-MODULATED BEAMS [Correspondence].—C. Strachey: Tombs: Kompfner. (*Wireless Engineer*, May 1940, Vol. 17, No. 200, p. 202–203.)

Referring to the work of Tombs and Kompfner (1805 & 1806 of May), Strachey gives an analysis leading to a formula for optimum drift-tube length which holds for all values for m below unity and which can be expanded into a power series provided m is less than 0.57. He compares this with Tombs' and Kompfner's results (*see* also 2545, above); Tombs replies.

2547. VELOCITY-MODULATED BEAMS [Correspondence].—D. M. Tombs: Kompfner. (*Wireless Engineer*, May 1940, Vol. 17, No. 200, pp. 203–205.)

Defence of the graphical method against Kompfner's criticism (1806 of May): his "exact" solution gives too large values when m is large (*cf.* 2545, above): occurrence of "double humps" (showing that overtaking is possible): agreement with Webster's results (3950 of 1939).

2548. THE PERIODIC EXTINCTION AND CONTROL OF A MERCURY-VAPOUR ARC BY GRIDS IN THE PLASMA [Experimental Investigation at Note and Radio Frequencies, with Conclusions on Power Amplification and Self-Excitation on Wavelengths down to 5 m].—G. Wehner. (*Zeitschr. f. tech. Phys.*, No. 3, Vol. 21, 1940, pp. 53–63.)

Kobel (1933 Abstracts, p. 636) succeeded in extinguishing the arc by the cooperation of a grid of special form with the anode. The present writer uses a grid in the plasma, without any noticeable combined action with the anode in the extinction process. His work is based on the results obtained by Fetz (2549, below) on the physical foundations of the extinction by "plasma-grids" with non-recurrent application of the grid voltage. Sealed-off mercury-vapour thyratrons (A.E.G. T. 143) were used, and a cathode-ray oscillograph was employed not only to give the grid-voltage/anode-current records but also to measure the power expended in the grid circuit. Saw-tooth voltages for application to the grid of the thyratron were generated by a condenser/saturation-valve/thyratron circuit so designed and connected to the valve under test (Th_L in Fig. 1) that by varying C_K and the emission of the saturation triode *SR*, the frequency of the saw-tooth oscillations was regulated; by varying the grid bias of the saw-tooth thyratron Th_K, the amplitude of the negative pulse; and by varying C_L, the striking instant to any desired point within the period. Since the control of a discharge naturally cannot occur without the expenditure of energy, retroaction from the discharge valve onto the saw-tooth circuits was bound to occur, and could only be avoided by connecting the latter not directly to the grid of the former but by way of a high-vacuum amplifier valve (type RV230): by adjusting the emission of this valve the rapidity of the quick rise of the negative control voltage could also be regulated. The above saw-tooth pulse arrangement could be used only for low frequencies; for high frequencies sinusoidal control voltages had to be employed.

The main results are summarised in section v, but in section iv the writer remarks that the most interesting question is the practicability of such control in the high-frequency field. "The more economical and (with mercury) practically inexhaustible gaseous-discharge cathodes, the low internal resistance of the discharge and the low voltages required, are in complete contrast with high-vacuum valves and lead to the expectation of first-line developments in the field of power-amplification. For high frequencies, the grids used in the above researches, with 3 meshes/cm, were very unfavourable from the power standpoint. At 1 Mc/s, for example, the controlling power reached the same order of magnitude as the controlled power," but later orienting tests with a mercury-vapour valve (kept connected to the pump) with a grid mesh of 10/cm and an anode voltage of 500 v, connected according to Figs. 12 (distorted a.c. output) and 13 (series-resonance conditions, giving undistorted output), gave at 1 Mc/s a controlling power of 100 w for a controlled output of 1.5 kw, with $\eta = 75\%$. "These tests on power amplification, and also on self excitation, were continued on to wavelengths down to 5 m." The trouble when fine-meshed grids are used is the damage by ion bombardment, but the results obtained show that further research is justified.

2549. INFLUENCE OF A CONTROL GRID IN THE PLASMA ON A MERCURY VACUUM ARC.—Fetz. (*Ann. der Physik*, Ser. 5, No. 1, Vol. 37, 1940, pp. 1–40.)

2550. INVESTIGATION OF PLASMA OSCILLATIONS IN SODIUM- AND MERCURY-VAPOUR LAMPS.—von Stengel. (*See* 2566.)

2551. AMPLITUDE, FREQUENCY, AND PHASE MODULATION [Relation between Changes in Frequency and Phase: Criticism of the Statement that there is a Critical Peculiarity when Extreme Phase Modulation equals One Radian: etc.].—G. W. O. H. (*Wireless Engineer*, May 1940, Vol. 17, No. 200, pp. 197–198.)

A previous Editorial, and Lawson & Weighton's letter on it (545 of February), are referred to, and then some statements by L. E. C. H. in a "Students' Section" *Electrician* article are criticised.

2552. A CATHODE-RAY FREQUENCY-MODULATION GENERATOR.—R. E. Shelby. (*Electronics*, Feb. 1940, Vol. 13, No. 2, pp. 14–18.) A summary was dealt with in 76 of January.

2553. NOTES ON FREQUENCY-MODULATED TRANSMITTERS [Definition of the Two Systems ("Free Oscillator" Type with Discriminator Circuit, and the Armstrong Phase-Shift Method—"the Only Crystal Controlled Method"): Description of Latter].—F. A. Gunther. (*Communications*, April 1940, Vol. 20, No. 4, pp. 11–13.)

2554. FREQUENCY-MODULATION IN TELEVISION: I—F-M APPLIED TO A TELEVISION SYSTEM: II—INTERSPERSED F-M AND A-M IN A TELEVISION SIGNAL.—C. W. Carnahan: A. V. Loughren. (*Electronics*, Feb. 1940, Vol. 13, No. 2, pp. 26 and 30–32: pp. 27–30.)

2555. DIFFERENTIAL MODULATION METER.—V. V. Gunsolley. (*Electronics*, Jan. 1940, Vol. 13, No. 1, pp. 18–20.)

2556. COMPRESSION WITH FEEDBACK [for Broadcasting Transmitters: by Control of Plate Resistance of Valve in Negative-Feedback Circuit: Reduced Distortion, Constant Frequency Response].—H. H. Stewart & H. S. Pollock. (*Electronics*, Feb. 1940, Vol. 13, No. 2, pp. 19–21.)

2557. A SIMPLIFIED EXCITER CIRCUIT: ELECTRICAL VARIATION OF CRYSTAL FREQUENCY [Adjustably Tuned Circuit in Series with Crystal gives 5 kc/s Variation of 7 Mc/s Frequency (and then a Series of Less Useful Lower Frequencies)].—W. D. MacGeorge. (*QST*, April 1940, Vol. 24, No. 4, p. 42.)

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2558. Neutralisation of Radio-Frequency Power Amplifiers.—W. H. Doherty. (*QST*, March 1940, Vol. 24, No. 3, pp. 52–53 and 110.) Quotation from a longer article.

2559. Neutralising Economy: Taking the D.C. off the Neutralising Condenser [thus increasing the Possible R.F. Voltage and preventing Damage done by D.C. Arc after a Flash-Over].—B. P. Hansen. (*QST*, March 1940, Vol. 24, No. 3, pp. 28–29.) Extension of Ferrill's suggestion, 477 of 1939.

2560. 160 to 2½ [Metres] in One Transmitter: Medium-Power Seven-Band Final and Driver.—E. P. Tilton. (*QST*, April 1940, Vol. 24, No. 4, pp. 23–25 and 98.)

2561. Papers on Transceivers.—(*See* under "Stations, Design & Operation.")

2562. Electronic Keying [Gas-Filled Triode in Modified Sweep-Oscillator Circuit, controlled by "Bug" (Lateral-Motion) Key, makes Dashes as well as Dots: Speed regulated from 15 to 40 w.p.m. by turning One Control].—H. Beecher. (*QST*, April 1940, Vol. 24, No. 4, pp. 9–14 and 110.)

RECEPTION

2563. A Practical 112-Mc/s Converter using Loktal Tubes for the U.H.F. Mixer and Oscillator [thus eliminating Use of the More Expensive Acorn Valves].—B. Goodman. (*QST*, March 1940, Vol. 24, No. 3, pp. 16–20.) *See* also Wise, 2273 of June.

2564. A Complete 56-Mc/s I.F. System: an Amplifier for Use with either Frequency or Amplitude Modulation.—B. Goodman. (*QST*, April 1940, Vol. 24, No. 4, pp. 16–19 and 74, 76.)

2565. A "Modified" Dickert Noise Limiter: a Circuit particularly adapted to Mobile Applications [Car Receivers, etc.].—J. L. Hill: Dickert. (*QST*, March 1940, Vol. 24, No. 3, pp. 22–23.) For Dickert's limiter *see* 496 of 1939.

2566. Investigation of Plasma Oscillations in Sodium- and Mercury-Vapour Lamps [causing Broadcast Interference: Nature of the Oscillations and Conditions for Their Occurrence].—H. H. von Stengel. (*Hochf:tech. u. Elek:akus.*, Feb. 1940, Vol. 55, No. 2, pp. 42–51.)

These oscillations, whose existence was already known through the work of Penning, Langmuir & Tonks, and others, came into prominence when metal-vapour lamps for street lighting became popular. Blok investigated the suppression of interference due to them (3738 of 1936: but *cf.* footnote on p. 46): Sick (? Dick: *Zeitschr. V.D.I.*, Vol. 79, 1935, p. 1521: *cf.* 1833 of 1935) also gave a suppression method. The present investigation showed that sodium-vapour lamps spontaneously produce h.f. oscillations, with either d.c. or a.c. supply. On d.c., the natural frequency of the plasma oscillations decreases with increasing arc current (*e.g.* from 1250 kc/s to 1100 kc/s: Fig. 8); auxiliary heating of the cathode, producing a lower arc voltage (Fig. 2), brings the frequency right down to around 650 kc/s (curve *d*, Fig. 8). On a.c., where the periodically varying ionisation produces oscillations of various frequencies, an increase of arc current increases the frequency. The effects of a coupled oscillatory circuit and of a magnetic field are dealt with in section IV.

Section V considers mercury-vapour lamps under the same conditions: no spontaneous oscillations could be traced, their absence being attributed to too high a damping owing to the higher pressure: spontaneous oscillations require a low gas density combined with a sufficiently high density of ions.

2567. Experiences in curing Broadcast Interference in an 85-Family Block of Flats after installing a 1-Kilowatt Convertor for Short-Wave Telephone.—G. Turney. (*QST*, April 1940, Vol. 24, No. 4, pp. 43–45.)

2568. The Communal Aerial as a Means of Reducing Broadcast Interference from High-Voltage Lines.—Moebes. (*See* 2581.)

2569. Improved Radio-Proof Insulator ["Conduction-Glazed Silentype" Pin-Type Insulators for Prevention of Interference].—Ohio Brass Company. (*Elec. Engineering*, Jan. 1940, Vol. 59, Advt. p. 8.) *See* also 3938 of 1939.

2570. A Visual Alignment Generator—Mayer. (*See* 2683.)

2571. The Siemens-Hell Printer.—Berck. (*See* 2767.)

AERIALS AND AERIAL SYSTEMS

2572. Quantic Emission in Phase in the Region of Radioelectric Waves.—T. V. Jonescu. (*Comptes Rendus*, 6th May 1940, Vol. 210, No. 19, pp. 666–669.)

The writer has already (2559 of 1937) calculated the radiation resistance of an aerial on the assumptions that "(1) at each oscillation a quantity of energy equal to $h\nu$ is emitted by an electron oscillating in an aerial; (2) this energy is comprised in the space of a wavelength." Theoretical arguments are given in the present paper "to show that these assumptions, together designated as the 'principle of quantic emission in phase,' can be verified by experiment," from measurements of the dielectric constant and conductivity of ionised gases in a magnetic field.

2573. Metal Horns as Radiators of Electric Waves [Gains of 28 db already obtained with Certain Types: Characteristic Diagrams].—A. P. King. (*Bell Lab. Record*, April 1940, Vol. 18, No. 8, pp. 247–250.) For previous work (as receivers) *see* 1888 of 1939.

2574. The Measurement of the Transmission Constants of Concentric Lines in the Decimetric-Wave Region.—Kaufmann. (*See* 2681.)

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2575. A Stationary Reversible Beam [Two Directions with a Fixed Three-Element Vertical Array, for 28 or 14 Mc/s Band: Reflector and Director interchanged by Transfer of Lengthening Piece].—W. J. Stiles. (*QST*, March 1940, Vol. 24, No. 3, pp. 56 and 102.)

2576. Directional Antenna Chart [showing Voltage Gain obtainable with Two-Aerial Arrays, as Function of Phasing for Various Spacings].—W. S. Duttera. (*Electronics*, Feb. 1940, Vol. 13, No. 2, p. 33.)

2577. Multi-Wire Dipole Antennas [may be Directly Coupled (without Matching Transformers) to Transmission Lines of High Impedance].—J. D. Kraus. (*Electronics*, Jan. 1940, Vol. 13, No. 1, pp. 26–27.)

2578. Development of Aircraft Radio Antennas.—R. McGuire & J. Delmonte. (*Communications*, March 1940, Vol. 20, No. 3, pp. 5–8 and 28.)

2579. Improving the Flying Skywire [Description of Demountable Kite, with "Automatic Wind Control," giving Wire Heights over 1200 Feet].—D. A. Griffin. (*QST*, April 1940, Vol. 24, No. 4, pp. 32–33 and 106 . . 110.)

2580. Sag Measurement on Overhead Lines [Description of Various Methods].—O. Naumann. (*Arch. f. Technisches Messen*, Jan. 1940, No. 103, double pp. T1–T2.)

2581. The Communal Aerial as a Means of Reducing Broadcast Interference from High-Voltage Lines.—Moebes. (*T.F.T.*, Jan. 1940, Vol. 29, No. 1, pp. 5–9.)

The reduction of interference from high-voltage lines by steps taken on the lines themselves is a costly business except when the cause is defective insulators or insulators of a design known to be unfavourable. In the laying-out of new high-voltage systems care must be taken to maintain a distance of some 100 m from buildings, but this has not been done in the past, nor is it always possible to do it. Since the interference field at a distance of 100–200 m is found to be only small, and since the type of aerial with screened transmission-line and amplifier enables the aerial and receiver to be separated by the same order of distance, the use of such an aerial system as a cure for the trouble is an obvious move. Economically such a solution is practical only in the form of a community reception system. To collect information on the subject, the German P.O. undertook experiments in a neighbourhood so troubled by a 200 kv line that interference with the local station (giving 30 mv/m) was sometimes complained of: a community reception installation was set up, the electricity companies guaranteeing a free supply of current for it for five years.

Fig. 1 shows the situation: the 220 kV line runs more or less parallel to the row of houses at a distance 90–120 m, and a 110 kv line runs at a distance of only 45 m and then bends and crosses above the houses. The interference probably originates chiefly in the first line and is distributed by the second. Preliminary tests with a sensitive frame receiver showed that at 100 m the interference vanished when the frame was turned at right angles to the line: indicating that a magnetic field due to the interference currents in the line was involved. The arrangement of the communal aerial (100 m from the line), screened overhead transmission-line (80 m long, with matching transformer), and amplifiers is shown: the probably better plan of using a buried transmission line was deliberately avoided because the intervening ground consisted partly of gardens. The earthing system is described at the end of p. 6. Various types of aerial were tried (Fig. 5), to find which gave the best signal/noise ratio and which the largest possible useful voltage (in view of the large number of small receivers involved, a subscriber voltage of at least a few millivolts was needed). A comparison was also made with a roof aerial on one of the most favourably situated houses ("Dachant." in the tables in r-h column of p. 8), and the finally adopted type of communal aerial was found to give, in comparison with this, not only twice or three times the useful voltage but also a signal/noise ratio twice or three times as large. This final choice of aerial was type 6, described as "a loop aerial, formed from the L-aerial of type 4 by extending it to make a loop of 20 × 4 metres," type 4 being given as "an L-aerial of about 20 m length, 10 m above ground, perpendicular to the high-voltage line, with about 4 m of unscreened lead and a screened lead (with transformer) running about 6 m above ground." In districts where the Deutschlandsender signals are very strong, the ordinary rod aerial, with its constructional advantages, may be preferable, the long-wave advantages of the bigger aerial being no longer required.

VALVES AND THERMIONICS

2582. Ballistic Models of Velocity-Modulated Transit-Time Devices.—Hollmann. (*See* 2544.)

2583. Correspondence on "Velocity-Modulated Beams."—Kompfner: Strachey: Tombs. (*See* 2545/2547.)

2584. Klystrons at Stanford University [Photographs only].—(*Electronics*, Jan. 1940, Vol. 13, No. 1, p. 25.)

2585. The Acceleration of Charged Particles in the Electromagnetic Alternating-Current Field [in Magnetrons].—Seibert. (*See* 2543.)

2586. Bolometers for Measurements in Magnetron Investigations.—Klumb. (*See* 2679.)

2587. Use of Loktal Valves in Ultra-Short-Wave Converters.—Goodman. (*See* 2563.)

2588. Ultra - High - Frequency Transmitting Triode, Hytron 75 [16 Watts Output at 224 Mc/s].—(*QST*, April 1940, Vol. 24, No. 4, p. 27.) Specially designed "for highly efficient operation at frequencies between 50 and 300 Mc/s."

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2589. The Periodic Extinction and Control of a Mercury-Vapour Arc by Grids in the Plasma [at Note and Radio Frequencies].—Wehner. (*See* 2548.)

2590. High-Power Dual-Unit Transmitting Triode, Eimac 152TL [Advantages include Smallness, High-Power Output at Low Voltages (750 Watts at 2000 Volts), etc.].—(*QST*, April 1940, Vol. 24, No. 4, p. 27.) On the same lines, the 304TL contains 4 sets of triode elements.

2591. "D-157654"—a Megacycle Repeater [for Wide-Band Coaxial Circuits: Miniature Pentode with Control Grids of 200 Turns per Inch].—Western Electric. (*Electronics*, April 1940, Vol. 13, No. 4, pp. 30, 31.)

2592. A New Type of Vacuum Tube [Repeater Valve with Very Long Life: the Question of Application to Broadcast Receiver Valves].—Bell Laboratories. (*Science*, 5th April 1940, Vol. 91, Supp. p. 14.) Referred to in 2274 of June.

2593. Four Tiny Pentodes for Hearing Aids [1½" Long, ½" Diam.].—Raytheon. (*Communications*, March 1940, Vol. 20, No. 3, p. 35.)

2594. A Procedure for the Direct Measurement of the Secondary Electron Output from Insulators [primarily in Connection with the Development of Image-Converter Pick-Up Tubes].—W. Heimann & K. Geyer. (*E.N.T.*, Jan. 1940, Vol. 17, No. 1, pp. 1–5.)

Cf. Salow, 1881 of May. For the pick-up tube in connection with which the present work was carried out, and the conditions in which are approximately reproduced in the present dynamic measurement method, *see* 1947 of 1938.

The principle of the method is explained with the help of Figs. 1 & 2. The basic curve of secondary emission from an insulator (Fig. 1) shows that the line parallel to the voltage axis, at a distance of unity ($\delta = 1$) from this, cuts the curve at two points, corresponding to voltages V_1 and V_2. The point V_2 is first found, as follows: the primary electrons are given a velocity V'_2 definitely above V_2: the surface takes on the potential V_2, and between it and the anode a collecting voltage $V'_2 - V_2$ is formed. Starting from this condition, the negative potential of the cathode is momentarily reduced by an amount V_T such that the new potential $V'_1 = V'_2 - V_T < V_2$, with the result that, for an instant, more secondary electrons leave the surface than primary electrons reach it. These secondary electrons fly to the anode A and produce a current pulse yielding an oscillogram of the form shown in Fig. 3a, which is clearly distinguishable from the oscillogram (Fig. 3b) produced when V_T is too small to reduce the primary electron voltage below V_2. If therefore the trace is watched while the original voltage V'_2 (the text gives V_2, presumably by a misprint), or the momentary voltage V_T, is slowly varied till the form changes from "a" to "b," the point V_2, for which $\delta = 1$, is obtained. After this, other short-time changes in the primary-electron velocity are carried out, and from the observed secondary-electron pulses the output curve is plotted, since the pulses are directly proportional to the ratio of the number of excess secondary electrons to the number of primary electrons; that is, to

$$(I_s - I_p)/I_p, \text{ or } \delta - 1.$$

The basic measuring circuit is shown in Fig. 4 and discussed: the process requires the fulfilment of three conditions (p. 3, r-h column) which cannot be fulfilled with ordinary cathode-ray systems. The development of a special system is therefore described on p. 4; the design of the experimental tube is shown in Fig. 6. Some results are seen in Fig. 8, for mica, glass with a large alkali content, and electrolytically prepared aluminium oxide.

2595. Secondary Emission from Films of Silver on Platinum [Determination of Depth of Origin of Total Secondary Emission as Function of Primary Energy, and of Secondaries having Given Energy].—A. E. Hastings. (*Phys. Review*, 15th April 1940, Ser. 2, Vol. 57, No. 8, pp. 695–699.)

2596. Calculation of Transmission Coefficients [for Certain Potential Barriers by W.K.B. Method: Approximations Higher than the First] and Explanation of the Periodic Deviations from the Schottky Line [by Interference Effects in the Transmission Coefficient].—C. J. Mullin & E. Guth. (*Phys. Review*, 15th Feb. 1940, Ser. 2, Vol. 57, No. 4, p. 349: abstract only.)

2597. Temperature Variation of the Work Function of Cathodes with Non-Uniformly Emitting Surface.—B. Gysae & S. Wagener. (*Zeitschr. f. Physik*, No. 5/6, Vol. 115, 1940, pp. 296–308.)

Mean values of work function for non-uniformly emitting surface: distinction between "arithmetic mean" and "mean value determining the emission current." Discussion and comparison of methods of measuring these mean values. Comparison of results hitherto obtained with these methods. For previous papers by these workers *see* 4383 of 1938 and 154 of 1939.

2598. A Note on the Maintenance of Electron Emission in Cossor Valves after the L.T. Supply is Disconnected.—N. S. Pandya & P. D. Pathak: Narasimhaiya. (*Indian Journ. of Phys.*, Dec. 1939, Vol. 13, Part 6, pp. 409–410.)

A study of the phenomenon reported by Narasimhaiya (2291 of 1935). The latter explained the persistence by assuming that the filament was kept hot by the anode current through it, but "the filament coating is the same in all the Cossor valves tried . . . and hence there is no reason why some of them should behave differently. Further work is being carried on to investigate this in detail and also to study the same under dynamic conditions" and to correlate the phenomenon with circuit arrangements and filament temperatures.

2599. Applications of X-Ray Technique to Industrial Laboratory Problems [including Valve Filaments].—H. P. Rooksby. (*Journ. Roy. Soc. of Arts*, 16th Feb. 1940, Vol. 88, pp. 308–336: Discussion pp. 336–338.) From the G.E.C. laboratories.

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2600. DISCUSSION ON "PRESENT-DAY TECHNIQUE OF VACUUM APPARATUS FOR VERY HIGH VOLTAGES" [including Denier's Conclusions regarding Induced Currents from Mains in Ferroconcrete Buildings, and Their Effects on Nerves of Inhabitants].—M. Matricon. (*Bull. de la Soc. franç. des Élec.*, March 1940, Ser. 5, Vol. 10, No. 111, pp. 193–195.) *See* 3956 of 1939.

2601. VACUUM SEALS FOR METALLIC ION AND ELECTRON TUBES.—V. S. Mashkov. (*Journ. of Tech. Phys.* [in Russian], No. 22, Vol. 9, 1939, pp. 2052–2056.)

Preliminary information on an enamel which has been developed for use as a vacuum seal; it is an easily melting glass of complex chemical composition (sand, quartz, various felspars, and clays). The constituent parts melt together at 1200–1300°C, and when cooled down the enamel becomes a hard opaque glass. The main properties vary within wide limits, depending on its composition, as follows: specific gravity 2.0–2.5; tensile strength 3–8 kg/mm^2; compression strength 60–125 kg/mm^2; modulus of elasticity 5900–10000 kg/mm^2; hardness (Mohs' scale) 5–7; specific heat 0.20–0.30 cal.; coefficient of expansion $270–380 \times 10^{-7}$. To test the thermal endurance a sample was heated 10 times to a temperature of 400°C and rapidly cooled to − 10°C between each heating. This treatment did not affect the hermetic properties of the seal. The sealing process and some of the tests are described.

DIRECTIONAL WIRELESS

2602. RADIO DIRECTION-FINDING ON WAVELENGTHS BETWEEN 2 AND 3 METRES [Preliminary Investigation, with Ranges up to 30 Miles: Errors somewhat Larger than on 6–10 m Waves: Octantal Error produced by Wooden Hut, depending on Nature of Wood and Direction of Grain: etc.].—R. L. Smith-Rose & H. J. Hopkins. (*Electrician*, 12th April 1940, Vol. 124, p. 288: summary of I.E.E. paper.) Extension, to shorter wavelengths, of the work dealt with in 3969 of 1938.

2603. FOG-LANDING EQUIPMENT, BALL SYSTEM, USING INFRA-RED LIGHT AND TELEVISION SCANNING TECHNIQUE.—(*Génie Civil*, 20th April 1940, Vol. 116, No. 16, p. 270.) Using a new photocell sensitive to a 25 000 AU wavelength.

2604. DEVELOPMENT OF AIRCRAFT RADIO ANTENNAS.—R. McGuire & J. Delmonte. (*Communications*, March 1940, Vol. 20, No. 3, pp. 5–8 and 28.)

2605. THE DIFFRACTION OF RADIO RANGES BY HILLS.—Haseltine. (*See* 2522.)

2606. WIRELESS POSITION FINDING.—W. Runge. (*Telefunken-Hausmitteilungen*, Dec. 1939, Vol. 20, No. 82, pp. 7–8.) Introductory note to the two papers dealt with below.

2607. WIRELESS NAVIGATION IN AERONAUTICS [Survey, including Maps & Charts, Telefunken Apparatus, etc.].—A. Leib. (*Telefunken-Hausmitteilungen*, Dec. 1939, Vol. 20, No. 82, pp. 9–68.)

I—Navigation by bearings and instructions from the ground: the letter groups: blind landing by thd "Durchstoss" (cloud breaking-through) process or the "ZZ" system (latter effective even when obstacles penetrate into clouds: *see* also 3632 of 1938): sense-determination, interference, plotting and compensation of errors due to local re-radiators (quadrantal error, etc.): automatic correctors using templates: deviations, hill effects, etc: night effect and its reduction (pulse system with c-r-tube reception, and its usefulness where there is no room for Adcock aerials: the Adcock system: ultra-short-waves): the question of the reliability of long-range (*e.g.* up to 2500 km) d.f. from the ground: Telefunken ground d.f. apparatus. II—Navigation by observations taken on board the aircraft itself: aircraft d.f. and target-flight methods and apparatus: calibration and error correction: night and hill effects: the ground stations: fog-landing by the "breaking-through" procedure (*see* also I) and the Hegenberger system, when visibility is good up to at least 50 metres (Fig. 8): European ground organisation: Telefunken apparatus: rotating beacons: crossed-loop beacons: ultra-short-wave beacons and landing beams.

2608. ON THE TESTING OF THE RESIDUAL POLARISATION ERROR OF ADCOCK DIRECTION-FINDER INSTALLATIONS FOR LONG WAVES.—M. Wächtler & A. Gothe. (*Telefunken Hausmitteilungen*, Dec. 1939, Vol. 20, No. 82, pp. 69–75.)

On the assumption of a 1000 m wave, an earth conductivity of 10^{-13} between transmitter and d.f., and a loss-free reflection from an ionospheric layer at 100 km height, the electric field is calculated at a frame aerial receiving from an aeroplane with a trailing aerial at 80° to the vertical; the results are applied to the consideration of the bearing errors and the broadening of the minimum likely to occur, for various distances (under and at 35 km: over and greatly over 35 km) of the aeroplane. Actually the results are less bad than the calculated, showing that the reflection is not loss-free but has a factor at most between 20 and 50%. The elimination of the horizontally polarised component causing the trouble is only partially effected by the Adcock system as at present developed, owing to imperfect design and to local environment, and the old method of testing for residual errors by the statistical working-out of prolonged observations on distant stations is unsatisfactory because of the changing conditions in the ionosphere. Tests based on definite polarisation angle and angle of elevation (*e.g.* 45° each—"standard wave factor") cannot be considered as adequate. The circle-flight method is examined, and the conclusion reached that it can only give reliable results if simultaneous observations with a frame aerial are carried out on the polarisation of the incident field for all the directions. Even so, the method can only deal with a limited range of angles of elevation, whereas a ray returning from the ionosphere may have a

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very large angle. The behaviour of the installation to such very steep rays was therefore investigated with an aeroplane carrying an aerial stretched across a wing and flying to and from the d.f. system, thus providing angles of elevation ranging from 0° through 90° to 180°. Tests by this method (whose working out is described in pp. 74–75) on various Adcock installations showed no discrepancies between them up to angles of elevation of about 30°, but for larger angles discrepancies appeared which were reproducible and not due to observational error. The testing of an installation by the two methods combined is a lengthy business, but there would seem to be no satisfactory substitute. In any case they need improving, particularly in the way of introducing recording instead of aural observation; the cathode-ray device of Dieckmann & Berndörfer (*cf.* 551 of 1937) is suggested.

ACOUSTICS AND AUDIO-FREQUENCIES

2609. The Acoustical Impedance of an Infinite Hyperbolic Horn [Exact Solution possible without Assumption of Plane Waves: Low Frequencies favoured much more than by Conical Type: Ideal Shape approaches Uniform Tube near Throat].—J. E. Freehafer. (*Journ. Acous. Soc. Am.*, April 1940, Vol. 11, No. 4, pp. 467–476.)

2610. Acoustic Line Loudspeakers [Cabinet Resonance eliminated, and Efficiency at Low-Frequency End increased, by incorporation of "Shunt" Line in Cabinet].—W. D. Phelps. (*Electronics*, March 1940, Vol. 13, No. 3, pp. 30–32.) From the RCA Company.

2611. Vented Speaker Enclosure [Analysis, neglecting Second-Order Effects, of Loudspeaker in Lined Cabinet with Added Vents].—C. E. Hoekstra. (*Electronics*, March 1940, Vol. 13, No. 3, pp. 34 and 54, 56.) From the Magnavox Company.

2612. The Coaxial Loudspeaker [Dual Loudspeaker, with H.F. Unit "nesting" within Cone of L.F. Unit and protected against Damaging L.F. Amplitudes].—B. Olney. (*Electronics*, April 1940, Vol. 13, No. 4, pp. 32–35 and 106 . . 108.) With some comments on microphones and studio technique for highest fidelity.

2613. Production [and Testing] of the Modern Loudspeaker.—H. Golden. (*Communications*, March 1940, Vol. 20, No. 3, pp. 15–16 and 37.) The writer is Plant Manager, United Teletone Corp. (Cinaudagraph).

2614. An Improved Loudspeaking Telephone [Western Electric 750A, with Formed Metal Diaphragm and 4-Inch Driving Coil].—H. F. Hopkins. (*Bell Lab. Record*, April 1940, Vol. 18, No. 8, pp. 251–254.)

2615. A New "Conference" Equipment with Loudspeaking Telephone without Valve Amplifier.—Hettwig & Pfeiffer. (*E.T.Z.*, 29th Feb. 1940, Vol. 61, No. 9, pp. 207–209.)

2616. "Heavy" Rochelle Salt: Dielectric Investigations on $KNaC_4 H_2 D_2 O_6 . 4D_2O$ Crystals.—J. Hablützel. (*Helvetica Phys. Acta*, Fasc. 6, Vol. 12, 1939, pp. 489–510: in German.)

2617. Graphical Determination of the Random Efficiency [" Directional Efficiency "] of Microphones [Direct Determination from Polar Response Pattern plotted on Special Coordinate Paper: Possible Extension of Method to Measurement of Total Power radiated by Loudspeakers, etc.].—B. Baumzweiger. (*Journ. Acous. Soc. Am.*, April 1940, Vol. 11, No. 4, pp. 477–479.)

2618. The Western Electric "Multimike" Microphone with Bi-Directional, Non-Directional, Cardioid, and Three Hyper-Cardioid Patterns by Selector Switch.—(*Communications*, April 1940, Vol. 20, No. 4, p. 22.)

2619. 1940 Sound [P.A. Equipments in Trailer Church, Private Motor-Cars: Paging System at Airport: etc.]—S. G. Taylor. (*Communications*, April 1940, Vol. 20, No. 4, pp. 17–18 and 36.)

2620. Improvements in Disc Records through Constant-Amplitude Recording.—A. W. Duffield. (*Communications*, March 1940, Vol. 20, No. 3, pp. 13–14 and 28.)

2621. A Light-Pattern Calibration Chart [for Determination of Frequency Response and Amplitude Distortion by Buckmann & Meyer Method].—A. J. Ebel. (*Communications*, April 1940, Vol. 20, No. 4, pp. 24–26.) *See* 1930 Abstracts, p. 458.

2622. A Universal Audio Broadcast Amplifier [High-Fidelity 12 Watt Output: Six Alternative Input Channels: Push-Pull Stages throughout: Universal Output Circuit: Power Supply Unit with "Automatic Voltage Regulation."]—L. C. Sigmon. (*Communications*, April 1940, Vol. 20, No. 4, pp. 14–16 and 37 . . 40.)

2623. Selective Amplification in Hearing Aids.—N. A. Watson & V. O. Knudsen. (*Journ. Acous. Soc. Am.*, April 1940, Vol. 11, No. 4, pp. 406–419.)

2624. Studies of Acquired and Inherited Deafness in Animals.—M. H. Lurie. (*Journ. Acous. Soc. Am.*, April 1940, Vol. 11, No. 4, pp. 420–426.)

" It may be more important from the human standpoint to develop more noise-preventing apparatus rather than more sound apparatus to irritate and destroy the delicate hair cells of our already over-stimulated organ of Corti."

2625. The Locus of Distortion in the Ear [Distortion is Insignificant in Middle Ear: Seat of Origin is beyond the Stapes, perhaps in Hair Cells of Organ of Corti].—Wever, Bray, & Lawrence. (*Journ. Acous. Soc. Am.*, April 1940, Vol. 11, No. 4, pp. 427–433.)

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2626. The Instability of Linear and Non-Linear Oscillations ("Mitnahme"—Pull-In—Oscillations).—W. Wenke. (*Hochf:tech. u. Elek:akus.*, March 1940, Vol. 55, No. 3, pp. 94–101: to be contd.)

The factors governing the oscillation of a point mass are its mass, stiffness, and damping. If these quantities are constant, the mass can oscillate undamped only with frequencies excited by external forces: its own natural oscillation decays exponentially. But if the stiffness or one of the other factors varies periodically with the time t, additional frequencies appear in the so-called "variation oscillations"; so that as soon as one coefficient in the differential equation for the free damped oscillation depends on x or t, side by side with the externally excited frequencies there appear additional frequencies whose amplitude, however, is a single-valued continuous function of the applied forces. If the stiffness, for instance, varies periodically with an angular frequency $2p$, the point mass can oscillate with continuously increasing amplitude if its natural frequency is half as large ($\omega_0 = p$). The classical example is the Melde string experiment; also, the Savart toothed wheel may give lower angular frequencies p/n (where $n = 1, 2, 3 \ldots$) if $p/2\pi$ is the number of teeth passing per second. The ratio between the exciting and the new frequencies is integral, as in harmonics, and this has led to the name "sub-harmonic." Since, however, "the following investigations show that not only integral ratios of p/ω_0 occur, and that the phenomena belong to a far more general class and have characteristics quite different from those of harmonics, they are more usefully classified, in accordance with their nature, as 'mitnahme' oscillations." Isolated investigations of such lower frequencies than the exciting frequency, as encountered in mechanics, acoustics, and electricity, have failed to establish their connection with one another, and the approximations used on account of the mathematical complexities have occasionally led to erroneous conclusions. "The present work will show quite generally when a damped system can be excited in its own frequency by a force with other and higher frequencies. Thereby a clear explanation will be provided of the 'mitnahme' phenomena already frequently employed for frequency division. Finally the relation between 'combination' and 'variation' oscillations will be discussed."

The present instalment covers Part 1, on linear oscillations with stiffness, mass, or damping varying with time: its three sections deal first with experimental investigations on the horizontal pendulum of Figs. 1 & 2 and the electrical model whose principle is shown in Fig. 5 and whose complete circuit is that of Fig. 6; then with a discussion of the relevant literature, such as the papers of Melde, Rayleigh, Raman, den Hartog, Winter-Gunther, Erdélyi, Strutt, & others, concerning acoustical, mechanical and electrical forms of the phenomenon, including "son rauque"—"subharmonics"—in loudspeakers (*see* Pedersen, 3479 of 1935 and back reference) and frequency division by valves (Schlicke, 1366 of April); and finally with the writer's own theoretical treatment. Of this, the writer says:—"The 'mitnahme' phenomena are generally explained by the Hill equation; this however is quite inadequate, since it covers only the frequency step-down of 1 : 2. Actually much greater step-downs occur. Moreover, the approximate calculations are by no means physically clear, a lack which will be to some extent remedied in the following section."

2627. The "Picture of Reflections" and Reverberation in Open Spaces.—G. A. Chigrinski. (*Journ. of Tech. Phys.* [in Russian], No. 16, Vol. 9, 1939, pp. 1484–1498.)

For previous work *see* 1081 of March. The estimation of reverberation by the "Method of Reflections" is applied to the cases of a closed parallelepiped and of partly open spaces, *e.g.* tunnels, streets, open-air staging, etc.

2628. Electroacoustic Sound-Pressure Measurements in Practice [Short Survey of Methods in Pressure Chamber, Rooms, & the Open Air].—Gosewinkel & Spandöck. (*Arch. f. Technisches Messen*, Feb. 1940, No. 104, double pp. T19–T20.) With 37 literature references.

2629. The Absorption of Sound by Systems with Double Resonance.—V. S. Nesterov. (*Journ. of Tech. Phys.* [in Russian], No. 19, Vol. 9, 1939, pp. 1727–1739.)

A theoretical discussion is presented on sound-absorbing systems consisting of two parallel perforated sheets (of metal, wood, or other material) spaced apart and away from the sound-reflecting wall, and covered with friction-producing material (gauze, cloth, etc.). A formula (4) is derived for determining the absorption coefficient α, from which the necessary conditions are established for making α close to unity; methods are indicated for calculating the active and reactive components of the system impedance. Diagrams are drawn showing the variation of α with the frequency and the parameters of the system. On the basis of this discussion a sound-absorbing system having predetermined characteristics can be designed completely. Experiments were also carried out and the results obtained are discussed.

2630. Sound Diffraction and Absorption by a Strip of Absorbing Material [Exact Solution for Panel set in Surface of Large, Rigid, Plane Wall: the "Shape Factor"].—J. R. Pellam. (*Journ. Acous. Soc. Am.*, April 1940, Vol. 11, No. 4, pp. 396–400.)

2631. On Sound Propagation at Grazing Incidence to Porous Materials.—K. Schuster. (*Journ. Acous. Soc. Am.*, April 1940, Vol. 11, No. 4, pp. 489–490.) Long summary of the German paper dealt with in 674 of February.

2632. An Experimental Investigation of Sound Damping in Ventilation Shafts.—A. I. Belov & N. D. Fainstein. (*Journ. of Tech. Phys.* [in Russian], No. 16, Vol. 9, 1939, pp. 1499–1509.)

Experiments with various methods of sound damping have shown that the value of damping per unit length of the shaft can be determined from formula (1) in terms of the "effective damping coefficient" α_0 of the material used. This co-

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efficient somewhat exceeds the real coefficient α; an approximate formula (8) determining the relationship is derived.

2633. The Attenuation of Sound in Tubes [Analysis covering High as well as Low Frequencies: Experimental Confirmation of First-Approximation Formulae for Attenuation Coefficients].—R. Rogers. (*Journ. Acous. Soc. Am.*, April 1940, Vol. 11, No. 4, pp. 480–484.)

2634. Errata: On the Theory of Fluctuations in the Decay of Sound [in a Room].—R. C. Jones. (*Journ. Acous. Soc. Am.*, April 1940, Vol. 11, No. 4, p. 485.) *See* 1467 of April.

2635. Some Practical Aspects of Architectural Acoustics, *and* Planning Functionally for Good Acoustics.—V. O. Knudsen: J. P. Maxfield & C. C. Potwin. (*Journ. Acous. Soc. Am.*, April 1940, Vol. 11, No. 4, pp. 383–389: pp. 390–395.)

2636. Measurement of Impact Sound Transmission through Floors.—R. Lindahl & H. J. Sabine. (*Journ. Acous. Soc. Am.*, April 1940, Vol. 11, No. 4, pp. 401–405.)

2637. On the Perception of Vibrations.—G. von Békésy. (*Journ. Acous. Soc. Am.*, April 1940, Vol. 11, No. 4, pp. 487–489.) Long summary of the German paper dealt with in 661 of February.

2638. High-Pitched Noises have Greater Depressing Effect than Lower-Pitched Ones of Equal Volume.—Van Liere & others. (*Science*, 5th April 1940, Vol. 91, Supp. p. 14: paragraph only.)

2639. The Limitation of Transformer Noise [and the Importance of Magnetostriction Effects].—Churcher & King. (*Electrician*, 5th April 1940, Vol. 124, p. 262: summary of I.E.E. paper.) *Cf.* Norris, 2041 of May. The paper is being reproduced in full in *Metropolitan-Vickers Gazette* (first instalment in May issue, pp. 403–408).

2640. The Industrial Stethoscope [Recording Frequency Analyser for diagnosing Condition of Running Machinery].—(*Scient. American*, Feb. 1940, Vol. 162, No. 2, pp. 100–101.)

2641. Tuning-Fork Stabilisation.—Norrman. (*See* 2690.)

2642. Construction and Properties of a Variable Acoustic Resistance Standard [for "Bridge"-Method Measurements of Absorption, etc.].—K. Schuster & W. Stöhr. (*Journ. Acous. Soc. Am.*, April 1940, Vol. 11, No. 4, pp. 492–494.) Long summary of the German paper dealt with in 4523 of 1939.

2643. A Sensitive Current- and Voltage-Recorder for 50 to 10 000 c/s.—Grave. (*See* 2695.)

2644. Indicating Frequency-Measuring Instruments for Note-Frequency and High-Frequency Technique.—Lübeck. (*See* 2694.)

2645. A Crosstalk Reference Standard.—J. E. Nielsen. (*Bell Lab. Record*, April 1940, Vol. 18, No. 8, pp. 232–235.)

2646. Recent Experimental Investigations of Vocal Pitch in Speech [Male Voice: Effects of Specific Emotional States: Relation to Maximum Singing Range: etc.].—G. Fairbanks. (*Journ. Acous. Soc. Am.*, April 1940, Vol. 11, No. 4, pp. 457–466.)

2647. References to Contemporary Papers on Acoustics, and Indexes to Volume Eleven of the *Journal*.—(*Journ. Acous. Soc. Am.*, April 1940, Vol. 11, No. 4, pp. 494–511 and i–iii.)

2648. "Schall und Klang" [Text Book of Electroacoustics for Architects, Electrical Engineers, & Students: Book Review].—F. Bergtold. (*Hochf:tech. u. Elek:akus.*, Feb. 1940, Vol. 55, No. 2, p. 72.) For Engl's book on architectural acoustics *see* 4000 of 1939.

2649. The Development of an Optical Method of Measuring the Supersonic Absorption in Gases and Liquids, *and* Theory of Optical Measurement of Supersonic Absorption.—O. Petersen: E. David. (*Physik. Zeitschr.*, 15th Jan. 1940, Vol. 41, No. 2, pp. 29–36: pp. 37–41.)

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2650. Frequency Modulation in Television: I—F-M applied to a Television System: II—Interspersed F-M and A-M in a Television Signal.—C. W. Carnahan: A. V. Loughren. (*Electronics*, Feb. 1940, Vol. 13, No. 2, pp. 26 and 30–32: pp. 27–30.)

2651. The Evolution of Methods of Transmission by Wire [Telephony and Television].—van Mierlo. (*Bull. de la Soc. franç. des Élec.*, April 1940, Ser. 5, Vol. 10, No. 112, pp. 223–242.) For a longer paper on coaxial cables *see* 4545 of 1939.

2652. The Wide-Band Amplifier: III—High-Frequency Correction by Auxiliary Valves.—Pieplow. (*See* 2530.)

2653. Shunt Peaking Compensation [Graphical Method for Wide-Band Amplifiers].—W. H. Freeman. (*Electronics*, Jan. 1940, Vol. 13, No. 1, pp. 35–36.)

2654. The DuMont Proposals [for Changes in R.M.A. Standards].—DuMont. (*Electronics*, Feb. 1940, Vol. 13, No. 2, pp. 22–23 and 63, 64.) *See* also 2314 of June.

2655. The Business Side of Television [Data based on NBC's First Nine Months of Public Service, including Views gathered from Audiences].—N. E. Kersta. (*Electronics*, March 1940, Vol. 13, No. 3, pp. 10–13 and 90, 91.)

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2656. The Television Service of the German State Post Office.—A. Gehrts. (*E.T.Z.*, 21st March 1940, Vol. 61, No. 12, pp. 285–291.) With about 30 literature and patent references, practically all German. For a book with the same title *see* 1603 of 1939.

2657. Fundamentals of Television Engineering: Part VII & VIII—Television Receivers: Television Transmission.—F. A. Everest. (*Communications*, March & April 1940, Vol. 20, Nos. 3 & 4, pp. 22–24 and 29, 33, 39: pp. 19–21 and 36–37.) For previous parts *see* 695 of February.

2658. British Vision Receivers: II.—W. J. Brown. (*Electronics*, March 1940, Vol. 13, No. 3, pp. 26–29.) For I *see* 1494 of April.

2659. A Design for Living—with Television: a High-Voltage Power Supply with Complete Safety Features.—P. Rosenblatt. (*QST*, March 1940, Vol. 24, No. 3, pp. 44–47.)

"Unless an 'unconfined high-voltage' law is passed before television's mass debut, Johnny Public and Willie Ham are likely to view angelic images when the back cover comes off the receiver."

2660. Television Lighting: Part II.—W. C. Eddy. (*Communications*, March 1940, Vol. 20, No. 3, pp. 25–26 and 37..39.) For Part I *see* 4561 of 1939.

2661. A Visit to the General Electric Plant at Schenectady [particularly the Television Installation on the Helderbergs].—General Electric. (*QST*, March 1940, Vol. 24, No. 3, pp. 9–15 and 115, 116.) *See* also 2331 of 1939.

2662. Discussions on "The Problem of Synchronisation of Television Receivers" and "The Influence, on the Form of Television Signals, of the Conditions of Employment of the Equipment."—Mandel: Delvaux. (*Bull. de la Soc. franç. des Élec.*, March 1940, Ser. 5, Vol. 10, No. 111, pp. 179–181: pp. 181–183.)

See 3234 & 4036 of 1939. The first discussion deals particularly with the choice of diode detectors (desirability of low internal resistance: special design for this purpose: preference for hard valves) and thyratrons *versus* hard valves in relaxation oscillators (Strelkoff's hard-valve oscillator giving frequencies up to 4 millions per second, using a double valve). The second discussion includes, among other points, the ease with which the Barthélémy "internal dephasing" transmissions can be received on various standard receivers of different countries; the unsatisfactory condition, at present, of multiple interlacing; and the question whether the framing frequency should be equal to (or a multiple of) the mains frequency.

2663. Italian Television.—A. Castellani. (*Bull. de la Soc. franç. des Élec.*, March 1940, Ser. 5, Vol. 10, No. 111, pp. 174–179.) Summary, with Discussion, of the paper referred to in 1497 of April.

2664. Television at the Swiss National Exhibition, 1939 [Reasons for Choice of Cold-Cathode Dufour-Type Tube: the Special Screen (Zinc-Oxide Material, protected by Aluminium Foil, to suit Spectral Sensitivity of Antinomy Photocell): etc.].—J. J. Müller. (*Bull. de la Soc. franç. des Élec.*, March 1940, Ser. 5, Vol. 10, No. 111, pp. 187–192.)

2665. On the Application of Electric and Magnetic Fields in Electron-Optics [Television, Cathode-Ray Oscillographs, Image-Converters].—E. Brüche. (*T.F.T.*, Jan. 1940, Vol. 29, No. 1, pp. 1–5.)

Shortened version of an address at the Zurich Assembly of the International Physical and International Television Conferences. Table 1 shows the errors of glass, electrostatic, and magnetic lenses, and how far they can be corrected (section 2): section 3 discusses the choice of the type of lens for various purposes: sections 4 & 5 deal only with the electrostatic type, particularly the "two-pole" design in which the two poles of the voltage source are connected to the two elements of the lens, without the complications of potentiometers, etc.; the use of such lenses (by Iams, 1996 of 1939; by Johannson, 1934 Abstracts, p. 51; in Schaffernicht's image-converter, 1469 of 1937; in Boersch's shadow-microscope, 2710, below, and back reference; etc.) is discussed. As a general rule, the writer considers that in developmental work magnetic methods are useful but that they should be replaced in commercial models by electrostatic; there are, of course, exceptions to this rule.

2666. Astigmatism of Magnetic Lenses, *and* Image Error Investigations on a Magnetic Lens free from Image Rotation.—Becker & Wallraff. (*See* 2712 & 2713.)

2667. A Picture-Signal Generator: I [Beginning of Series giving Complete Design Data, etc., of Testing Generator giving Standard R.M.A. T-111 Video Signal].—M. P. Wilder & J. A. Brustman. (*Electronics*, April 1940, Vol. 13, No. 4, pp. 25–29.)

2668. A Procedure for the Direct Measurement of the Secondary Electron Output from Insulators [primarily in Connection with the Development of Image-Converter Pick-Up Tubes], *and* Secondary Emission from Films of Silver on Platinum.—Heimann & Geyer: Hastings. (*See* 2594 & 2595.)

2669. Discussion on "Television Transmitting Tubes [Mosaic-Type Pick-Ups]: Their Manufacture in France."—P. Tarbès. (*Bull. de la Soc. franç. des Élec.*, March 1940, Ser. 5, Vol. 10, No. 111, pp. 184–186.)

See 707 of February. The writer's curves of spectral sensitivity are different from the usual ones for photocells and from previously published iconoscope curves: but Barthélémy says that they agree well with his results with French, and foreign, iconoscopes, and mentions tests of his own which indicate that the extraction potential in the icono-

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scope is so low that sensitivity towards the red is considerably reduced. The rest of the discussion deals with "dark spots" and their formation by the irregular distribution of secondary electrons leaving the mosaic: the RCA "orthicon" and its attempt to avoid secondary emission by using a low-velocity scanning ray (Barthélémy says that the latest experiments have greatly improved the number of lines practicable with this pick-up, though "great difficulties remain in concentrating the spot").

2670. A Gas-Filled Photocell with Magnetic Deflection.—L. Goncharski. (*Journ. of Tech. Phys.* [in Russian], No. 16, Vol. 9, 1939, pp. 1455–1456.)

Owing to the ionisation of gas molecules, larger currents may be obtained in gas-filled photocells than in the vacuum type. In practice, however, this increase does not exceed 20 to 30 times, and moreover at voltages approaching the striking voltage the cathode is subjected to severe bombardment by positive ions which affects the photoelectric properties of the cell. In the present paper a preliminary description is given of a gas-filled photocell in which a uniform magnetic field is utilised for deflecting the liberated electrons and positive ions. A progressively increasing current displaced with regard to the illuminated area of the cathode is thus produced. It is stated that a considerable current amplification was obtained in this type of cell, but no exact data are given.

2671. The Effect of Metastable Atoms on the Inertia of Gas-Filled Photocells.—N. A. Penin. (*Journ. of Tech. Phys.* [in Russian], No. 19, Vol. 9, 1939, pp. 1712–1718.)

The appearance of metastable atoms in the discharge of a gas-filled photocell, and their effect on the inertia of the photocell, are discussed and experiments are described with an Ag-K-S-K photocell filled with neon. The main conclusions reached are: (1) the presence of metastable atoms affects considerably the inertia of the cell; (2) the addition of argon (in order to reduce the life of the metastable atoms) increases the inertia at high frequencies (of the order of 10 kc/s) and decreases it at medium and low frequencies; (3) an increase in the voltage applied to the cell increases the inertia; and (4) an increase in the distance between the electrodes reduces the inertia.

2672. The Antimony-Caesium Photocathode.—S. S. Prilezhaev. (*Journ. of Tech. Phys.* [in Russian], No. 16, Vol. 9, 1939, pp. 1439–1454.)

A detailed report on an experimental investigation mainly concerned with the effect of temperature and of caesium vapour-pressure on the sensitivity of an antimony-caesium cell which is in a state of equilibrium with the saturated caesium vapour. The experiments are described and the information obtained is given under the following headings: (a) spectral sensitivity, (b) output energy of electrons, (c) energy-distribution of electrons, (d) variation of caesium vapour-pressure, (e) the effect of diminishing this pressure practically to zero, (f) thermionic emission, and (g) resistance of the photosensitive layer. A theoretical interpretation of the results obtained is given.

2673. On the Mechanism of the Photoeffect in Antimony-Caesium Photocells.—S. Yu. Luk'anov, N. N. Lusheva, & I. S. Mazover. (*Journ. of Tech. Phys.* [in Russian], No. 20, Vol. 9, 1939, pp. 1808–1811.)

In certain types of antimony-caesium vacuum photocells the photocurrent does not reach saturation with increase of anode voltage but continues to rise approximately linearly. Lukirski & Lusheva (1079 of 1938) have suggested that this effect is due to the surface resistance of the photosensitive layer, which causes a considerable potential variation along the layer surface. Owing to this, some of the liberated electrons, instead of reaching the anode, may fall back on the layer and cause secondary emission. The superposition of the secondary-emission current on the photocurrent would account for the effect under consideration. On the other hand, Khlebnikov and Zaitsev have suggested (609 of Feb. and 1112 of March) that the effect is due to an inner photoeffect, *i.e.* to a change in the conductivity of the layer under illumination. The present paper reports on experiments confirming the former point of view.

2674. The Effect of Sulphur on the Photosensitivity of the BiCs–Cs Cathodes, *and* The Effect of Oxygen on the Photosensitivity of the BiCs–Cs Cathodes.—G. A. Morozov. (*Journ. of Tech. Phys.* [in Russian], No. 22, Vol. 9, 1939, pp. 2012–2017: pp. 2018–2022.)

Numerous experiments were carried out with a view to raising the sensitivity of the BiCs–Cs cathodes. In the first paper the preparation of these cathodes is described and conditions are established under which the addition of sulphur (a) increases, and (b) decreases, the sensitivity of the cathode. Under the optimum conditions, and using an incandescent lamp at a temperature of 2500°K, an increase in the sensitivity from approximately 10 μA/lm to 20 μA/lm was obtained, while at the same time the spectral characteristic of the cathode remained unchanged.

In the second paper it is shown that the oxidation of the Bi layer should precede the addition of the caesium. Using this method, cathodes having a sensitivity of 30 μA/lm were obtained. Spectral characteristics of the BiCs–BiO–Cs cathodes are plotted, and the conclusion reached is that this type of cathode compares favourably with the SbCs–Cs, the Ag–Cs_2O, Cs, and the Ag–Cs types. A theoretical interpretation of the experimental results is also given.

2675. The Relationship between the Conductivity and the Emission Characteristics of Caesium-Oxide Photocathodes.—P. Borzyak. (*Journ. of Tech. Phys.* [in Russian], No. 22, Vol. 9, 1939, pp. 2032–2043.)

A report is presented on an experimental investigation of the type [M]–Cs_2O, Cs–Cs cathodes (de Boer notation). Measurements were made of the electro-conductivity of the working layer, photosensitivity, secondary emission, and thermoelectron emission. The results obtained are discussed in

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detail and the following main conclusions are reached: (1) The conductivity of the layer is sufficient for compensating the electrons drawn by the anode: this seems to be in contradiction with the conception of the fatigue of caesium-oxide cathodes developed by de Boer. (2) The variation of secondary emission does not follow the variation of caesium concentration in the oxide layer. It is therefore incorrect to assume that caesium serves as a source of supply of secondary electrons.

2676. ON THE CONTACT POTENTIAL DIFFERENCE BETWEEN SILVER AND OXYGEN-CAESIUM SURFACES.—Yu. M. Kushnir, E. A. Veinrib, & V. P. Goncharov. (*Journ. of Tech. Phys.* [in Russian], No. 22, Vol. 9, 1939, pp. 2044–2047.) Determined experimentally by a photoelectric method under conditions corresponding to secondary emission and photoeffect, a value of 2.5–3 v was found.

2677. FILTERS FOR ADJUSTING THE SPECTRAL SENSITIVITY OF A SELENIUM PHOTOCELL TO THE SENSITIVITY CURVE OF THE HUMAN EYE.—R. Fridland. (*Journ. of Tech. Phys.* [in Russian], No. 21, Vol. 9, 1939, pp. 1952–1959.)

2678. FOG-LANDING EQUIPMENT, BALL SYSTEM, USING INFRA-RED LIGHT AND TELEVISION SCANNING TECHNIQUE.—(*Génie Civil*, 20th April 1940, Vol. 116, No. 16, p. 270.) Using a new photocell sensitive to a 25 000 AU wavelength.

MEASUREMENTS AND STANDARDS

2679. BOLOMETERS FOR SHORT ELECTRIC WAVES [Micro-Waves: Comparable with Crystal Detector in Sensitivity].—H. Klumb. (*Zeitschr. f. tech. Phys.*, No. 3, Vol. 21, 1940, pp. 71–75.)

The need for a highly sensitive measuring instrument which should be as insensitive as possible to mechanical and thermal disturbances, and above all capable of standing sudden overloads, arose in investigations on magnetron oscillators (8–200 mm wavelengths: *cf.* also 2680, below), and the bolometers here described were developed for this purpose by the application, to the design of bolometers for current measuring, of the results of workers in the field of bolometric measurement of optical radiations. The writer deals first with the reasons for his choice of tungsten wires for the filament, in spite of the claims of the higher-resistance tantalum and molybdenum. The general lines followed are indicated in the description of the single-filament bolometer (Figs. 1 & 2): the straight 7 mm filament, of 10μ wire, is stretched as a bridge across a parallel-wire system which proceeds through the container wall in one direction (h.f. leads) and in the other is capacitively short-circuited and choked (double-spiral of molybdenum in glass) before leaving the container, to act as connections to the d.c. measuring circuit. The container may be evacuated or (to increase the admissible load) filled with pure nitrogen at 5–50 mm pressure, at which the thermal conductivity of the gas has reached its full value while convection effects are still low: the load can be increased still further by the use of oxygen. On the other hand, the indicating sensitivity can be increased (*e.g.* trebled) by having the filament spiral instead of straight, thus increasing its possible length.

Increased sensitivity is also the property of the two-wire type next described, for the two filaments are connected in opposite arms of the bridge circuit. The necessary good insulation between the filaments, combined with the leading-in of equal h.f. energies to each, is obtained by bringing the h.f. Lecher pair into the plane of symmetry between the two filaments (Fig. 3) and connecting them capacitively to the filament carriers by the special, rigid form of coupling condenser shown in Fig. 4. The two other arms of the bridge circuit can with advantage be formed from a second similar bolometer separated by distance from the first to prevent the entrance of high frequency. The two-wire bolometer has advantages over the single-wire type not only in sensitivity but also in its insensitivity to fluctuations of the ambient temperature. To eliminate these effects still further, the four-wire type shown in Fig. 7 was constructed so that all four arms of the bridge circuit might lie in one and the same container: this involved the design of a screening arrangement which, in the confined space of a bolometer bulb, would protect the two "d.c. only" elements from the intrusion of high frequencies over the whole of the wavelength range employed (actually about 20–150 mm). The "blocking plate" device seen in Fig. 6 (and in position in Fig. 7) was found to give from 95 to 98% protection at a wavelength of 100 mm, which was quite satisfactory for the purpose. "Such 'blocking plates' should be useful for many purposes in the micro-wave region."

Section III deals with the optimum working conditions and the sensitivity of a four-wire bolometer, compared with a tungsten/silicon detector, as a function of the filament current (table I): there is an optimum current value, giving a maximum relative sensitivity which (for a 65 mm wave) may be as great as 19. The best filament-temperature range, it is concluded from complementary measurements, is from 300° to 600°.

2680. QUESTIONS OF INTENSITY IN THE REGION OF VERY SHORT ELECTRIC WAVES [10 mm–0.1 mm].—Klumb. (*See* 2542.)

2681. THE MEASUREMENT OF THE TRANSMISSION CONSTANTS OF CONCENTRIC LINES IN THE DECIMETRIC-WAVE REGION [Method avoiding Defects of Previous Methods (Change of Length of Test Piece, Measurements over Range of Frequencies)].—H. Kaufmann. (*Hochf:tech. u. Elek:akus.*, Feb. 1940, Vol. 55, No. 2, pp. 37–42.)

The use, in this method, of a fixed frequency (*e.g.* 600 Mc/s) for plotting the resonance curve enables a potential indicator of high input impedance to be employed (2443 of 1939), and the influence of the open ends can be made harmless by the use of a terminating impedance and a special input line. The resonance curve is obtained by varying this terminating impedance, which takes the form of a

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short-circuited line whose admittance is varied by displacing the short circuit. The special input line (one wavelength long) is made with practically nothing but air as dielectric, so that the wavelength λ' in it is approximately equal to the wavelength λ in air; its attenuation, etc., can readily be calculated and checked by measurement (eqn. 13); but as it is made short, electrically, compared with the test piece it can, for a first approximation, be entirely neglected, since its potentials at the ends and the middle (where the potential indicator is attached) are nearly the same.

The well-known "half-value" resonance-curve procedure is followed: the variable terminating impedance is varied until the potential, and with it the value of the input impedance, fall to $1/\sqrt{2}$ times their maximum values. On the assumption that the input and terminating impedance are both of them free from loss ($\beta_0 = 0$, since these two lines are, for convenience, made with similar transmission equivalents and characteristic impedances) the required values can be obtained from equations 9 & 10. If, however, the cable under test is only a few metres long, the above simplifying assumption cannot be made and the various loss resistances of the circuit, including the input admittance of the potential indicator, must be taken into account (p. 39). A certain simplification is obtained by making the cable length equal to $\lambda/4$. The method was tested by measurements on air-dielectric coaxial-tube lines which lent themselves to calculation, and finally applied to two lengths of wide-band cable with styroflex insulation (table 1). Comparison with measurements at 1 Mc/s leads to the conclusions that even with 50 cm waves the styroflex is responsible for only about one seventh of the total attenuation.

2682. AN ANOMALY IN THE ELECTRICAL CONDUCTIVITY OF CONCENTRATED NaCl SOLUTIONS IN THE REGION OF DECIMETRIC WAVES.—N. N. Malov. (*Journ. of Tech. Phys.* [in Russian], No. 22, Vol. 9, 1939, pp. 2004–2011.)

In studying the electrical properties of liquid bodies, such as blood, which are of interest in biophysics, it has been observed that their conductivity decreases at wavelengths of the order of 65 cm. Control experiments with concentrated NaCl solutions have shown the same effect. This seems to be in contradiction with the statements made in general literature that the conductivity of an electrolyte does not vary at high frequencies, and accordingly a report is presented on the author's experiments with NaCl solutions. Drude and Coolidge methods of measuring conductivity were used, and their theory is discussed. The results obtained are shown in a number of curves.

2683. A VISUAL ALIGNMENT GENERATOR [for Alignment of R.F. and I.F. Circuits in Developmental Work on Receivers: Central Frequency variable from 0 to 60 Mc/s, Sweep Frequency from 0 to 1.1 Mc/s, without Moving Parts].—H. F. Mayer. (*Electronics*, April 1940, Vol. 13, No. 4, pp. 39–41.)

2684. THE JUDGMENT AND OBJECTIVE COMPARISON OF THE MEASURING EFFICIENCY OF CATHODE-RAY OSCILLOGRAPHS.—von Borries & Ruska. (*Arch. f. Elektrot.*, 15th March 1940, Vol. 34, No. 3, pp. 161–166.)

"The efficiency of a cathode-ray oscillograph as a measuring instrument is characterised by the recording velocity and the sensitivity of measurement. . . . The recording velocity together with the diameter of the recording spot gives a measure for the temporal resolving power of the oscillograph. The sensitivity of measurement together with the spot diameter gives a measure for the accuracy of reading of the measuring instrument. The requirement of high sensitivity of measurement is in fundamental contradiction to that of high recording velocity, so that the measuring efficiency can only be described by a combination of the two quantities. For one and the same cathode-ray tube, a different temporal resolving power is obtained according to the light intensity and the size of the photograph chosen for recording the image on the phosphorescent screen. It is proposed to refer the measuring efficiency of a cathode-ray oscillograph to a photograph on the scale 1/1 with a lens of aperture $1/F = 1/1$, in order to obtain comparable values. On the lines of this proposal, the measuring efficiencies of some recently-designed cathode-ray oscillographs are compared."

2685. ON THE GOLD-CHROMIUM RESISTANCE ALLOY FOR STANDARD RESISTANCES.—Schulze. (*Physik. Zeitschr.*, 15th March 1940, Vol. 41, No. 6, pp. 121–126.)

2686. ON TEMPERATURE-INDEPENDENT ELECTRICAL RESISTANCES [Compensation Methods for Specially Rigorous Requirements].—F. Hildebrandt. (*Zeitschr. f. tech. Phys.*, No. 3, Vol. 21, 1940, pp. 64–70.)

The development of gold/chromium alloys (*see*, for example, 2685, above) and of specially tempered manganin has allowed extremely small temperature coefficients of resistance to be attained. There are still, however, numerous cases in which compensation methods are necessary: thus in magnetic-field investigations with the help of bismuth spirals, the resistance change due to warming-up may be of the same order of magnitude as that due to the magnetic field; even more difficult is the case where a resistance thermometer is used to measure gas pressures at varying temperatures. The writer deals with various circuit arrangements for overcoming such difficulties, considering first the simple connection, in series, of two resistances with different, suitably chosen, coefficients, one positive and the other negative. The conditions (eqn. 1) for compensation are obtained: in certain cases it is desirable to provide an auxiliary current (eqn. 3) through the compensating resistance, when the severe limitations imposed by eqn. 1 are removed. Next considered is compensation by the Wheatstone bridge circuit ("the Thomson bridge has only a low sensitivity"), first without and then with the use of auxiliary current (which, however, can be made zero by a suitable design—*see* p. 68): the compensation of the bismuth spiral and the resistance thermometer, mentioned above, are taken as examples of

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the successful use of the latter arrangement (Figs. 6 & 7). The thermometer compensation requires the use of a special alloy "NBW 173" with a coefficient of about -4×10^{-5}.

So far, it has been assumed that the temperature coefficients of the materials considered are constant. Unfortunately this is not always so, a pronounced exception being manganin, whose coefficient not only varies but actually changes its sign. Compensation then means that a temperature-independent coefficient must somehow be converted into a temperature-dependent one, or that the temperature-dependence of a coefficient must be removed before the final compensation. In many cases this can be done by the paralleling of two wires (Fig. 8), which can sometimes be done very conveniently by depositing a coating of one metal on a wire of the other.

After a section on the compensation of other temperature-dependent factors, including the sensitivity of a bridge (compensated by a parallel resistance), the writer deals finally with the problem of the production of some definite temperature coefficient, sometimes of adjustable value. Such an arrangement may be required for eliminating, somewhere else, the effect of a variation of temperature: or it can be used to record, by an ink-writer, very small differences in temperature. A very sensitive instrument of this type, using bridge-circuit compensation, is the Siemens & Halske "Kompensograph," which with thermoelements gives a full-scale reading for about 100°, for about 10° in another arrangement using a resistance thermometer, and for about 2° when auxiliary currents are employed (Fig. 10). The elimination of these auxiliary currents by the use of two additional resistances leads to the "bridge within a bridge" circuit of Fig. 11. Tests of this arrangement showed that temperature variations of ± 1/100th degree Centigrade could be recorded with an ink-writer, and that that sensitivity could be doubled by exposing both the resistances, instead of only one, to the temperature variation.

2687. RADIO-FREQUENCY POWER MEASUREMENT [Direct Method, Independent of Frequency, using Diode Rectifier & Wattmeter: Theory & Practice].—P. M. Honnell. (*Electronics*, Jan. 1940, Vol. 13, No. 1, pp. 21–24.)

2688. THE "RHO-METER" AND ITS USE IN MEASURING POWER FACTORS OF VALVES, HOLDERS, CONDENSERS, ETC.—Bogle. (*See* 2529.)

2689. SHORT-WAVE INDUCTANCE CHART [giving Required Inductance with Highest Possible Q-Value, for Coils with Optimum Proportion $l = \frac{1}{2}d$].—F. C. Everett. (*Electronics*, March 1940, Vol. 13, No. 3, p. 33.) Based on Pollack's work, 497 of 1938.

2690. TUNING-FORK STABILISATION [Tempering: Improved Drive Circuit: Effects of Changes of Atmospheric Pressure, of Position, of Ageing].—E. Norrman. (*Electronics*, Jan. 1940, Vol. 13, No. 1, pp. 15–17.)

2691. WAVE PROPAGATION IN SHEARING QUARTZ OSCILLATORS OF HIGH FREQUENCY [Demonstration of Elastic Waves along X-Axis of Low Frequency/Temperature Coefficient Quartz Plate gives Experimental Verification of Theory of Edge Grinding].—E. W. Sanders. (*Journ. of Applied Phys.*, April 1940, Vol. 11, No. 4, pp. 299–300.)

2692. "HEAVY" ROCHELLE SALT: DIELECTRIC INVESTIGATIONS ON $KNaC_4H_2D_2O_6 \cdot 4D_2O$ CRYSTALS.—J. Hablützel. (*Helvetica Phys. Acta*, Fasc. 6, Vol. 12, 1939, pp. 489–510: in German.)

2693. INDICATING FREQUENCY-MEASURING INSTRUMENTS FOR NOTE-FREQUENCY AND HIGH-FREQUENCY TECHNIQUE.—Lübeck. (*E.T.Z.*, 7th March 1940, Vol. 61, No. 10, pp. 252–255.)

The AEG direct-reading meter for 10 c/s to 60 kc/s (extendable to 1 Mc/s) on the condenser-charge principle (*see* for example Wahl, 4062 of 1938): the AEG "compensation" meter (Kaden, 736 of February): the Grützmacher-Lottermoser "tone-pitch recorder" (for "melody curves": Sohn, 3201 of 1939): and the "tone-frequency spectrometer" for the simultaneous measurement of frequency and amplitude in the analysis of a mixed tone (or mixture of high-frequency components), using a cathode-ray oscillograph working from a special circuit containing a pentode (in the "sliding" connection—*see* Kettel's paper on automatic tuning correction, 1393 of 1938) to give, by its capacity variation, a periodic "wobble" frequency.

2694. INDICATING FREQUENCY METERS FOR HEAVY-CURRENT ENGINEERING [Ferrari-Disc and Phase-Jump Instruments for 49–51 c/s: Photoelectric Revolution Counter].—Lübeck. (*E.T.Z.*, 29th Feb. 1940, Vol. 61, No. 9, pp. 205–207.)

2695. A SENSITIVE CURRENT- AND VOLTAGE-RECORDER FOR 50 TO 10 000 c/s [Ink Recorder: Rotating-Coil Instrument with Copper-Oxide Rectifier].—H. F. Grave. (*Arch. f. Elektrot.*, 10th Feb. 1940, Vol. 34, No. 2, pp. 61–82.)

II—The frequency variation of normal rectifier-type instruments. III—The frequency variation of the present instrument, with rectifier cells arranged in Graetz circuit (Fig. 2a). Calculation of the frequency error. Derivation of the data required for the calculation. The frequency error for current rectification; Fig. 13, circuit for determining this error. The frequency error for voltage rectification; Fig. 16, circuit for determining this error. Compensation of the frequency error. Influence of the rectifier load on the frequency curve. IV—Further properties: effect of temperature, curve form; input impedance; scale division; insensitivity to overloads. V—Conclusions from the results of III concerning other types of rectifier instruments.

2696. A.C. BRIDGE FOR THE MEASUREMENT OF THE INTERNAL RESISTANCE AND INTERNAL CAPACITY OF DRY CELLS [on Open Circuit and on

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Load: Requirements of the Bridge Condensers: Correction Factors: Calculation of Working Range, Sensitivity, & Accuracy: Some Results].—W. Hübner. (*E.T.Z.*, 15th Feb. 1940, Vol. 61, No. 7, pp. 149–151.)

The marked frequency-dependence of R_i and $1/\omega C_i$ (Fig. 3) may be interpreted as indicating that the impedance of the battery must be represented not by a simple *RC* equivalent diagram but by a complex circuit whose elements possess frequency-dependent components.

2697. An Amplifier for D.C. Galvanometers.—A. W. Sear. (*Electronics*, Jan. 1940, Vol. 13, No. 1, pp. 28–29.) Combining with a portable instrument to give a sensitivity comparable with that of a d'Arsonval galvanometer.

2698. A Magnet System with Variable Astatic Arrangement.—J. Tagger. (*Physik. Zeitschr.*, 15th Dec. 1939, Vol. 40, No. 23/24, pp. 718–721.) It is suggested that such a system might raise the needle galvanometer to the level of the moving-coil instrument.

2699. Midget Meters for Special Purposes [Ammeters, 200 μA–3 A, Voltmeters 3–40 V: Diameter of Case only 26 mm, Weight about 30 gm].—Metrawatt A.G. (*E.T.Z.*, 7th March 1940, Vol. 61, No. 10, p. 261.)

SUBSIDIARY APPARATUS AND MATERIALS

2700. Ballistic Models of Velocity-Modulated Transit-Time Devices.—Hollmann. (*See* 2544.)

2701. The Acceleration of Charged Particles in the Electromagnetic Alternating-Current Field [in Magnetrons].—Seibert. (*See* 2543.)

2702. A Mechanical Model of the Cyclotron.—Jayaraman: Ward. (*Current Science*, Bangalore, March 1940, Vol. 9, No. 3, p. 154.) A "less exact analogue than Ward's model" [292 of January] but "the acceleration is greater and spectacular."

2703. The Judgment and Objective Comparison of the Measuring Efficiency of Cathode-Ray Oscillographs.—von Borries & Ruska. (*See* 2684.)

2704. A Multiple Oscillograph of High Recording Efficiency on the Pre-Anode Principle.—Thielen. (*Arch. f. Elektrot.*, 10th Jan. 1940, Vol. 34, No. 1, pp. 57–60.)

For previous work *see* 2021 of 1938 and 2918 of 1939 (for later work on a cold-cathode tube for very low voltages *see* 4642 of 1939). For Rogowski's pre-anode principle *see* Boekels & Dicks, 1933 Abstracts, p. 283. The suitability of this principle for multiple oscillographs is first discussed (§ 2); a two-ray oscillograph based on it is described in § 3 (schematic section Fig. 4). It is found that this oscillograph requires less auxiliary apparatus and is simpler to handle than other types of multiple oscillograph; a record of an oscillation of frequency 10^6 c/s with the time axis is shown.

2705. A High-Performance Oscillograph with a Sealed-Off Cathode-Ray Tube.—von Borries & Ruska. (*Arch. f. Elektrot.*, 10th Feb. 1940, Vol. 34, No. 2, pp. 106–114.)

Small commercial oscillographs will give recording speeds up to about 50 km/s, but electrical processes requiring higher speeds have hitherto involved the use of high-powered tubes connected to the pump. It is true, a footnote remarks, that attempts have recently been made to record very rapid processes with tubes using only 10 or 15 kv voltage (Whipple, in the I.E.E. Discussion referred to in 707 of 1939: Katz & Westendorf, 4098 of 1939); "but these were experimental tubes and not commercial apparatus"; a relevant paper by the present writers will shortly appear in the *Archiv*. The rapid development of television has led to high-performance tubes, but the best of these employ fully magnetic deflection which facilitates the problem but renders them unsuitable for measuring purposes.

The equipment now described, first shown on the Siemens & Halske stand at the March 1939 Leipzig Fair, attains the measuring performance of continuously evacuated tubes while having a transportable form. At 25 kv the tube gives a recording speed (external recording with camera and lens) of 8300 km/s with a trace thickness of 0.5 mm, or 4700 km/s with a thickness of 0.3 mm: the sensitivity is 0.034 mm/v. With the higher sensitivity of 0.1 mm/v (8.4 kv) the corresponding speeds are 550 and 330 km/s. Special Agfa emulsions and a specially efficient tube enable these figures to be surpassed: thus a speed of 6500 km/s was obtained with a trace thickness of 0.3 mm and a ray voltage of 17.5 kv.

The special precautions taken in the design and construction of the tube itself are described in section 2: thus "by special measures taken during the sealing-in of the cathode an extremely accurate coaxial mounting of the anode and cathode systems are obtained. At the position of the accelerating field the tube diameter reaches 45 mm, so that the necessary insulation path need not be obtained at the expense of lengthening the tube [the total length is 550 mm] . . ." After describing the various auxiliary units and the performance (as summarised above) the paper ends with the description of a demonstration oscillograph, made possible by the ray outputs thus obtained, for the projection of fairly slow non-recurrent processes (up to note frequencies) in large halls, with the brightness attained by large projecting receivers in television. In this case not only magnetic concentration is used (as in the first type) but also magnetic deflection.

2706. Cathode-Ray Tube with Bellows to Control Number of Air Molecules.—Westinghouse Company. (*Scient. American*, April 1940, Vol. 162, No. 4, p. 198.)

2707. Extended Possibilities of Application of the Cathode-Ray Oscillograph owing to New Accessories [Spot Brightness increased by Unit for applying Post-Acceleration, making possible the Use of Projection

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Lens for 1000 Viewers and increasing Good Photograph Recording Speed to 50 km/s: Drum Recording Unit: etc.].—A.E.G. (*E.T.Z.*, 15th Feb. 1940, Vol. 61, No. 7, Advert. p. 15.) Based on Bruchmann's paper, *AEG-Mitteilungen*, No. 11, 1939, pp. 471–473.

2708. A RECORDING SYSTEM DESIGNED FOR THE INVESTIGATION OF THE ELECTRICAL RELATIONS IN THE BRAINS OF SMALL ANIMALS [Equipment using Two C-R Oscillographs recording on Common Photographic Strip: Shielding of Components of Amplifiers, and Use of Symmetrical Circuits, eliminate Interference: No Phase or Frequency Distortion from 10–800 c/s and Little from 5–1500 c/s].—Woonton. (*Canadian Journ. of Res.*, April 1940, Vol. 18, No. 4, Sec. A., pp. 65–73.)

2709. A UNIVERSAL ELECTRON MICROSCOPE FOR USE WITH BRIGHT FIELDS, DARK FIELDS, AND STEREO-IMAGES.—von Ardenne. (*Zeitschr. f. Physik*, No. 5/6, Vol. 115, 1940, pp. 339–368.)

The instrument here described in detail was designed to have the highest possible resolving power, to work with either magnetic or electrostatic lenses as required, to enable an immediate change to be made from the photography of bright fields to that of dark fields, and to take electron-microscopical stereo-pictures. A section through the instrument is shown in Fig. 1, a photograph of the whole apparatus in Fig. 2; the versatility of the instrument is attained by designing it so that almost all the important components can be removed separately from the microscope when ready for use, most of them sideways from the tubular casing. For example, the magnetic lens systems can be exchanged for an electrode system of high-voltage electrostatic lenses; various objectives or projection lenses can be introduced into the electron beam path as required, etc. All stops can be centred or exchanged for others in a vacuum (4107 of 1939); this provides a quick change from bright-field to dark-field work. An auxiliary focusing arrangement is also provided (1667 of 1939). It is claimed that the instrument is completely insensitive to mechanical vibration, while the magnetic objectives have focal lengths between 1.6 and 0.9 mm. All sensitive parts of the electron beam are magnetically screened by an external permalloy screen (Fig. 3). Stereo-images are obtained by swinging the object from outside and adjusting its position so that two successive images of the same section of the object are obtained, which only differ by the slightly changed direction in which the electron beam passes through them (Fig. 14).

The beam-production system and condenser unit are described in detail; photographs of various separate parts of the instrument are given and described. A number of photographs taken under various experimental conditions are shown; it is claimed that a resolving power of 30 AU is attained with an electron beam passing through the object, a magnetic objective, and bright-field observation. On one picture reproduced (Fig. 23) particles of only 10 AU diameter are pointed out. For dark-field working, a resolving power of 50 AU was attained.

2710. NOTE ON "THE ELECTRON SHADOW MICROSCOPE: PART I" [and Its Exposure Time compared with That of the Raster Microscope].—Boersch: von Ardenne. (*Zeitschr. f. tech. Phys.*, No. 3, Vol. 21, 1940, p. 75.)

In a footnote to his paper (1571 of April) Boersch accused von Ardenne of saying (4106 of 1939) that the former's shadow microscope would require an exposure of several hours; von Ardenne, he says, has now written to him pointing out that this accusation was based on a misunderstanding, and has supplied data which indicate "that the exposure time in the shadow microscope is only about one order of magnitude smaller than in the raster microscope."

2711. ON THE APPLICATION OF ELECTRIC AND MAGNETIC FIELDS IN ELECTRON-OPTICS.—Brüche. (*See* 2665.)

2712. ASTIGMATISM OF MAGNETIC LENSES [Experimental Investigation of Astigmatic Electron-Optical Image Errors for Some Iron-Free Magnetic Lenses: Comparison with Theory: Connection between Astigmatism, Focal Length, and Lens Thickness: Experimental Determination of Seidel's Astigmatism Coefficient S_4].—Becker & Wallraff. (*Arch. f. Elektrot.*, 10th Jan. 1940, Vol. 34, No. 1, pp. 43–48.) For previous work *see* 279 of January, and Rogowski, 662 of 1938.

2713. IMAGE ERROR INVESTIGATIONS ON A MAGNETIC LENS FREE FROM IMAGE ROTATION.—Becker & Wallraff. (*Arch. f. Elektrot.*, 10th Feb. 1940, Vol. 34, No. 2, pp. 115–120.)

The ordinary magnetic lens has the property of producing not only refraction of the ray but also a rotation of the image field: it thus corresponds to an anisotropic medium in optics. The rotation can be through any angle, unlike that of optical and electrostatic lenses, where it is either zero or 180°. Busch's formula for the refracting power (eqn. 2) shows that the latter would be unaffected by the introduction of an opposing lens, so that by such a combination it should be possible to obtain a lens free from image rotation (*cf.* Boekels & Dicks, 1933 Abstracts, p. 283, and Stabenow, 306 of 1936) and thus to investigate, separately, the isotropic and anisotropic properties of magnetic lenses. In the present investigations an air-cored double coil was used, and preliminary tests (section 2a) showed that complete elimination of rotation could be obtained, but at the expense of an increase of about 6.2 times in the ampere-turns for the same optical relations (better conditions could no doubt be obtained by the use of iron-enclosed coils). In addition to this objection, the rotation-corrected lens was found to have considerably greater errors than the simple lens: thus its spherical aberration and image curvature were about twice as great. It is concluded that such a lens would therefore be used only when it is absolutely necessary to eliminate the rotation.

2714. PHOTOELECTRIC PROPERTIES OF DISINTEGRATED [by Alpha Rays] ZnSCu-PHOSPHORS.—Goos. (*Ann. der Physik*, Ser. 5, No. 1, Vol. 37, 1940, pp. 76–88.)

For previous work *see* 1148 of 1939. Here

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measurements are described on ZnSCu-phosphors with various radium contents, on radium-free ZnS, on phosphors impregnated with radium emanation, and on a zinc-blende crystal. Fundamental changes in the photoelectric properties are found, including the occurrence of a previously absent absorption in the long-wave region, in which two effects are distinguished, the *red effect* of the primary photoelectric current and the *extinction effect* (" Tilgungeffekt ") of the phosphorescence, which is measured by means of the parallel behaviour of the dielectric constant. These effects are analysed; it is found that the red effect is a phenomenon occurring in the basic crystalline material, independent of its phosphorescent properties, while the extinction effect represents a specific phosphorescent property and arises from an action on the luminous centres.

2715. Absorption Spectrum of Single-Crystal ZnS Phosphors [Curve of Relative Intensity of Light Transmitted as Function of Wavelength].—Brasefield. (*Phys. Review*, 15th Jan. 1940, Ser. 2, Vol. 57, No. 2, p. 162.)

2716. Luminescence of Pure Radium and Barium Compounds.—Kabakjian. (*Phys. Review*, 15th April 1940, Ser. 2, Vol. 57, No. 8, pp. 700–705.)

2717. On the Influence of Foreign Substances on the Absorption of Dyestuffs in Solution [with Reference to the Quenching of Fluorescence].—Mitra. (*Indian Journ. of Phys.*, Dec. 1939, Vol. 13, Part 6, pp. 397–405.)

2718. Vacuum Seals for Metallic Ion and Electron Tubes.—Mashkov. (*See* 2601.)

2719. Secondary Emission from Films of Silver on Platinum.—Hastings. (*See* 2595.)

2720. A Procedure for the Direct Measurement of the Secondary Electron Output from Insulators.—Heimann & Geyer. (*See* 2594.)

2721. Charge and Secondary Electron Emission.—Scherer. (*Arch. f. Elektrot.*, 15th March 1940, Vol. 34, No. 3, pp. 143–160.)

" The phenomena occurring when solid bodies are irradiated by electrons are first shortly described; these are the normal secondary-electron emission, when the body is at anode potential, and the charge arising at certain anode voltages, when the body is highly insulated. Known methods of measurement and results for the latter case are described. A new arrangement for charge measurement [using an electron indicator, which is deflected from the charge according to its magnitude and form] is given [Fig. 4] and its behaviour tested. It is used to investigate charge phenomena on conductors, insulators, and fluorescent materials. Photographs of charge on some screens for different types of electron irradiation are shown and described." Glass and mica are found to behave in the same way as conductors under electron irradiation. The magnitude of the charge on a metal plate is found to diminish when the insulation resistance of the plate is artificially decreased. The mode of preparation of a fluorescent screen is found to have an important effect on its behaviour. The writer finds that screens made by spraying fluorescent material on water-glass do not charge up for anode voltages under 20 000 v.

2722. A High-Gain D.C. Amplifier for Bioelectric Recording [Max. Voltage Amplification 6×10^6, with Noise Level less than 2 Microvolts over 5000 c/s Band].—Goldberg. (*Elec. Engineering*, Jan. 1940, Vol. 59, No. 1, Transactions pp. 60–64.)

2723. " Fortschritte der Chemie, Physik, und Technik der makromolekularen Stoffe " [Book Review].—Röhrs & others. (*E.T.Z.*, 15th Feb. 1940, Vol. 61, No. 7, p. 160.)

2724. The Triple Alliance in Electrical Insulation: a Review of Progress achieved by Combined Efforts of Physicists, Chemists, and Electrical Engineers.—Berberich. (*Elec. Engineering*, Jan. 1940, Vol. 59, No. 1, pp. 23–32.)

2725. Current Progress in Electrical-Insulation Research reflected at National Research Council Conference [Abstracts of Papers].—(*Elec. Engineering*, Jan. 1940, Vol. 59, No. 1, pp. 33–36.) *See* also next three abstracts, and 831 of Feb. & 1187 of March.

2726. Dielectric Properties of the Rutile Crystalline Modification of Titanium Dioxide.—Berberich & Bell. (*See* 2725, above: also *Phys. Review*, 15th Feb. 1940, Vol. 57, No. 4, pp. 350–351—summary only.)

Investigations on discs pressed from powdered crystals and then sintered. The dielectric constant rises at very low frequencies, probably owing to interfacial polarisation, with a uniformly high value of about 100 extending through the highest radio frequencies and falling off only in the infra-red. " A qualitative explanation of the high dielectric constant and negative temperature coefficient can be made in the light of published work on weakly ionic crystals . . ."

2727. The Use of Statistical Methods of Analysis in Insulation Research [particularly on Impregnated-Paper Insulation].—Egerton & McLean. (*See* 2725, above.)

2728. Further Progress with a New Optical Method for studying Electrical Discharges [Adaptation of Toepler's " Schlieren " Optical Arrangement].—Alexander. (*See* 2725, above.)

2729. Electrical Discharge on Liquid Surfaces [of Soap and Other Bubbles: Discharge Path follows Bubble Surface].—Snoddy, Henry, & Beams. (*Phys. Review*, 15th Feb. 1940, Ser. 2, Vol. 57, No. 4, p. 350: abstract only.) For previous work *see* 2692 of 1939.

2730. The Electric Strength of Solid Dielectrics in Relation to the Theory of Electronic Breakdown.—Austen & Whitehead. (*Proc. Roy. Soc.*, Ser. A, 10th April 1940, Vol. 175, No. 961, p. S21: abstract only.)

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2731. THE BEHAVIOUR OF POLAR MOLECULES IN SOLID PARAFFIN WAX.—Pelmore & Simons. (*Proc. Roy. Soc.*, Ser. A, 10th April 1940, Vol. 175, No. 961, pp. 253–254.) Results of experiments complementary to those of Sillars (1233 of 1939).

2732. "ALSIFILM," ARTIFICIAL MICA, OBTAINED FROM BENTONITE.—Hauser. (*Génie Civil*, 20th April 1940, Vol. 116, No. 16, p. 268.) *See* also 758 of 1939.

2733. PERMANENCE OF THE PHYSICAL PROPERTIES OF PLASTICS.—Delmonte. (*Engineering*, 26th April & 3rd May 1940, Vol. 149, pp. 447–448 & 456–457.)

2734. TABLES OF TYPE-CLASSIFIED GERMAN MOULDING MATERIALS, WITH MANUFACTURERS' NAMES, ETC.—(*E.T.Z.*, 14th, 21st, & 28th March 1940, Vol. 61, Nos. 11/13, pp. 282–284, 300–304, & 317–320.)

2735. THE DEVELOPMENT OF A PRE-STRESSED GLASS INSULATOR, *and* THE PERFORMANCE OF GLASS INSULATORS.—Hogg: E.R.A. (*Engineering*, 26th April 1940, Vol. 149, p. 449: p. 434: summaries of I.E.E. papers.)

2736. DIELECTRIC CONSTANT, POWER FACTOR, AND RESISTIVITY OF MARBLE.—Scott. (*Journ. of Res. of Nat. Bur. of Stds.*, March 1940, Vol. 24, No. 3, pp. 234–240.)

2737. INSULATING CONCRETES WITH HIGH INSULATING RESISTANCE AND HIGH DIELECTRIC STRENGTH.—Lambert. (*Bull. de la Soc. franç. des Élec.*, April 1940, Ser. 5, Vol. 10, No. 112, pp. 257–263.)

2738. DIELECTRIC LOSS IN ICE [Special Properties of Ice: Effect on H.F. Losses in Open-Wire Lines].—Murphy. (*See* 2846.)

2739. WIRES AND CABLES WITH VERY THIN FOIL INSULATION [of Hydrocellulose, Cellulose Triacetate, Polystyrol, Polyvinyl Chloride, etc: Improvement in Life, Resistance to Temperature, etc., & Electrical Properties, over Enamelled Wire: Wires with Single & Multi-Fold Wrappings: Applications: etc.].—Fischer. (*E.T.Z.*, 22nd Feb. 1940, Vol. 61, No. 8, pp. 163–165.)

2740. DISCUSSION ON "ELECTROCHEMICAL CONDENSERS" [particularly the Question of the Equivalent Resistance].—André. (*Bull. de la Soc. franç. des Élec.*, March 1940, Ser. 5, Vol. 10, No. 111, pp. 171–172.) *See* 4158 of 1939.

2741. MEASUREMENTS OF THE DIELECTRIC LOSSES OF CONDENSERS AND OTHER COMPONENTS OF RADIO CIRCUITS.—Bogle. (*See* 2529.)

2742. ON TEMPERATURE-INDEPENDENT ELECTRICAL RESISTANCES [Compensation Methods].—Hildebrandt. (*See* 2686.)

2743. ON THE GOLD-CHROMIUM RESISTANCE ALLOY FOR STANDARD RESISTANCES.—Schulze. (*Physik. Zeitschr.*, 15th March 1940, Vol. 41, No. 6, pp. 121–126.)

2744. THE DEVELOPMENT AND APPLICATIONS OF BERYLLIUM-COPPER AND BERYLLIUM-NICKEL ALLOYS.—Smith. (*Scient. American*, March 1940, Vol. 162, No. 3, pp. 142–144.)

2745. A NEW ALLOY OF MANGANESE AND COPPER [Strong as Steel, but absorbs Vibrations like Rubber: Low Thermal Conductivity].—Dean. (*Science*, 5th April 1940, Vol. 91, Supp. p. 12.)

2746. POLONIUM ALLOY FOR SPARK-PLUG ELECTRODES [gives Decrease of Apparent Breakdown Voltage].—Dillon. (*Journ. of Applied Phys.*, April 1940, Vol. 11, No. 4, pp. 291–299.)

2747. A THEORY OF SPARK DISCHARGE [Mechanism depending on Photo-Ionisation and Electron Multiplication in the Gas].—Meek. (*See* 2524.)

2748. INVESTIGATION OF PLASMA OSCILLATIONS IN SODIUM- AND MERCURY-VAPOUR LAMPS.—von Stengel. (*See* 2566.)

2749. THE PERIODIC EXTINCTION AND CONTROL OF A MERCURY-VAPOUR ARC BY GRIDS IN THE PLASMA [at Note and Radio Frequencies], *and* INFLUENCE OF A CONTROL GRID IN THE PLASMA ON A MERCURY-VAPOUR ARC.—Wehner: Fetz. (*See* 2548 & 2549.)

2750. HIGH-VOLTAGE RECTIFIERS FOR LABORATORY PURPOSES [Hot-Cathode Mercury-Vapour Tubes in Transportable Equipment].—Häder. (*E.T.Z.*, 7th March 1940, Vol. 61, No. 10, pp. 245–247.)

2751. THE "SPECIFIC QUALITY COEFFICIENT" OF COPPER-OXIDE RECTIFIERS.—Vitenberg. (*Journ. of Tech. Phys.* [in Russian], No. 21, Vol. 9, 1939, pp. 1945–1951.)

It is suggested that instead of the rectification coefficient, a "quality coefficient" should be used for denoting the working properties of a rectifier. This is defined as the ratio of the back resistance of the rectifier at 4 v per element to the forward resistance at a current density of 50 mA/cm². Experiments have shown that this coefficient depends considerably on the size of the rectifier, and in comparing rectifiers of different sizes it is therefore necessary to use specific coefficients.

2752. VALVE-CONTROLLED VOLTAGE AND FREQUENCY STABILISING EQUIPMENTS [for Commercial & Other Purposes: AEG Equipments].—Kelbe. (*E.T.Z.*, 29th Feb. 1940, Vol. 61, No. 9, pp. 209–210.)

2753. DRY BATTERIES WITHOUT DETERIORATION [Inactive Cells packed round Glass Vessel containing Activating Liquid, shattered by striking Bottom of Battery].—(*Scient. American*, April 1940, Vol. 162, No. 4, p. 230.)

2754. THE MANUFACTURE OF DRY BATTERIES.—Drotschmann. (*Zeitschr. V.D.I.*, 16th March 1940, Vol. 84, No. 11, pp. 181–189.)

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2755. A.C. BRIDGE FOR THE MEASUREMENT OF THE INTERNAL RESISTANCE AND INTERNAL CAPACITY OF DRY CELLS.—Hübner. (*See* 2696.)

2756. THE LIMITATION OF TRANSFORMER NOISE [and the Importance of Magnetostriction Effects].—Churcher & King. (*Electrician*, 5th April 1940, Vol. 124, p. 262: summary of I.E.E. paper.) *See* 2639, above.

2757. THE AMPLIFIER-CHOKE [Construction: Circuit: Magnetic Properties: Static Control Phenomena].—Reuss. (*Arch. f. Elektrot.*, 10th Dec. 1939, Vol. 33, No. 12, pp. 777–800.)

A choke with a mumetal core, controlling an alternating current flowing through a load; the control is effected by means of d.c. magnetisation. The amplifier effect produced depends on the fact that the power required for control is smaller than that used in the load circuit.

2758. TERNARY IRON-COBALT ALLOYS [Short Survey of German Work].—Köster: Geller. (*Metallurgist*, Supp. to *Engineer*, April 1940, pp. 104–105.)

2759. ON THE PERMALLOY PROBLEM [Explanation of the Very High Permeability in the (Atomically) Unordered Condition (Quick Cooling from 600° C) and the Lower Permeability in the Ordered Condition (Slow Cooling from Same Temperature or below)].—Schlechtweg. (*Physik. Zeitschr.*, 15th Jan. 1940, Vol. 41, No. 2, pp. 42–43.) Deductions from experimental work referred to in 4727 of 1939.

2760. THE SCREENING ACTION OF MULTI-LAYER SHIELDING COATS IN TELEPHONE CABLES.—Kaden & Sommer. (*E.N.T.*, Jan. 1940, Vol. 17, No. 1, pp. 6–16.)

Previous work (*e.g.* 1932 Abstracts, p. 654) has dealt with homogeneous screens, but "theoretical foundations for the calculation of compound screens [combinations of layers of iron with layers of copper or aluminium, giving a considerable economy in material] have hitherto been lacking." The present paper deals with thin cylindrical screens, but an appendix extends the treatment to cylindrical screens of arbitrary thickness, and the method is applicable also to spherical screens.

2761. INK-WRITERS OF THE HIGHEST SENSITIVITY WITH SELF-COMPENSATED AMPLIFIERS [Two Types of Air-Jet Bolometer Instruments and a Photoelectric Amplifier for Portable Ink-Writer].—Derigs & Voss. (*E.T.Z.*, 29th Feb. 1940, Vol. 61, No. 9, pp. 193–195.) *See* also Merz, 1999 of 1937 and 4532 of 1938.

2762. A RELAY-CHATTER METER [better than Oscillograph].—Cory. (*Bell Lab. Record*, April 1940, Vol. 18, No. 8, p. 254.)

2763. THE INTERVAL SELECTOR: A [Valve] DEVICE FOR STUDYING TIME DISTRIBUTION OF PULSES.—Roberts. (*Phys. Review*, 15th March 1940, Ser. 2, Vol. 57, No. 6, p. 564: abstract only.)

2764. NEW VACUUM TUBE SCALING CIRCUITS OF ARBITRARY INTEGRAL OR FRACTIONAL SCALING RATIO.—Lifschutz. (*Phys. Review*, 1st Feb. 1940, Ser. 2, Vol. 57, No. 3, pp. 243–244.)

STATIONS, DESIGN AND OPERATION

2765. FREQUENCY MODULATION: A REVOLUTION IN BROADCASTING?—Editorial. (*Electronics*, Jan. 1940, Vol. 13, No. 1, pp. 10–14.) "A survey of the facts, as well as of matters requiring further investigation." For comments, and the FCC Hearing, see *ibid.*, April 1940, pp. 13–16 and 74 . . 80.

2766. NARROW-BAND CARRIER TELEPHONY ["Information Carrying Capacity" increased by Scheme based on Steinberg's Linear Correlation between Speech Frequencies and Power].—Csepely. (*Electronics*, March 1940, Vol. 13, No. 3, pp. 14–17 and 88, 89.)

"Mr. Csepely provides only a single narrow band and juggles the signal spectrum so that the active frequencies—those existing at any given time—are pushed into that band. . . Although this scheme is theoretically sound, a number of quantitative assumptions have to be made to put it into practice . . ." (Warren Horton).

2767. THE SIEMENS-HELL PRINTER [Later Developments: Carbon Paper replaced by Ink Roller: Reduction of Lines from 12 to 7, with Consequent Reduction of Band Width: Direct-Current Working: etc.].—Berck. (*E.T.Z.*, 7th March 1940, Vol. 61, No. 10, pp. 237–240.)

2768. COMPRESSION WITH FEEDBACK [for Broadcasting Transmitters].—Stewart & Pollock. (*See* 2556.)

2769. DIFFERENTIAL MODULATION METER.—Gunsolley. (*Electronics*, Jan. 1940, Vol. 13, No. 1, pp. 18–20.)

2770. THE INFLUENCE OF WIRE BROADCASTING ON THE FORM AND TECHNIQUE OF TELEPHONE PLANT [Lines, Cables, & Station Equipment].—Waldow. (*E.T.Z.*, 21st March 1940, Vol. 61, No. 12, pp. 296–297: summary only.)

2771. THE CHILE CONFERENCE [Second Inter-American Radio Conference, Jan. 1940, and the Amateur Bands & Privileges].—Budlong. (*QST*, April 1940, Vol. 24, No. 4, pp. 20–22 and 39.)

2772. AUTOMATIC TIME SIGNALS [Simple Method].—Batteau. (*Communications*, April 1940, Vol. 20, No. 4, p. 29.)

2773. A BATTERY TRANSCEIVER FOR 112 Mc/s: COMPACT SELF-CONTAINED UNIT FOR FIELD WORK, *and* A 56-Mc/s CRYSTAL-CONTROLLED TRANSCEIVER: A COMPLETELY PORTABLE BATTERY-OPERATED STATION.—Chambers: Jacobs. (*QST*, April 1940, Vol. 24, No. 4, pp. 28–31: pp. 46–49.)

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GENERAL PHYSICAL ARTICLES

2774. Quantic Emission in Phase in the Region of Radioelectric Waves.—Jonescu. (*See* 2572.)

2775. The Radio-Frequency Spectra of Atoms [Hyperfine Structures of Ground States].—Kusch, Millman, & Rabi. (*Phys. Review*, 15th Feb. 1940, Ser. 2, Vol. 57, No. 4, p. 352: abstract only.) *See* also 2106 of May and 2776, below.

2776. An Electrical Quadrupole Moment of the Deuteron. The Radio-Frequency Spectra of HD and D_2 Molecules in a Magnetic Field.—Kellogg, Rabi, & others (*Phys. Review*, 15th April 1940, Ser. 2, Vol. 57, No. 8, pp. 677–695.) *See* also 2775, above.

2777. Remarks on an Analogy between the Schrödinger Differential Equation and a Wave Equation [for Inhomogeneous Media].—Matossi. (*Physik. Zeitschr.*, 15th Jan. 1940, Vol. 41, No. 2, pp. 47–52.)

Author's summary:—Prompted by a remark of Schrödinger, an additional term, introducing an analogy to the propagation of waves in an inhomogeneous medium, has been added to the Schrödinger differential equation. The working out of two examples (linear oscillator and Kepler motion) shows that the Schrödinger equation thus extended is not consistent with the observed results.

2778. Some Properties of Retarded and Advanced Potentials [in General Solution of Inhomogeneous Wave Equations for Charged Particle moving in External Field].—Podolsky & Kunz. (*Phys. Review*, 15th Feb. 1940, Ser. 2, Vol. 57, No. 4, pp. 349–350: abstract only.)

2779. Graphical Representation of Relations between *e*, *m*, and *h*.—Birge. (*Phys. Review*, 1st Feb. 1940, Ser. 2, Vol. 57, No. 3, p. 250: abstract only.)

2780. Thermal Ionisation of Barium [New Method for Experimental Study of Thermal Ionisation of Gases: Results agree with Theory].—Srivastava. (*Proc. Roy. Soc.*, Ser. A, 28th March 1940, Vol. 175, No. 960, pp. 26–36.)

2781. On the London-van der Waals Forces between Two Disc-Like Particles.—Dube & Dasgupta. (*Indian Journ. of Phys.*, Dec. 1939, Vol. 13, Part 6, pp. 411–417.)

2782. Electromagnetism: Some Observations on Fundamentals.—Howe: Cullwick. (*Electrician*, 26th April 1940, Vol. 124, pp. 323–325.) *See* 1261 of March.

MISCELLANEOUS

2783. The Poisson Integral and Its Applications to the Theory of Linear A.C. Networks.—Cauer. (*See* 2539.)

2784. Probable Error for Poisson Distributions [Probable Error and Probability that a Deviation should not exceed the Standard Deviation approach as Limits the Corresponding Values for Normal Distributions].—Rodgers. (*Phys. Review*, 15th April 1940, Ser. 2, Vol. 57, No. 8, pp. 735–737.)

2785. The Application of Matrix Calculation in Electrotechnics.—Strecker. (*See* 2540.)

2786. The Analysis of Symmetrical Vibrating Systems [using Methods of Laplacian Transformation and Matrix Algebra].—Pipes. (*Journ. of Applied Phys.*, April 1940, Vol. 11, No. 4, pp. 279–282.)

2787. Correspondence on the Damping-Coefficient Term of the Vibrational Equation.—(*Engineer*, 19th April 1940, Vol. 169, pp. 378–379.) Prompted by an Editorial in the issue for 5th April.

2788. A Method of Solving Second Order Simultaneous Linear Differential Equations using the Mallock Machine.—Wilkes. (*Proc. Camb. Phil. Soc.*, April 1940, Vol. 36, Part 2, pp. 204–208.)

2789. The Organisation of Scientific Research in France.—Longchambon. (*Génie Civil*, 20th April 1940, Vol. 116, No. 16, pp. 269–270: with Discussion.)

2790. "Bulletin analytique" of the Centre national de la Recherche scientifique (C.N.R.S.), Paris.—Service de Documentation du C.N.R.S.

Nos. 1/6 of Vol. 1 of this publication of the French Ministry of Education have been produced as a single issue (Jan./March 1940) of some 440 pages, Nos. 7/8 (April 1940) follows as an issue of about half that thickness, and in future the *Bulletin* will appear twice a month. Each number is divided into three parts, of which the first may be classified as physical and the second as chemical, while the third covers agriculture, biological chemistry, and physiology. It is naturally Part 1, with its sections ranging from "A: Mathematical Physics" and "B: Corpuscular Physics," to "F: Electricity, Magnetism" and "G: Astrophysics, Geophysics," which specially concerns the wireless engineer and research worker.

Taking the April issue (which contains several references to journals as recent as March) as a typical monthly output, Section F is found to give about 180 items, excluding the sub-sections dealing with power engineering; while Section G gives about 95 items, of which 11 are in the subsection "Atmosphere, Stratosphere, Ionosphere." Each item consists of the title of the paper, translated into French, with its journal reference and a summary varying from one to about fifty words; it is, in fact, roughly equivalent to one of the "extended titles" used in these "Abstracts & References" chiefly for papers in the English language. There are no long abstracts; indeed these could hardly be expected, in view of the enormous field included between cover and cover. But an inset headed "Microfilms" shows how

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these summaries may be employed to the full by subscribers to the *Bulletin*. By quoting the identification number of the item in which he is interested, the subscriber can obtain a microfilm of the original paper, "according to a very low tariff which will be fixed by special circulars." Further, by cutting out the item and mounting it on a filing card of suitable size, the reverse side of which carries a little pocket for the corresponding microfilm (cut into lengths each representing 7 or 10 pages of the original paper) "a complete and compact bibliography can be collected." The ordinary *Bulletin* is printed on both sides of the paper, but special duplicate sheets can be supplied regularly, on better paper, for cutting out in this way.

Other services which the C.N.R.S. offers, to writers of scientific papers and unpublished theses, are described in a second inset. At the present time these, and also the microfilm service, are limited to France and Great Britain, and their Empires.

2791. Efficiency in Documentation.—Bradford. (*Engineering*, 1st March 1940, Vol. 149, pp. 217–218.)

2792. Valve Circuit Conventions.—Bell: G.W.O.H. (*Wireless Engineer*, April 1940, Vol. 17, No. 199, p. 165.) Discussion on the editorial referred to in 2096 of May.

2793. "Production and Direction of Radio Programs" [Book Review].—Carlisle. (*Communications*, Feb. 1940, Vol. 20, No. 2, p. 44.)

2794. "High-Frequency Alternating Currents" [Book Review].—McIlwain & Brainerd. (*Wireless Engineer*, Jan. 1940, Vol. 17, No. 196, p. 20.) An American review was referred to in 3836 of 1939.

2795. "The Radio Amateur's Handbook, 1940" [Book Review].—A.R.R.L. Headquarters Staff. (*Wireless Engineer*, Feb. 1940, Vol. 17, No. 197, p. 64.)

2796. N.P.L. Research: Abstracts of Papers published during 1938 [Notice of Booklet]. —(*Wireless Engineer*, Feb. 1940, Vol. 17, No. 197, p. 64.)

2797. The Activities of the National Electrotechnical Institute "Galileo Ferraris" in the Fifth Year of Its Existence—1938/9.—Vallauri. (*La Ricerca Scient.*, Jan./Feb. 1940, Year 11, No. 1/2, pp. 4–44.)

2798. The Rôle of Science in the Electrical Industry.—Smith. (*Elec. Engineering*, Feb. 1940, Vol. 59, No. 2, pp. 63–67.)

2799. Progress in Engineering Knowledge during 1939.—Alger. (*Gen. Elec. Review*, Feb. 1940, Vol. 43, No. 2, pp. 60–88.)

2800. "VDE-Fachberichte 1938" [Book Review].—Verband Deutscher Elektrotechniker. (*E.N.T.*, Jan. 1940, Vol. 17, No. 1, p. 5.)

2801. Scientific Instruments and Apparatus.—(*Engineer*, 29th March 1940, Vol. 169, pp. 297–300.) First of a series of articles on material intended for the Physical Society's exhibition which did not take place.

2802. A Decade of Electronics: 1930–1940 [Résumé of Important Events].—Henney. (*Electronics*, April 1940, Vol. 13, No. 4, pp. 17–24.)

2803. Novelties in Radioelectric Construction in France [7th Exhibition of Component Parts, etc., Paris, 1940].—Adam. (*Génie Civil*, 30th March 1940, Vol. 116, No. 13, pp. 216–218.)

2804. The 16th Great German Broadcasting and Television Exhibition.—Fuchs. (*Hochf:tech. u. Elek:akus.*, Jan. 1940, Vol. 55, No. 1, pp. 1–9.)

2805. Patents—How to Write and Understand Them.—Goldsborough. (*Electronics*, Feb. 1940, Vol. 13, No. 2, pp. 10–13 and 46, 47.)

2806. The Use of the Air-Jet Bolometer [for Measurement & Control of Small Movements: Compensation Methods for Increased Reliability].—(*Zeitschr. V.D.I.*, 17th Feb. 1940, Vol. 84, No. 7, pp. 121–123.)

2807. Magnetic Strain Gauge for Aerial-Cable Sheath [for studying Daily Movements due to Temperature Changes, Vibratory Strain due to Wind, etc.].—(*Bell Lab. Record*, Feb. 1940, Vol. 18, No. 6, p. 181.)

2808. Vibration Stresses of Aeroplane Parts measured during Flight [using Graphite Strips cemented to the Parts].—Kearns. (*Sci. News Letter*, 3rd Feb. 1940, Vol. 37, No. 5, p. 73.) *Cf.* 1697 of April.

2809. Experimental Investigation of "Dry Friction" Forces [Application of Piezo-electric-Circuit Technique to Dynamic Method of Investigation].—Khaikin & others. (*Journ. of Phys.* [of USSR], No. 5/6, Vol. 1, 1939, pp. 455–564: in English.)

2810. Investigation of Knock in Internal-Combustion Engines, with Electro-acoustical Measuring Apparatus.—Schmidt & Generlich. (*Zeitschr. V.D.I.*, 20th Jan. 1940, Vol. 84, No. 3, p. 48: summary only.)

2811. Metropolitan-Vickers Capacity-Change Manograph for the Recording of Instantaneous Pressures.—Goodall. (*Génie Civil*, 6th April 1940, Vol. 116, No. 14, p. 235: summary only.)

2812. A Moisture Meter for Textile Materials. —Jones. (*Journ. of Scient. Instr.*, March 1940, Vol. 17, No. 3, pp. 55–62.) From the Shirley Institute.

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2813. An "Electric Ear" for the Control of the Feed to Mills [giving Optimum Output].—(*Zeitschr. V.D.I.*, 17th Feb. 1940, Vol. 84, No. 7, p. 110.)

2814. A Feedback Welding Timer [Half-Cycle Thyratron Timer for Small-Parts Welding].—Kurtz. (*Electronics*, April 1940, Vol. 13, No. 4, p. 47.) *Cf.* 2815, below.

2815. Automatic Timer for Small Parts Welding [Circuit with Grid-Controlled Rectifier (handling up to 77 Amperes) allowing Current to pass during Single Half-Cycle of Mains Supply, giving Complete Uniformity of All Operations].—Callite Company. (*Communications*, Feb. 1940, Vol. 20, No. 2, p. 12.)

2816. Electronic Control Gear for Resistance Spot and Seam Welding of Light Metals.—(*Electronics and Television & Short-Wave World* [formerly *Television*], Jan., Feb., & March 1940, Vol. 13, Nos. 143, 144, & 145.)

2817. A High-Frequency Step-Down Transformer improves Arc Stabiliser.—Hoh. (*Electrot. Journ.*, Tokyo, Feb. 1940, Vol. 4, No. 2, p. 46.)

2818. Circuit Arrangement for High-Pressure Mercury-Vapour Lamps for the Generation of Light Flashes [for Stroboscopy, etc.]: Correction.—Ewest. (*Zeitschr. f. tech. Phys.*, No. 2, Vol. 21, 1940, p. 48.)

In his paper (798 of February) on a low-voltage circuit, Ewest omitted to mention that the big AEG stroboscope (Drewell, 1704 of April), by an "induction shock" device, is able to replace the usual 10–20 kv condenser voltage by one of only some 1000 v.

2819. A Small High-Intensity Stroboscopic Source.—Sinclair. (*Review of Scient. Instr.*, March 1940, Vol. 11, No. 3, p. 109.)

2820. A Practical Stroboscope Circuit [using Cooper-Hewitt Lamp: Wide Frequency Range and Controlled Duration of Light Pulses].—Street. (*Electronics*, April 1940, Vol. 13, No. 4, pp. 36–37.)

2821. High-Speed Motion Pictures of the Human Vocal Chords.—Farnsworth. (*Bell Lab. Record*, March 1940, Vol. 18, No. 7, pp. 203–208.)

2822. Electroencephalography [Preliminary Report on Bose Institute Results].—Bagchi. (*Sci. & Culture*, Calcutta, March 1940, Vol. 5, No. 9, p. 559.) For previous work *see* 893 of February.

2823. Discussion on "Some Ideas on Human Electroencephalography" [particularly the Need for Collaboration in Terminology].—Fischgold. (*Bull. de la Soc. franç. des Élec.*, March 1940, Ser. 5, Vol. 10, No. 111, pp. 195–196.) *See* 894 of February. Newell's paper in *Radiology* is quoted.

2824. Low-Power Ultra-High-Frequency Diathermy Apparatus [using the HK-24 Valve on 100 Mc/s].—Hutchins. (*Electronics and Television & Short-Wave World* [formerly *Television*], March 1940, Vol. 13, No. 145, p. 107: summary of American article.)

2825. "Manuale introduttivo alla Marconiterapia" [Short-Wave Therapy: Book Review].—Vallardi. (*Boll. del Centro Volpi*, English Edition, July/Aug./Sept. 1939, Year 2, No. 3, p. 367d.)

2826. The Electrical Functioning of the Nerve [including Practical Conclusions].—Beau & Fischgold. (*Bull. de la Soc. franç. des Élec.*, Jan. 1940, Ser. 5, Vol. 10, No. 109, pp. 19–30.)

2827. On the Activation of Liquids by Means of Piezoelectricity [Water (and Nitrobenzol) acquires Special Properties after Filtering through Compressed Piezoelectric Crystals].—Piccardi. (*La Ricerca Scient.*, No. 9, Year 10, 1939, pp. 813–820.)

2828. An Anomaly in the Electrical Conductivity of Concentrated NaCl Solutions in the Region of Decimetric Waves [and the Decrease in the Conductivity of Blood].—Malov. (*See* 2682.)

2829. Bibliography on the Effects of Short and Ultra-Short Waves on the Human Organism [26 Items].—(*Bull. de la Soc. franç. des Élec.*, March 1940, Ser. 5, Vol. 10, No. 111, pp. 196–197.)

2830. Induced Currents and Their Effect on Nerves of Inhabitants of Ferroconcrete Buildings.—Denier. (*See* 2600.)

2831. A Recording System designed for the Investigation of the Electrical Relations in the Brains of Small Animals.—Woonton. (*See* 2708.)

2832. A High-Gain D.C. Amplifier for Bioelectric Recording.—Goldberg. (*See* 2722.)

2833. Safety Rules for Radio Installations: comprising Part 5 of Fifth Edition of National Electrical Safety Code.—Nat. Bureau of Standards. (*Handbook* H35: 25 pp: for sale from Superintendent of Documents, Washington, D.C: price 10 cents.)

2834. On the Calculation of the Electrical Resistance of Petroliferous Rocks.—Kagan. (*Journ. of Tech. Phys.* [in Russian], No. 20, Vol. 9, 1939, pp. 1873–1878.)

2835. Science and the Divining Rod.—Maby. (*Journ. Roy. Soc. of Arts*, 19th April 1940, Vol. 88, pp. 519–535: Discussion pp. 535–539.) For the book by Maby & Franklin *see* 1283 of March.

2836. Locating Guns by Seismic Methods.—(*Sci. News Letter*, 6th April 1940, Vol. 37, No. 14, pp. 218–220.)

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2837. DISPELLING FOG [M.I.T. Investigations, including Effect of Micro-Waves and Use of Calcium Chloride Spray].—Compton. (*Scientific Monthly*, April 1940, pp. 383–384.)

2838. ON A METHOD OF DETERMINING THE ELASTIC CONSTANTS OF ISOTROPIC SOLID BODIES WITH THE HELP OF SUPERSONIC WAVES.—Bär. (*Helvetica Phys. Acta*, Fasc. 1, Vol. 13, 1940, pp. 61–76: in German.)

2839. AN APPARATUS FOR DETERMINING THE ORIENTATION OF CRYSTALS BY X-RAYS [with Examples for Cold-Rolled Permalloy].—Haworth. (*Review of Scient. Instr.*, March 1940, Vol. 11, No. 3, pp. 88–91.)

2840. X-RAY APPARATUS FOR THE MACROSCOPIC EXAMINATION OF MATERIALS.—de Graaf. (*Philips Tech. Review*, March 1940, Vol. 5, No. 3, pp. 69–74.)

2841. APPLICATIONS OF X-RAY TECHNIQUE TO INDUSTRIAL LABORATORY PROBLEMS.—Rooksby. (*See* 2599.)

2842. "LIGHTNING" RADIATION [near Soft X-Ray Region], EMITTED FROM LIGHTNING-ARRESTER INSULATION, LOWERS GAP RESISTANCE.—Berkey. (*Scient. American*, April 1940, Vol. 162, No. 4, p. 223.)

2843. NARROW-BAND CARRIER TELEPHONY ["Information Carrying Capacity" increased].—Csepely. (*See* 2766.)

2844. THE EVOLUTION OF METHODS OF TRANSMISSION BY WIRE [Telephony and Television].—van Mierlo. (*Bull. de la Soc. franç. des Élec.*, April 1940, Ser. 5, Vol. 10, No. 112, pp. 223–242.) For a longer paper on coaxial cables *see* 4545 of 1939.

2845. A BROAD-BAND CARRIER SYSTEM FOR OPEN-WIRE LINES [Type J System: including Curves of Typical Attenuations of Open-Wire Lines, Wet, Dry, & Ice-Covered].—Moore. (*Bell Lab. Record*, April 1940, Vol. 18, No. 8, pp. 226–231.)

2846. DIELECTRIC LOSS IN ICE [Special Properties of Ice due to Rotating Polar Molecule: Effect on H.F. Losses in Open-Wire Lines].—Murphy. (*Bell Lab. Record*, April 1940, Vol. 18, No. 8, pp. 241–242.)

2847. CARRIER-CURRENT LOSSES MEASURED AND INTERFERENCE MINIMISED ON BOULDER/LOS ANGELES TRANSMISSION LINES.—Laughlin & others. (*Elec. Engineering*, Jan. 1940, Vol. 59, No. 1, Transactions pp. 4–10.)

2848. RELATIONS BETWEEN A CARRIER-CURRENT SYSTEM AND ITS LINE [with Applications to H.T. Systems, Wire Broadcasting, and ME Systems].—Kluge. (*E.T.Z.*, 15th Feb. 1940, Vol. 61, No. 7, pp. 141–146.)

2849. WATER-LEVEL INDICATOR [for Direct Reading or Recording, using Bridge-Controlled Thyratron "Follow-Up" System].—Ware. (*Electronics*, March 1940, Vol. 13, No. 3, pp. 23–25.)

2850. ELECTRICAL MEASUREMENT OF PRESSURES: CAPACITY-VARIATION CIRCUITS AND INSTRUMENTS [Survey, with 25 Literature References].—Müller. (*Arch. f. Technisches Messen*, Jan. 1940, No. 103, double pp. T3–T5.)

2851. ELECTROMETRIC MEASUREMENT OF IONISATION CURRENTS [Survey of Methods].—Jaeger. (*Arch. f. Technisches Messen*, Jan. 1940, No. 103, double pp. T6–T7.)

2852. NEW ELECTROMETRIC MEASURING METHODS, PARTICULARLY FOR CONTINUOUS SERVICE [for Watching & Control of Chemical Processes, etc.].—Wengel. (*Arch. f. Technisches Messen*, Feb. 1940, No. 104, double pp. T13–T15.)

2853. PIEZOELECTRIC *versus* SPRING PRESSURE GAUGE [Modern Cathode-Ray Recording with Piezoelectric Gauge gives Over-All Natural Frequency much Higher than with Spring Pressure Gauge].—Kent & Hodge. (*Journ. of Applied Phys.*, April 1940; Vol. 11, No. 4, p. 240.) *See* Webster, 1295 of March.

2854. "ELECTROLIMIT" GAUGES [Inductance-Bridge Principle].—(*Engineering*, 1st March 1940, Vol. 149, pp. 220–222.)

2855. THE INDUSTRIAL STETHOSCOPE [Recording Frequency Analyser for diagnosing Condition of Running Machinery].—(*Scient. American*, Feb. 1940, Vol. 162, No. 2, pp. 100–101.)

2856. A GLOW-DISCHARGE ANEMOMETER.—Zacharov. (*Journ. of Tech. Phys.* [in Russian], No. 21, Vol. 9, 1939, pp. 1971–1975.) For Lindvall's earlier work on such an instrument *see* 1934 Abstracts, p. 573, r-h column.

2857. THE DESIGN AND MODE OF ACTION OF THE MOST IMPORTANT SYSTEMS OF REMOTE-CONTROL RELAYS.—Gutmann. (*E.T.Z.*, 1st Feb. 1940, Vol. 61, No. 5, pp. 107–112.)

2858. A RADIO-CONTROLLED MODEL AEROPLANE WHICH HAS MADE OVER ONE HUNDRED SUCCESSFUL FLIGHTS.—Good. (*QST*, March 1940, Vol. 24, No. 3, pp. 24–27 and 86, 88.)

2859. A DEVICE FOR THE VIEWING OF SLOW ROTARY MOTIONS [Optical Mechanism: Reversing Prism rotating about Longitudinal Axis at One-Half the Speed of the Observed Rotation].—Sutton. (*Phys. Review*, 15th Feb. 1940, Ser. 2, Vol. 57, No. 4, p. 357: abstract only.)

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Wireless Patents

A Summary of Recently Accepted Specifications

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

ACOUSTICS AND AUDIO-FREQUENCY CIRCUITS AND APPARATUS

519 486.—Audio-frequency amplifier with an attenuation control which increases automatically as the amplitude of the higher frequencies falls off.

F. J. Chart (assignee of M. G. Clay). Convention date (U.S.A.) 23rd November, 1937.

520 350.—Tone-control circuit, utilising both negative and positive feed-back, for a low-frequency amplifier.

E. K. Cole and A. W. Martin. Application date 19th October, 1938.

AERIALS AND AERIAL SYSTEMS

519 444.—Aerial for television or short-wave working, and with a figure-of-eight shape for concentrating the radiation in a horizontal plane.

Hazeltine Corporation (assignees of H. A. Wheeler). Convention date (U.S.A.) 20th October, 1937.

519 883.—Spacing and supporting a short-wave dipole aerial and its associated reflector.

Belling & Lee and F. R. W. Strafford. Application date 3rd October, 1938.

DIRECTIONAL WIRELESS

519 461.—Rotary arrangement of frame and dipole aerials for use in automatic direction-finding.

Standard Telephones and Cables (assignees of Le Matériel Téléphonique Soc. Anon.). Convention date (France) 17th September, 1937.

519 462.—Aerial system for determining the absolute direction in space of an incoming signal.

Standard Telephones and Cables (assignees of Le Matériel Téléphonique Soc. Anon.). Convention date (France) 17th September, 1937.

519 809.—Stream-lined casing for the frame aerial of a direction-finding installation used on a high-speed aeroplane.

Standard Telephones and Cables and B. J. Axten. Application date 4th October, 1938.

RECEIVING CIRCUITS AND APPARATUS

(*See also under Television*)

518 991.—Construction of wireless cabinet designed to prevent acoustic feed-back between the loud speaker and the chassis.

The General Electric Co. and W. H. Peters. Application date 14th September, 1938.

519 058.—Means for producing "free" biasing potentials in a wireless receiver, and for maintaining them constant in spite of supply fluctuations (divided out of 513 626).

L. L. de Kramolin. Application date 7th June, 1938.

519 110.—Coupling-devices in the form of concentric transmission-lines for ultra-short-wave amplifiers.

Marconi's W.T. Co. (assignees of P. D. Zottu). Convention date (U.S.A.) 4th June, 1937.

519 448.—Stabilised push-pull Class-A amplifier in which negative feed-back is applied to one of the stages.

Philco Radio and Television Corporation (assignees of L. E. Barton). Convention date (U.S.A.) 16th October, 1937.

519 451.—High-frequency coupling arrangement utilising powdered-iron cores, the inductance of which can be varied without affecting their "Q" value.

W. J. Polydoroff. Application date 23rd September, 1938.

519 530.—Receiver including a non-linear impedance operating as a voltage-limiter of very short time-constant, for minimising the effect of interference.

A. A. Thornton (communicated by Philco Radio and Television Corporation). Application date 26th August, 1938.

519 703.—Automatic frequency-control system using variable permeability, and designed to give a uniform response over a wide tuning range.

F. W. Cackett and T. G. Thorne. Application date 29th September, 1938.

519 720.—Means for preventing the tendency of a short-wave generator "to over-oscillate," particularly in a superhet set.

Philips' Lamp Co. Convention date (Germany) 2nd September, 1937.

519 755.—Press-button receiver in which certain of the pre-set tuning circuits are used as rejector or acceptor circuits in order to minimise interference.

Murphy Radio and L. A. Moxon. Application date 1st October, 1938.

519 781.—Interlocking arrangement for maintaining the setting of the press-button selectors during any one tuning operation of a remotely-controlled wireless receiver.

J. F. Ellis and H. E. Gauss. Application date 26th September, 1938.

TELEVISION CIRCUITS AND APPARATUS

FOR TRANSMISSION AND RECEPTION

519 011.—Circuit for the linear amplification of the saw-toothed oscillations used for scanning in television.

Radio-Akt. D. S. Loewe (K. Schlesinger). Convention date (Germany) 10th June, 1937.

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519 015.—Electron lens system, for a cathode-ray tube, made of metal-foil which is permeable to relatively slow-moving electrons.

The British Thomson-Houston Co. Convention date (Germany) 10th July, 1937.

519 111.—Construction and assembly of the electrodes and "lenses" of a cathode-ray tube, particularly for television.

Pye and G. Liebmann. Application date 9th June, 1938.

519 515.—Phonic motor driven by a valve amplifier for synchronising the scanning elements in a television system.

I.M.K. Syndicate; P. Nagy; and D. H. Byron. Application date 4th June, 1938.

519 575.—Means for securing intense field-illumination in a television scanning-system of the rotating mirror-drum type.

R. D. Lemert. Convention date (U.S.A.) 24th July, 1937.

519 594.—Television transmitter in which means are provided for momentarily reducing the electron current produced in an electron multiplier at the end of each complete "framing" period.

Electrical Research Products Inc. Convention date (U.S.A.) 1st October, 1937.

519 631.—Auxiliary superheterodyne circuit for preventing "frequency drift" in a television receiver.

Kolster-Brandes and W. A. Beatty. Application date 22nd September, 1938.

519 727.—Preventing interference, due to the local oscillator, in a broadcast set fitted with a frequency-converter to adapt it to receive television signals.

Marconi's W.T.Co. (assignees of G. L. Grundmann). Convention date (U.S.A.) 29th September, 1937.

519 743.—Thermionic valve circuit for amplifying slowly-fluctuating uni-directional voltages, e.g. for changing the carrier-level in broadcast and television receivers.

Kolster-Brandes and P. K. Chatterjea. Application date 30th September, 1938.

TRANSMITTING CIRCUITS AND APPARATUS

(See also under Television)

519 264.—Multiplex signalling system in which all the carrier-waves are harmonics of the same fundamental frequency.

L. W. Meyer (communicated by Philips' Lamp Co.). Application date 10th October, 1938.

519 490.—Pentode power amplifier, in which the potential of the suppressor grid is varied in phase with the anode voltage and has a predetermined relation to the anode-grid-cathode voltages, in order to prevent "arcing."

The General Electric Co. and R. le Rossignol. Application date 24th October, 1938.

519 558.—Method of automatic amplification control when broadcasting "multiple" programmes, such as sound-and-vision or stereoscopic or binaural effects.

Hazeltine Corporation (assignees of H. M. Lewis). Convention date (U.S.A.) 23rd April, 1938.

CONSTRUCTION OF ELECTRONIC-DISCHARGE DEVICES

519 087.—Means for protecting from deterioration the leading-in wires for a valve, particularly of the so-called Acorn type.

C. Lorenz Akt. Convention date (Germany) 24th September, 1937.

519 168.—Cathode-ray tube in which at least one of the scanning movements is controlled by a switching relay mounted inside the tube.

K. Tihanyi. Convention date (Germany) 13th September, 1937.

519 195.—Construction of the base or foot, taking the leading-in wires, of an ultra-short-wave valve.

Standard Telephones and Cables and A. I. Vangeen. Application date 16th September, 1938.

519 592.—Electron multiplier in which the "target" electrodes are arranged in a series of spirals.

Telefunken Co. Convention date (Germany) 25th September, 1937.

SUBSIDIARY APPARATUS AND MATERIALS

518 999.—Microphone in which the path of the current through the granules is deliberately restricted in order to minimise distortion.

"Fides" Ges.m.b.h. Convention date (Germany) 4th October, 1937.

519 042.—Means for preventing the gradual "blackening" of the fluorescent screen of a cathode-ray tube.

Standard Telephones and Cables and H. Wolfson. Application date 13th September, 1938.

519 240.—Means for controlling the power-output taken from a valve-oscillator, particularly for diathermy apparatus.

E. K. Cole and E. Garthwaite. Application date 7th October, 1938.

519 263.—Visual tuning indicator in which a diverging stream of electrons is projected onto a fluorescent screen.

Philips' Lamp Co. Convention date (Netherlands) 13th October, 1937.

The Industry

USEFUL data on the metallurgy and applications of soft solders are contained in a booklet, "Solders and Soldering," published by Multicore Solders, Ltd., Bush House, London, W.C.2. In the cored solder manufactured by this firm the flux, which is specially treated resin, is distributed in the cross-section of the wire in three cores. A wide variety of gauges and alloys is available.

A catalogue of "Metrovac" rotary vacuum pumps, which are of English manufacture, has been received from W. Edwards and Co. (London) Ltd., Southwell Road, Loughboro' Junction, London, S.E.5. Three types are available, with displacements from 9.3 to 1133 litres per minute, and vacuum pressures from 0.0005 to 0.007 mm/Hg.

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