THE
WIRELESS ENGINEER

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Editorial

The Behaviour of Resistors at High Frequencies

IN the Editorial of June, 1935 (Vol. 12, p. 291), we discussed the phenomenon of the relatively sudden and large decrease in the effective resistance of resistors of the rod type when the frequency was increased beyond a certain value. We showed that the distributed self-capacitance of the resistor would cause such a decrease. Although this capacitance is not uniformly distributed, we showed that by assuming it to be so, and taking an average value, the resistor can be treated as a transmission line having only resistance and capacitance and lending itself therefore to very simple mathematical treatment. We gave a curve showing the variation of resistance with the variable $flCR_0$ from which the behaviour of any resistor could be predicted. R_0 is the d.c. resistance, f the frequency, l the length or semi-length of the rod, and C the capacitance per unit length which depends only on the ratio of the diameter to the length of the rod.

Subsequent measurements, especially a series made at the National Physical Laboratory by Dr. Hartshorn*, employing a highly developed technique up to frequencies of 100 Mc/s, have fully confirmed the correctness of the theory and method. As Dr. Hartshorn points out, however, the calculated value of C is an idealised value, ignoring entirely any effects due to neighbouring conductors or to neighbouring dielectrics having permittivities differing from that of air. Some of the resistors tested consisted of films on glass rods enclosed by porcelain tubes; they would obviously have a much larger capacitance than the calculated value. The correct value of C was therefore determined experimentally at a low frequency and Dr. Hartshorn then found that, with the exception of one abnormal resistor, the "calculation accounts for all the results within the probable errors of calculation and experiment." With regard to the values of C it was stated that the experimental and calculated values were of the same order but that the calculated values were definitely low. As a matter of fact, the values deduced from observations varied from 2.5 to 3.0 times the calculated values of C as is shown in Fig. 1.

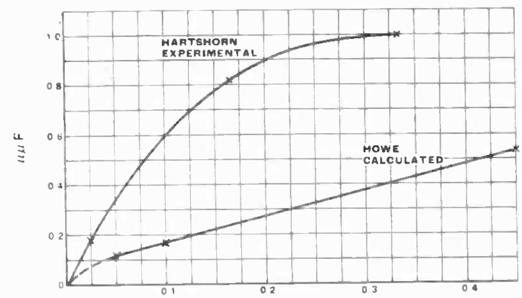

Fig. 1.

*Wireless Engineer, July, 1938, p. 363.

A series of experiments was also made at the Galileo-Ferraris Institute at Turin by Bressi* and the results were analysed and discussed by Pontecorvo.† Here again the results confirmed the theory but the value of the distributed capacitance deduced from the observations differed so considerably from that calculated from its dimensions, and differed in such a strange way, that we felt compelled to return to the subject and endeavour to find the cause of the discrepancies.

Pontecorvo pointed out that certain advantages are gained by plotting a series of curves showing the calculated values of R_f/R_0 to a base of $\sqrt{fR_0}$ for different assumed values of the somewhat uncertain distributed capacitance $C_d = Cl$ where C is the capacitance per unit length and l is the semi-length of the rod. [In what follows we shall always denote the total length of the rod by $2l$; the equivalent transmission line has a length l.] The position of any experimentally determined point on the graph shows at once the value of its capacitance C_d. If tests are made on a number of resistors of the same dimensions but of different resistances, the observed values of R_f/R_0 should all lie on the same curve, since they should have the same C_d. He confirmed this from Bressi's results and illustrated the point in his letter to the *Wireless Engineer*. In this way the value of C_d was determined for several values of $d/2l$, where d is the diameter of the rod,

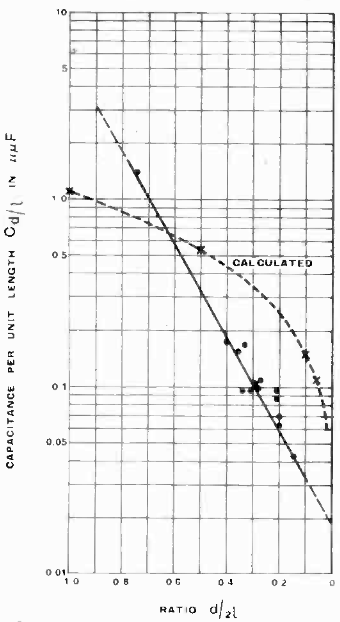

Fig. 2.

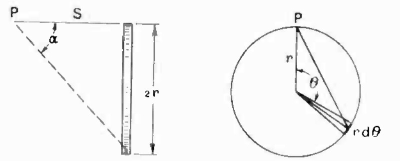

Fig. 3.

and the results when plotted gave the straight line of Fig. 2 which is reproduced from Fig. 7 of Pontecorvo's Italian article. Now this straight line is very surprising; it indicates that if the length is kept constant and the diameter of the rod increased four times, so that $d/2l$ is increased from 0.2 to 0.8, the capacitance per unit length increases from 0.06 to 2.0 $\mu\mu$F per cm., an increase of over 30 times, which is really incredible.

In the 1935 Editorial we gave detailed calculations of the capacitance for the case in which $d/2l$ is equal to 0.05 and obtained a capacitance of 0.12 $\mu\mu$F. per cm.; we also stated that for $d/2l = 0.1$ an approximate calculation gave a value of 0.166 $\mu\mu$F. In view of Pontecorvo's figures we thought it desirable to calculate the capacitance for cylinders in which $d/2l$ was 0.5 and 1.0. We must emphasise that these calculations are based on the assumption of a thin cylindrical film of resistance material on a core or tube assumed to have unit dielectric constant and to be surrounded by a medium of unit dielectric constant. We also ignore for the present any effects of metallic end-caps or terminals; we shall discuss these later.

The method employed for long thin rods is not applicable to cylinders, the length of which is of the same order as the diameter. The method now to be employed is based upon the following considerations. If a ring of radius r is given unit charge, the potential V_p at a point P on the same cylindrical surface at a distance s (Fig. 3) is

$$V_p = 2\int_0^{\pi} \frac{d\theta/2\pi}{\sqrt{s^2 + 4r^2\sin^2\frac{\theta}{2}}}$$

Alta Frequenza, Aug.-Sept., 1938, p. 551;
†the same, p. 570, also *Wireless Engineer*, Sept. 1938, p. 500.

or putting $\theta/2 = \psi$ and $m = \frac{2r}{s} = \tan\alpha$

$$V_p = \frac{2}{\pi s}\int_0^{\pi/2}\frac{d\psi}{\sqrt{1 + m^2\sin^2\psi}}$$

$$= \frac{2}{\pi s m}\int_0^{\pi/2}\frac{d\psi}{\sqrt{1/m^2 + 1 - \cos^2\psi}}$$

$$= \frac{2}{\pi s m}\cdot\frac{1}{\sqrt{\frac{1}{m_2} + 1}}\int_0^{\pi/2}\frac{d\psi}{\sqrt{1 - \frac{m^2}{m^2+1}\cos^2\psi}}$$

As the integral is from 0 to $\pi/2$, $\sin^2\psi$ can be substituted for $\cos^2\psi$, and putting

$$k^2 = m^2/m^2 + 1$$

we have

$$V_p = \frac{2}{\pi s}\cdot\frac{1}{\sqrt{m^2+1}}\int_0^{\pi/2}\frac{d\psi}{\sqrt{1 - k^2\sin^2\psi}}$$

$$= \frac{1}{\pi r}\sin\alpha\int_0^{\pi/2}\frac{d\psi}{\sqrt{1 - k^2\sin^2\psi}}$$

in which

$$k = \frac{m}{\sqrt{m^2+1}} = \frac{\tan\alpha}{\sqrt{\tan^2\alpha + 1}} = \sin\alpha.$$

$$\int_0^{\pi/2}\frac{d\psi}{\sqrt{1 - k^2\sin^2\psi}}$$

is the complete elliptic integral $F(k,\pi/2) = K(k)$, values of which are tabulated against the angle α in Jahnke and Emde, p. 150 (2nd edition). Hence

$$V_p = \frac{1}{\pi r}\sin\alpha\,.\,K(\sin\alpha).$$

In Fig. 4 we have plotted the values of $\sin\alpha\,.\,K(\sin\alpha)$ against cotan α, that is, taking the diameter of the coil as unity, against different values of the distance s in Fig. 3.

We now assume that the charge on the surface of the cylindrical resistance is distributed in such a way that its density is proportional to the distance from the mid-point. Let the charge per unit length be qxl where xl is the distance from the mid-point. If the total length be divided into 10 sections of length $2l/10$, the charge on any section will be $2qxl^2/10$ and we can now with the help of Fig. 4 write down the potential at any point on the cylinder due to the charge on any section. It is simply

$$V_p = 2qxl^2/10 \times \frac{\sin\alpha\,.\,K(\sin\alpha)}{\pi r}.$$

Let us assume that $l = r$ as shown in Fig. 5

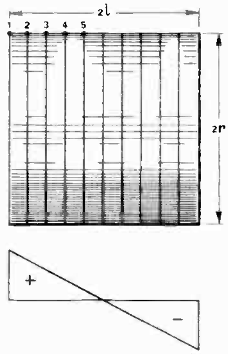

Fig. 5.

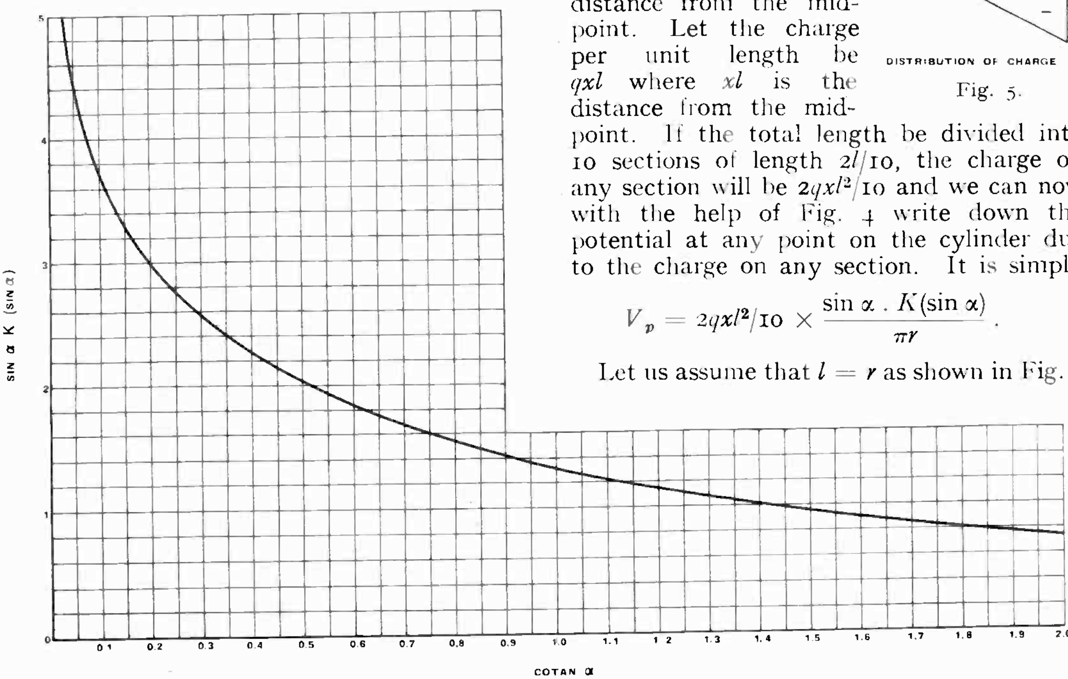

Fig. 4.

then $V_p = \frac{qxl}{5\pi} \sin\alpha \,.\, K\,(\sin\alpha)$

where $x = 0.1$, 0.3, 0.5, 0.7, and 0.9 respectively. As an example let us calculate V_1 at the extreme end of the cylinder due to all the sections.

Section No.	Cotan α	x	Sin α . K (sin α)	$\frac{V_1}{ql}$	V_1/ql	
1	—	0.9	—	0.271		
2	0.15	0.7	3.28	0.1462		
3	0.25	0.5	2.75	0.0875	+ 0.5641	
4	0.35	0.3	2.40	0.0458		
5	0.45	0.1	2.14	0.0136		0.3236
6	0.55	0.1	1.93	0.0123		
7	0.65	0.3	1.75	0.0334		
8	0.75	0.5	1.60	0.0510	− 0.2405	
9	0.85	0.7	1.48	0.0660		
10	0.95	0.9	1.36	0.0778		

Similar schedules are drawn up for the potentials V_2, V_3, etc. at the other points along the cylinder, and can be filled in very rapidly, since many of the figures recur in successive schedules.

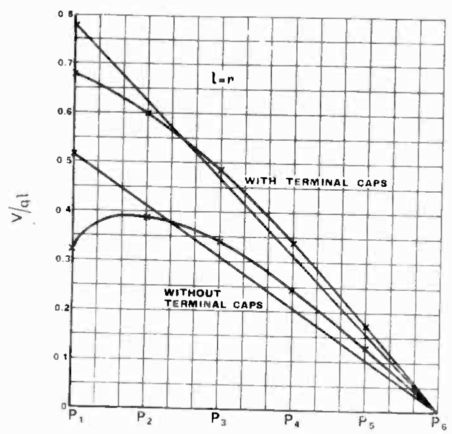

Fig. 6.

The potential at a point due to the section on which it is situated is calculated from the formula

$$V = 2\sigma w\left(\log_e \frac{8r}{w} + 1\right)$$

where $\sigma = \frac{qxl}{2\pi r}$ = charge per sq. cm.

and w = width $= l/5$. In the present example $l = r$

$$\therefore\ V = \frac{qxl}{5\pi}(\log_e 40 + 1) \text{ and } x = 0.9$$

$$\therefore\ V = 0.268\ ql.$$

This will be somewhat low since the density of the charge is increasing towards the point P_1 whereas the formula is based on the assumption of a uniformly charged ring. A closer approximation gives $0.271\ ql$, which is entered in the schedule above. The potential at the point midway between P_1 and P_2 was also calculated, as the potential varies rapidly in this region.

As a further example we give the schedule for finding the potential at the point P_5.

Section No.	Cotan α	x	Sin α . K (sin α)	$\frac{V_5}{ql}$	$\frac{V_5}{ql}$	
1	0.35	0.9	2.4	0.1375		
2	0.25	0.7	2.75	0.1225		
3	0.15	0.5	3.28	0.1044	+ 0.484	
4	— }	0.2	—	0.1193		
5	— }					0.128
6	0.15	0.1	3.28	0.0209		
7	0.25	0.3	2.75	0.0525		
8	0.35	0.5	2.4	0.0765	−0.356	
9	0.45	0.7	2.14	0.0955		
10	0.55	0.9	1.93	0.1105		

The values of the potential calculated in this way are plotted in Fig. 6 and the straight line has been drawn to give a triangle of the same area as the figure. We assume that the potential along the cylinder is given by this line so that, like the density of the charge, it is proportional to the distance from the midpoint, and consequently gives a constant value for the capacitance per unit length.

When $x = 1$, that is, at the extreme end, $V = +\,0.515\ ql$ at one end, and $-\,0.515\ ql$ at the other end, the P.D. being therefore $1.03\ ql$. The charge per unit length at this point is ql since $x = 1$

$$\therefore\ C \text{ per unit length} = \frac{ql}{1.03\,ql} = 0.97 \text{ e.s. units}$$

$$= 1.08\ \mu\mu\text{F}.$$

Exactly similar calculations have been made for the case in which the rod is twice as long as the diameter, i.e. $l = 2r$, and the calculated potentials are plotted in Fig. 7. Here again the straight line has been drawn to give a triangle of the same area as the figure and the capacitance per unit length calculated as above; the result is $C = 0.544\ \mu\mu$F. These calculated capacitances per unit length are plotted in Fig. 1 for comparison with Hartshorn's observed results, and in Fig. 2 for comparison with Pontecorvo's surprising graph. It will be seen that if l is kept constant and d increased four times so that $d/2l$ increases from 0.2 to 0.8, the calculated capacitance increases from about 0.25 to 0.85, which is roughly what one would expect.

If, instead of the logarithmic ordinate scale adopted by Pontecorvo, a linear scale is employed, the calculated results are as shown in Fig. 8 and it is seen that they lie on as straight a line as Pontecorvo's logarithmically plotted results.

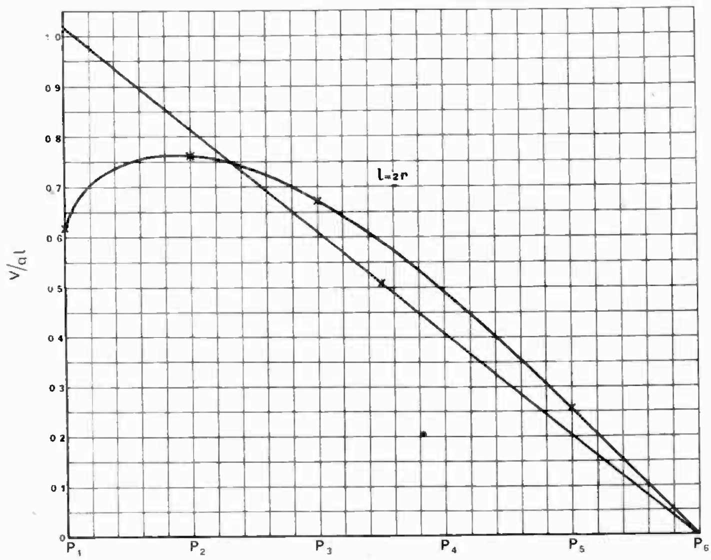

Fig. 7.

When the diameter of the cylinder becomes large compared with its length, the result should approximate to that calculated for a straight strip. If the charge per sq. cm. is qx, where x is the distance from the centre line of the strip, the field strength E at the point P_1 distant β from the centre is (see Fig. 9)

$$2q\left(2l + \beta \log_e \frac{l-\beta}{l+\beta}\right)$$

where $2l$ is the width of the strip.

The P.D. between the two points P_1 and P_2 will be

$$4q\left\{2l\beta + \int_0^\beta x \log_e \frac{l-x}{l+x}\,dx\right\}$$

$$= 4ql\beta + 4ql^2\left\{\tfrac{1}{2}\left(1 - \frac{\beta^2}{l^2}\right)\log_e \frac{l+\beta}{l-\beta}\right\}$$

$$= 4ql^2\left\{\alpha + \frac{1-\alpha^2}{2}\log_e \frac{1+\alpha}{1-\alpha}\right\}$$

where $\alpha = \beta/l$.

If, for example, $\alpha = \frac{1}{2}$, which would apply to the points P_1P_2 in Fig. 9, then

$$V_{12} = 4ql^2\{\tfrac{1}{2} + \tfrac{3}{8}\log_e 3\} = 4ql^2 \times 0.912.$$

The ordinates in Fig. 10 were calculated in this way and the straight line drawn to give a figure of equal area.

At the edge where $x = l$ the charge per unit area is ql and the P.D. between the two edges $4ql^2 \times 1.594$; the capacitance per sq. cm. is therefore

$$\frac{1}{4 \times 1.594l} = 0.157/l \text{ e.s. units or } 0.174/l\ \mu\mu\text{F}.$$

If now, instead of being straight, the strip is bent into a ring of large diameter d, the capacitance per unit length (axially) of the ring, when charged as assumed, will be $0.174\pi d/l = 1.095\ d/2l\ \mu\mu$F. This gives the dotted straight line through the origin in Fig. 8 but it is only applicable for large values of $d/2l$. It is seen, however, that the curve merges into the line when $d/2l = 1$. This serves as a confirmation of the calculated values and leaves no room for doubt as to the accuracy of these values for the assumed ideal conditions.

We are now faced with the question as to the causes of the large discrepancies between the calculated and observed values. The dielectric constants of the surrounding media would explain values two or three times those calculated, as found by Dr. Hartshorn, but not values varying from 0.25 to 5.0 times

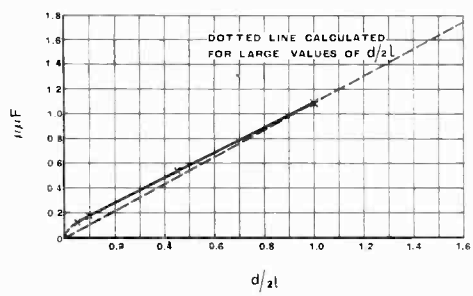

Fig. 8.

those calculated, as given by Pontecorvo in Fig. 2.

Assuming that no conductors are very close to the resistor—and it is a simple precaution that one would naturally take when making the measurements—it is difficult to see any cause for an increase of the capacitance other than dielectrics of high permittivity in close contact with the resistor. If the resistor consists of a metallic deposit on a glass tube with another tube of glass or porcelain surrounding it, the capacitance may easily be three or four times the calculated value.

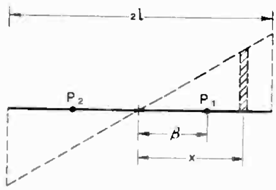

Fig. 9.

If the resistor has metal caps or terminals one may be tempted to see in them a source of additional capacitance, but, as a matter of fact, they have exactly the opposite effect. The capacitance between the two caps is external to the resistor and plays no part in the phenomenon of the reduction of the resistance at high frequencies. They have the effect, however, of *reducing* the effective self-capacitance of the resistor. This may be seen in a general way by picturing the electric flux passing through space between the two end sections of the resistor. In the absence of the caps it could spread out into space, but with the caps, their field occupies the outer space and the resistor field is more confined, so that for a given charge there is a larger P.D. between the ends of the resistor. In order to get some idea of the magnitude of this effect let us assume that the resistor with $2l = 2r$, that we have already considered, is fitted with terminal cylinders of length 0.2 of that of the resistor, as shown in Fig. 11.

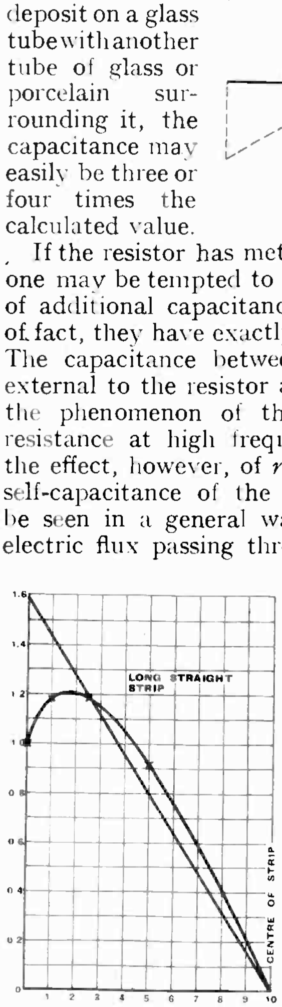

Fig. 10.

The charge per unit length on the cap will be roughly the same as that on the ends of the resistor, viz. ql, and as the length of each cap is $0.4l$, the charge on each cap will be $0.4\ ql^2$. The potential at point 1 due to the adjacent cap can be calculated by the formula $2\sigma w(\log 8r/w + 1)$; this gives $\frac{0.4}{\pi} ql \times 4$. For the negative cap $\cot \alpha = 1.1$ and $\sin \alpha \,.\, (K \sin \alpha) = 1.22$; the potential due to it is therefore $\frac{0.4}{\pi} ql \times 1.22$. The resultant potential is the difference of these two, viz. $\frac{0.4}{\pi} ql \times 2.78 = 0.354ql$, and this is the increase of the potential V_1 due to the caps which is therefore increased from $0.324\ ql$ to $0.678\ ql$. The increased values of the potential at the other points along the resistor have been calculated and are plotted in the upper curve of Fig. 6. The equivalent straight line gives an increase of potential due to the presence of the caps in the ratio of 0.777/0.514, which means a *decrease* of capacitance to two-thirds of its original value. Hence metallic end caps of the relatively large size shown in Fig. 11 only cause a decrease of 33 per cent. in the self-capacitance of the resistor and can therefore be ruled out entirely as an explanation of the discrepancies. Up to this point we have assumed cylindrical deposits on dielectric tubes and the caps were metal cylinders. If the caps have also end discs, or if the resistors are solid rods of resistance material fitted with metallic end discs, there will be a further reduction of resistor capacitance due to the restriction or total suppression of its electric field inside the cylinder, but the effect will be small. It should be noted, moreover, that Pontecorvo obtained excessively large capacitances for short thick resistors like Fig. 11 and excessively small capacitances for long thin rods for which the effects of the end caps will be relatively small.

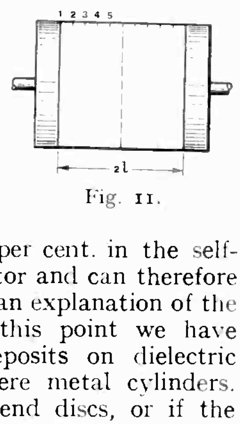

Fig. 11.

It may be suggested that the assumption of a constant capacitance per unit length upon which our calculations are based is so rough an approximation that it may account for some of the discrepancy. The whole frequency range may be divided into three parts; first, the range over which R_f/R_0 falls very slowly, then the relatively narrow range in which it falls very rapidly, and finally, still higher frequencies where it again falls slowly. One is mainly interested in the second range, or the borderline between the first and second, and there can be little doubt that our approximation is here near enough for all practical purposes. When the frequency is so high that R_f/R_0 has fallen to a small fraction, the voltage distribution may differ very much from that assumed and the capacitance may be seriously modified, but we have then little interest in it.

There remains a possible cause of discrepancy in a fact mentioned by Pontecorvo, viz. that for resistors of the same overall dimensions various values of resistance are obtained by cutting spirals in the cylindrical deposit. It is possible that the inductance thus introduced is by no means negligible. It might be thought that it could be allowed for by inserting the inductance term in the transmission line formula but, although this might be permissible in a long thin rod, it would hardly be so in Fig. 11 on account of the mutual inductance between the turns of the spiral. It is obviously a point that should be looked into when making tests on resistors. In the absence of definite data as to such spiralisation it is impossible to hazard a guess as to its effect in Pontecorvo's measurements, the results of which defy every effort that we have made to find a reasonable explanation. It is not only that they are at variance with the calculations; they are entirely inconsistent with the experimental results of Dr. Hartshorn.

G. W. O. H.

Scientific Advisers to the Government

THE terms of reference of the Scientific Advisory Committee appointed by the Lord President of the Council to ensure the continuance of the fullest co-operation of scientific workers with the Government in the national war effort are:—

(*a*) To advise the Lord President on any scientific problem referred to them.

(*b*) To advise Government Departments, when so requested, on the selection of individuals for particular lines of scientific enquiry or for membership of committees on which scientists are required. and

(*c*) To bring to the notice of the Lord President promising new scientific or technical developments which may be of importance to the war effort.

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Sir William Bragg, O.M., K.B.E., President of the Royal Society.

Dr. E. V. Appleton, F.R.S., Secretary to the Committee of the Privy Council for Scientific and Industrial Research.

Sir Edward Mellanby, K.C.B., F.R.S., Secretary of the Medical Research Council.

Sir Edwin Butler, C.M.G., F.R.S., Secretary of the Agricultural Research Council.

Professor A. V. Hill, O.B.E., F.R.S., M.P., Physical Secretary of the Royal Society.

Professor A. C. Egerton, F.R.S., Biological Secretary of the Royal Society.

Correspondence

Amplitude, Frequency and Phase-Angle Modulation

To the Editor, The Wireless Engineer.

SIR,—In the August 1940 issue of *The Wireless Engineer* you do me the honour of quoting (on page 341) from my 1922 I.R.E. paper "Notes on the Theory of Modulation." You then go on to say that "it would be interesting to know if Carson is still of the same opinion."

In reply I would state that I *am* of the same opinion, and that I stand squarely behind my published words of eighteen years ago.

As regards narrowing the required transmission band by frequency-modulation as compared with amplitude-modulation, I presume there is no question involved. The invention, however, was submitted to me with the claim that it made possible a narrowing of the frequency-band, and it is with this aspect of frequency-modulation that my paper is principally concerned.

As regards my statement that frequency-modulation does not minimise transient disturbances, I would call your attention to the fact that *frequency-modulation* per se *does not and cannot minimise transient disturbances or noise*. It is the combination of *frequency-modulation* with *amplitude limitation* that makes possible the reduction of interference and noise, and then only when the noise power is less than the signal power. Amplitude limitation had not been proposed at the time my paper was written.

To touch briefly on another matter, I note and deprecate the introduction of the barbarous term "angular velocity modulation." I would suggest that we retain the terms, now well established, *frequency*-modulation and *phase*-modulation, and introduce the generic term *gonoidal*-modulation to comprehend both.

In conclusion, I shall be glad if you care to give this reply publicity in the pages of *The Wireless Engineer*.

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Research Consultant.
New York, U.S.A.

Velocity Modulation*

Results of Further Considerations

By R. Kompfner

SUMMARY.—Problems connected with velocity modulation are discussed. Simplifying assumptions are made and an ideally modulating field is described and examined with a view to practical possibilities. A sinusoidal modulating field is treated in more detail, a derivation of the distance of optimum bunching or focusing is shown and the beam current distribution before, during and after optimum bunching. The absolute velocities of the split-bunches are found to be approximately equal to the velocities of the fastest and slowest beam electrons. The terms "Aperature," "Definition" and "Depth of Focus" are defined and correlated. Two devices are suggested, both making use of velocity modulation, the one directed to the generation of U.H. frequencies, the other to function as a television pick-up tube.

(1) Aim of Study

VELOCITY modulation, electron bunching, phase focusing and compression are different names for one and the same phenomenon, namely superimposing periodically varying velocities upon the constant velocity of a continuous uniform electron beam, causing periodically varying electron densities along the beam. The greater the variation of density, generally speaking, the better is the beam modulated. An ideally well-modulated beam would consist of infinitely thin layers of electrons separated by equal empty spaces. But unfortunately, modulating fields of the required wave forms to produce this effect are not practicable at the frequencies involved; and moreover, the mutual repulsion of the electrons would not allow an infinitely thin layer of electrons proceeding along its path in the drift tube for more than an infinitely short time without spreading.

However, for whatever purpose velocity modulation might be used, it will be advantageous to investigate several questions, such as: What is the distance from the modulating field to the point where optimum compression (or bunching) of the electrons occurs, both for an ideally modulating field and for a sinusoidally modulating field? What is the maximum possible compression for different "apertures" ("aperture" being the portion of the complete cycle of the modulating field during which electrons are allowed to enter the drift tube)? What is the length of the drift tube along which the electrons are practically confined within a certain defined layer width, a quantity which I propose to call "depth of focus"? What happens to the electrons after passing the distance of optimum compression?

I am attempting to answer these questions and others, because of the obvious bearing which they have on drift-tubes of the Haeff or Hahn Type, Klystrons and similar devices which doubtless will be of ever increasing importance for the generation and reception of very high frequencies. Later on I propose to outline in a general way a device for generating very high frequencies which makes use of frequency multiplication and a device for generating television picture signals making use of the storage principle in a novel way; both embodying the principles of velocity modulation.

(2) Assumptions

I propose the following assumptions to facilitate the calculations:

(1) Space charge neglected.

(2) Electro-magnetic wave propagation effects neglected.

(3) The modulating field infinitely short.

(4) Electrons constrained to move parallel to drift tube axis and to use the same notation as in D. Martineau Tombs' article in *The Wireless Engineer*, February, 1940.

(3) Ideally Modulating Field

As shown on the space-time diagram Fig. 1, an electron beam passing through

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

the modulating field (for instance two grids) with a constant velocity $u_0 = \tan \phi_0$ will be compressed into an infinitely thin layer or bunch at a distance S' from the modulating field if the modulating field results in a velocity u

$$u = \tan \phi = u_0 \frac{T'}{T' - t}.$$

T' is the time an electron with a velocity u_0, starting at $t = t_0$, needs to arrive at S'; an electron starting at $t = T'$ would have to have an infinite velocity to catch up the electrons which had started before.

The field which produces the velocity u is due to a varying potential U which can be expressed by the following formula

$$U = U_0 \frac{(T')^2}{(T' - t)^2} \quad \ldots \quad \ldots \quad (1)$$

and shown on Fig. 2.

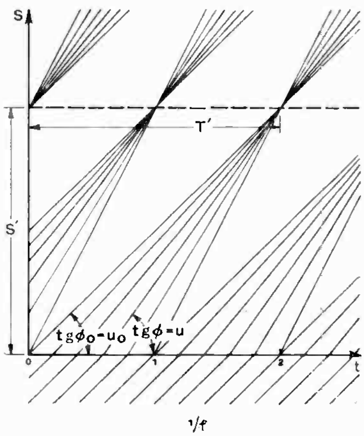

Fig. 1.

Taking the highest practicable frequency f at which such a pulse could be produced as 3 megacycles, the basic acceleration potential U_0 as 25 volt and limiting the peak voltage U_p to $4U_0$, that is 100 volt (one-half only of T' will thus be utilised), we get an optimum drift tube length S' from

$$S' = u_0 \cdot T' \simeq 6.10^7 \sqrt{U_0} \cdot \frac{2}{f}$$

which is about 200 cm.

It can be seen that a device employing an ideal modulating pulse as that shown on Fig. 3 is quite feasible even though it certainly is near the border of impracticability. Using heavier particles than electrons, such as caesium ions* would bring the matter

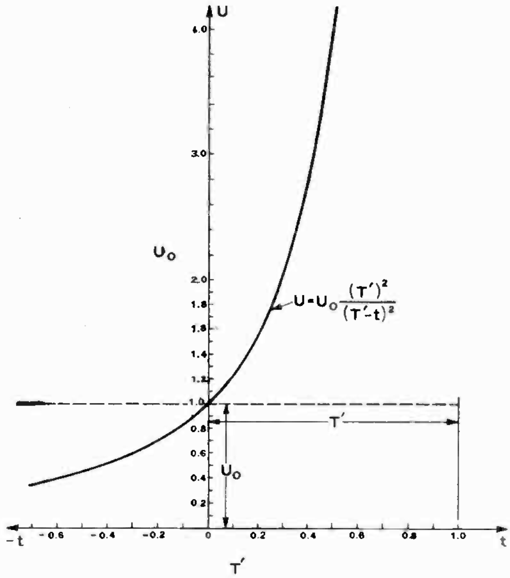

Fig. 2.

down to the order of dimensions usually connected with electronic tubes.

(4) Sinusoidal Modulating Field

(a) General :

Naturally, interest centres on the behaviour of a sinusoidally velocity-modulated electron beam, as it must seem difficult to produce any other kind of pulse at the very high frequencies where transit time effects become important.

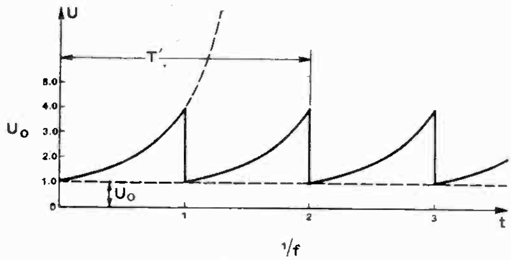

Fig. 3.

Below I will indicate yet another method for finding the optimum drift tube length S' analytically; Fig. 4b shows the space-time

*See a letter from W. S. Elliott and T. A. Ratcliffe in *Nature*, February 17th, 1940.

C

diagram of electrons modulated with a potential $U = U_0(1 + m \sin \omega t)$ where m is the depth of modulation (Fig. 4a).

(*b*) *Derivation of "Time of Arrival" Function:*

Denoting the time of arrival of an electron at S as a, taking the time of arrival of an electron which started at $t = 0$ as zero, we find from the geometry of Fig. 4b

$$a = t + \frac{S}{u} - \frac{S}{u_0} \quad .. \quad (2)$$

As $\frac{u}{u_0} = (1 + m \sin \omega t)^{1/2}$ we can transform the formula (2) into

$$a = t + \frac{S}{u_0}\left[(1 + m \sin \omega t)^{-1/2} - 1\right] \quad .. \quad (3)$$

This formula will be called the "time of arrival" function and is shown in Fig. 4c.

(*c*) *Derivation of S′.*

From a study of this curve (Fig. 5) it will be apparent that the closer any of its portions approaches the horizontal, the greater will be the relative current density at that point. Electrons which, though starting at different times t arrive all at the same time a, can be said to be bunched, compressed or focused. The distance S at which it occurs can be called a focus, although whether there is *optimum focusing* will depend on several circumstances.

Wherever the "time of arrival" function goes through an extremum (maximum or minimum) there will be focusing, and it is clear that the focusing will be the better, the flatter the curve is at these points or the greater the radius of curvature.

If the radius of curvature is $\pm \infty$ at the extremum, in our case: *at a point of inflexion*, then the condition for optimum focusing will be fulfilled.

In more mathematical language:—

Where $\frac{da}{dt} = 0$ there will be focusing, while if both

$$\frac{da}{dt} = 0 \text{ and } \frac{d^2a}{dt^2} = 0$$

there will be optimum focusing and S will be equal to S', the optimum drift tube or "focal length." Now we have

$$\frac{da}{dt} = 1 - \frac{S}{2u_0} m \,\omega \cos \omega t(1 + m \sin \omega t)^{-3/2} = 0 \quad .. \quad .. \quad (4)$$

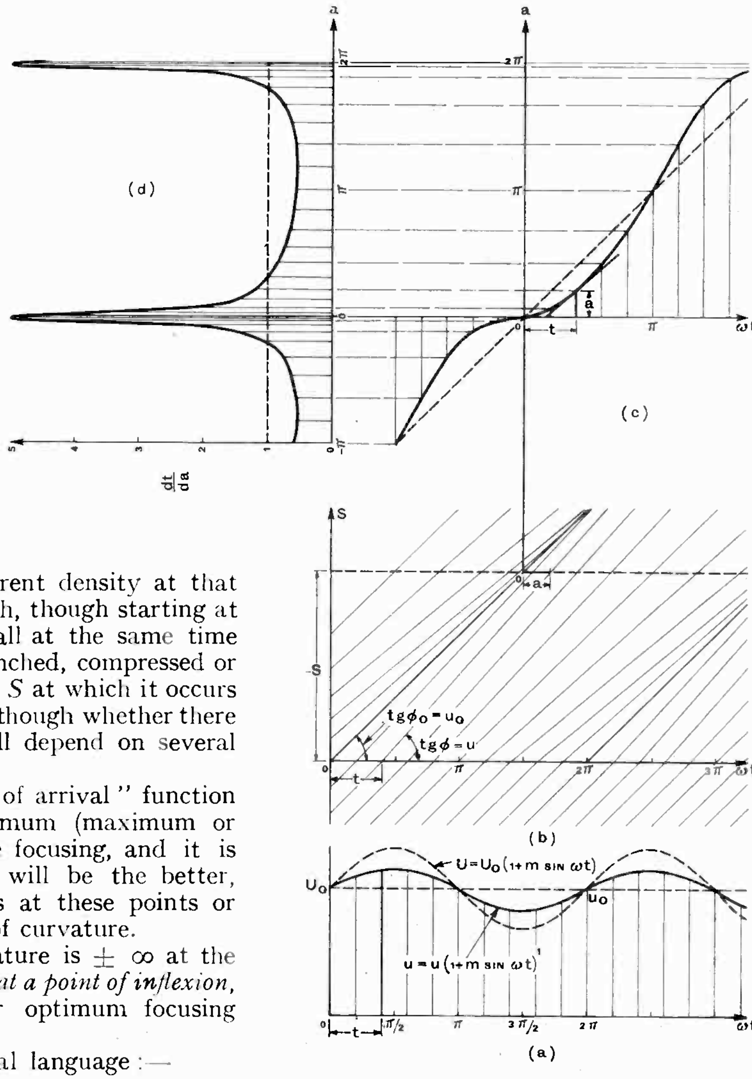

Fig. 4.—*Illustrating the derivation of the "time of arrival" function.*

and

$$\frac{d^2a}{dt^2} = \frac{Sm\omega^2}{2u_0} \cdot \frac{\sin \omega t + \frac{3}{2} m \frac{\cos^2 \omega t}{1 + m \sin \omega t}}{(1 + m \sin \omega t)^{3/2}} = 0 \quad \ldots \quad (5)$$

From (5) we find :—

$$\sin \omega t_f = \frac{1}{m} - \sqrt{\frac{1}{m^2} + 3}$$

where t_f is the time of departure of the optimum focused electrons, or the point where the inflexion of the time of arrival curve occurs.

And $\cos \omega t_f = \sqrt{2}$

$$\sqrt{\frac{1}{m}\sqrt{\frac{1}{m^2} + 3} - \frac{1}{m^2} - 1}$$

These values inserted into (4) give us at once the expression for S', the optimum drift tube length :

$$S' = \frac{\sqrt{2}u_0}{\omega} \cdot \frac{(2 - \sqrt{1 + 3m^2})^{3/2}}{(\sqrt{1 + 3m^2} - m^2 - 1)^{1/2}} \quad \ldots \quad (6)$$

or written in a slightly different way :

$$S' = \frac{u_0}{\pi f m} \cdot c \quad \ldots \quad (7)$$

where c is a correction factor :

$$\frac{\left(2 - m\sqrt{\frac{1}{m^2} + 3}\right)^{3/2}}{\sqrt{2}\left(\frac{1}{m}\sqrt{\frac{1}{m^2} + 3} - \frac{1}{m^2} - 1\right)^{1/2}}$$

The graph of c as a function of m (Fig. 6) shows that c will be nearly 1 for small values of m, which are the ones most likely to occur in practice.

(d) Approximate formula for S'.

As a first approximation one can take $\sin \omega t_f = 0$ for small values of m ; and find the approximate formula for S'.

$$S' \simeq \frac{u_0}{\pi f m} \quad \ldots \quad (8)$$

directly from (4).

This is identical with the formula in a letter published in *The Wireless Engineer*, March, 1940.

(e) Phase displacement T'

The phase displacement T', that is the time an electron starting at $t = 0$ takes to arrive at the focus or to cover the distance S' is given by :—

$$T' = \frac{S'}{u_0} = \frac{1}{\pi f m} \cdot c \quad \ldots \quad (9)$$

It is, as has been pointed out by Tombs*, independent of the unmodulated velocity u_0. It might be worth while to remark that, if $m \simeq \frac{1}{\pi}$, not more than *one* bunch will ever

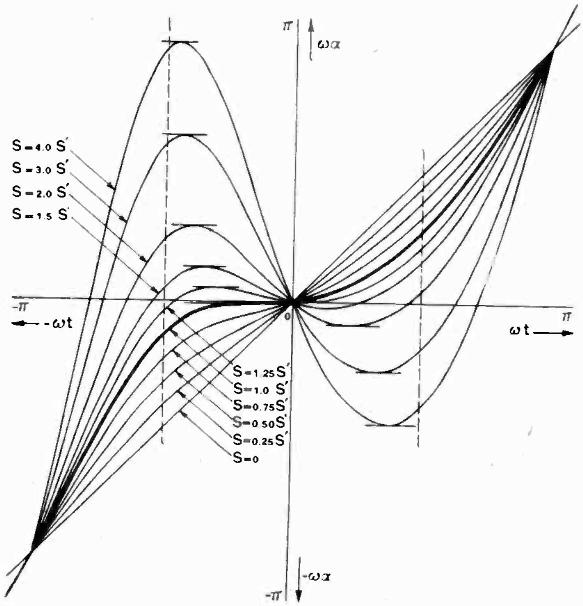

Fig. 5.—"*Time of arrival*" *curves for different values of S.* ($m = \frac{1}{\pi} = 0.318$).

be in existence between the modulating field and the point of optimum drift tube length S'. The number of bunches in being, or being formed at one time over that distance is given by $\frac{1}{\pi m}$, while the distance between successive bunches K_0 is about $\frac{u_0}{f}$.

(f) Beam current i at S as function of t

If the current i_0 is passing through the modulating field between the times t and

* *The Wireless Engineer*, February, 1940, p. 58.

$t + \Delta t$, then between the corresponding times of arrival $a + \Delta a$ a current i will flow past a point S distant from the modulating field, such that :—

$$i = i_0 \frac{\Delta t}{\Delta a} \text{ or } i_0 \cdot \frac{dt}{da}$$

Thus

$$i = i_0 \frac{1}{1 - \frac{sm\omega}{2u_0} \cos\omega t(1 + m \sin\omega t)^{-3/2}} \quad \cdots \quad (10)$$

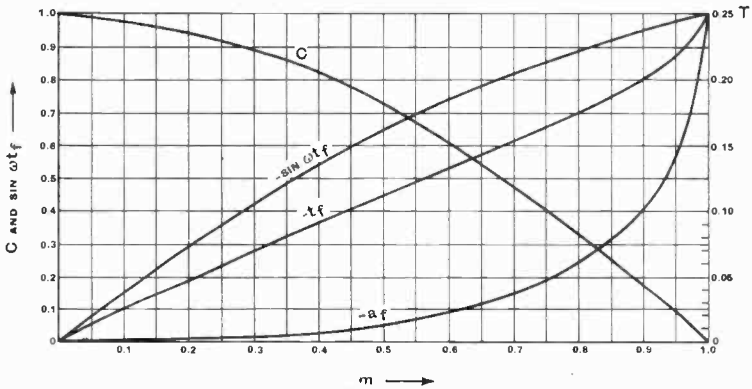

Fig. 6.

This is identical with Strachey's† formula for the instantaneous electron density at any point S at any time a. It has to be pointed out that this is *not* the current i at S as a function of a, which would be a most interesting formula. Unfortunately this formula is not obtainable analytically as it would involve an inversion of the transcendental equation (3). But its graphical solution is quite easy and is shown on Fig. 4d and on Plate I, where the functions $i = f(a)$ for different values of S and $m = 1/\pi$ are shown in their proper time relations, giving a three-dimensional picture of what happens in a drift tube.

For S', given by (7), we find, if we set $t = 0$ and consequently

† *The Wireless Engineer*, May, 1940, p. 202.

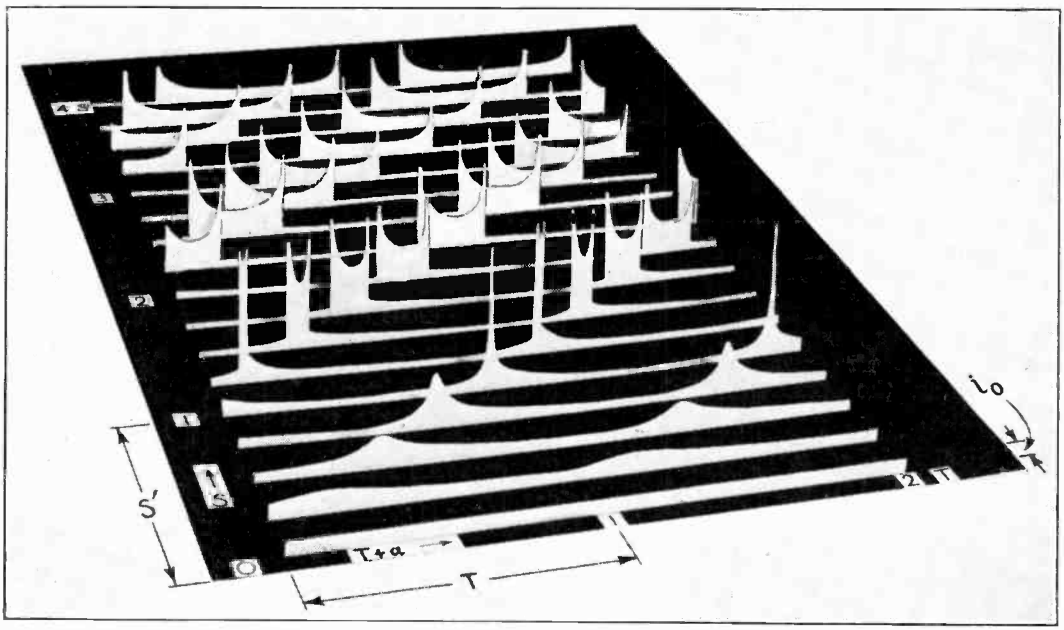

Plate I.—*The electron density distribution* $i = i_0 \cdot \frac{dt}{da}$ *at various distances* S *as a function of* a *(time of arrival).* $m = \frac{1}{\pi}$

$$a = 0, \quad . \quad . \quad . \quad i = i_0 \frac{1}{1 - c}.$$

But the actual peak of the current does not occur when $t = 0$ (only in the hypothetical case of $m = 0$), it occurs when

$$\sin \omega t_f = \frac{1}{m} - \sqrt{\frac{1}{m^2} + 3}$$

and is given by the formula

$$i_f = \frac{1}{1 - \dfrac{Sm\omega}{2u_0 c}}.$$

For $S' = S$, i_f therefore becomes infinite.

(g) *Split-bunches*

If we put $S = b.S'$, where b is an arbitrary constant, and insert this and the value for S' from formula (7) into (4), $\frac{da}{dt} = 0$, we get an equation of the third degree in $\sin \omega t$ of the form:

$$\sin^3 \omega t + \frac{b^2c^2 + 3m^2}{m^3} \sin^2 \omega t + \frac{3}{m^2} \sin \omega t + \frac{1 - b^2c^2}{m^3} = 0$$

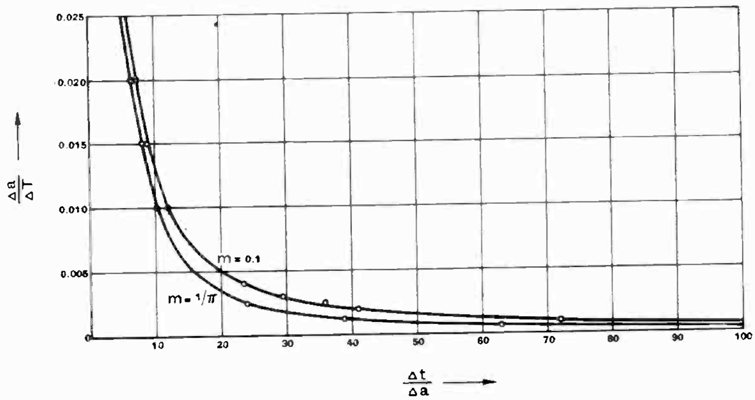

Fig. 7.—" *Definition* " $\frac{\Delta a}{T}$ *as a function of* " *compression* "—*factor* $\frac{\Delta t}{\Delta a}$, *for* $m = 0.1$ *and* $\frac{1}{\pi}$

It can be seen that the influence of the first member is small compared with the others, especially when $m \ll 1$; it can therefore be neglected, and the equation is reduced to one of the second degree with the solution:

$$\sin \omega t_{1,2} = \frac{-3m \pm \sqrt{9m^2 + 4(b^2c^2 + 3m^2)(b^2c^2 - 1)}}{2(b^2c^2 + 3m^2)} \quad .. \quad .. \quad (11)$$

t_1 and t_2 give the positions of the so-called double or split-bunches to a fair approximation so long as m is taken small enough. Again it has to be pointed out that the really interesting function for the position of the split-bunches expressed by a cannot easily be found.

(h) *Absolute velocities of split-bunches*

If b is large, that is if S is very much longer than S', then $\sin \omega t$ approaches unity and $\omega t = \pm \pi/2$; inserted into the formula (3) for the " Time of Arrival " function we get the following:—

$$a_{1,2} = \frac{1}{f}\left[\pm 0.25 + \frac{cb}{\pi m}\left(\frac{1}{\sqrt{1 \pm m}} - 1\right)\right] \quad .. \quad (12)$$

or neglecting the first constant inside the brackets:—

$$a_{1,2} = \frac{cb}{\pi f m}\left(\frac{1}{\sqrt{1 \pm m}} - 1\right) \quad .. \quad (13)$$

These are the times of arrival of the split-bunches relative to the u_0 electron at a point bS' but are only valid for very large values of b.

Now, the velocities of the " split "-bunches can be evaluated as follows:—

The absolute time $\left(\text{neglecting the } \frac{0.25}{f} \text{ term}\right)$ needed by a " split "-bunch electron to cover the distance $b \,.\, S'$ will be $b \,.\, T' + a_{1,2}$; therefore the absolute velocity u_s is:—

$$u_s = \frac{b \,.\, S'}{b \,.\, T' + a_{1,2}}.$$

With the formulae (7), (9) and (13) we get:—

$$u_s = u_0 \sqrt{1 \pm m} \quad .. \quad (14)$$

This was to be expected, as the velocity u of the electrons as a function of the time t is expressed by:—

$$u = u_0 \sqrt{1 + m \sin \omega t}$$

The fastest (and slowest) electrons are passing through the modulating field at $\omega t = \pm \pi/2$ and have therefore the velocities (14).

The " group velocity " of a split-bunch apparently cannot be greater than the velocity of the electrons comprising the bunch.

(*i*) "*Aperture*"

It will often be advantageous to utilise only a part of the complete cycle, for instance, by "chopping" the electron beam before it enters the modulating field (cutting out the

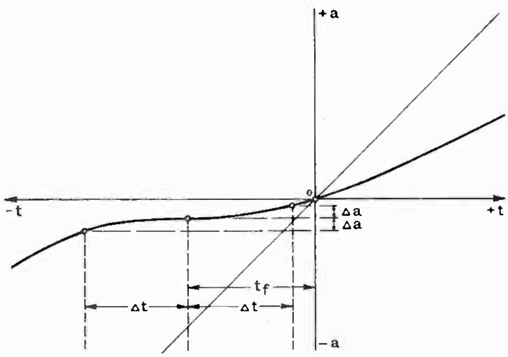

Fig. 7a.—"*Aperture*" $\frac{\Delta t}{T}$ *and* "*definition*" $\frac{\Delta a}{T}$

unwanted part of the cycle). The best method would be to chop the beam so that an equal amount Δt of electrons is left on either side of t_f; $\frac{\Delta t}{T}$ will be called the "aperture." See Fig. 7.

(*j*) "*Definition*" *and* "*Compression Factor*"

On the portion of cycle left in action, together with the factor m, will depend what the "compression factor," denoted by $\frac{\Delta t}{\Delta a}$, will be. It is difficult to find this compression factor analytically; but curves showing $\frac{\Delta t}{\Delta a}$ as a function of $\frac{\Delta a}{T}$ and various m have been found by a graphical method and are shown in Fig. 7.

I propose to call $\frac{\Delta a}{T}$ the "definition"; it is that part of the complete cycle T during which electrons arrive at S'.

The smaller the aperture $\frac{\Delta t}{T}$ the better the definition, i.e. the smaller $\frac{\Delta a}{T}$, but the higher the compression ratio $\frac{\Delta t}{\Delta a}$.

(*k*) "*Depth of Focus*"

Now it is found, leaving everything else unchanged, that $\frac{\Delta a}{T}$ does not increase with increasing distance from S' up to a point $S' + \Delta S$. This distance ΔS I propose to call "depth of focus."

Let us consider the state of affairs in a bunch of an aperture $\frac{\Delta t}{T}$ about to pass through the optimum distance S'. This point is first reached by layers, at the time $-\Delta a$, moving at a slower rate than the average velocity u_0; then at the time $a = 0$ by a layer of u_0 exactly and at $a = \Delta a$ by a layer faster than u_0. Now while the faster layer catches up the slower one and overtakes it by about the same distance as it was behind the slower one, some time will elapse and therefore some distance will be covered. This distance is the depth of focus ΔS and can be found by the graphical method shown on the diagram Fig. 8.

A tangent is drawn on to the S' curve from the point R (given by the Δa in question), touching the curve at the point P. Where the horizontal through R cuts the vertical through P we get the point Q, and $\frac{QW}{PW}$ is the ratio $\frac{S' + \Delta S}{S'}$ from which we find ΔS.

Referring back to Fig. 4b we find, for geometrical reasons, that $\Delta S \simeq 2S' \frac{\Delta a}{\Delta t}$. Thus ΔS can be found also by using the graph on Fig. 7a.

(5) Frequency Multiplier

It is proposed to describe a suggestion for methods of producing very high frequencies which makes use of some of the properties of sinusoidal modulating fields investigated above.

The principle consists, in short, of using a number of electron beams, all velocity modulated, but each different in phase from the other, to excite oscillations in a suitably shaped resonator (Rhumbatron or tank), through which all the electron beams are converging. While the current density of one beam is low, that is between two bunches, the current peaks or bunches of the others arrive in successive equal intervals.

If there are n electron beams, each velocity modulated with the identical frequency f_1 the frequency with which the "bunches" will arrive at a fixed point will be $n . f_1$, and this should also be the frequency of the resonator.

Two main ways are open to make the bunches of the different beams arrive at different times. (a) The phases of the fields modulating the beams differ from each other by an equal amount $2\pi/n$, while the distance (covered by each bunch) from the modulating field to the electric field of resonator, is the same for each of them. (b) The modulating fields oscillate in phase (synchronously) but the distance from each of the modulating fields to the resonator differs from that of the next by an equal amount.

The optimum position for the oscillating body will be some distance beyond S', because it is there that the greatest electron energy is compressed to a small but finite thickness. The actual distance depends on various factors such as the gap of the oscillating body (the distance between the two grids of a rhumbatron), the internal diameter of that body, the beam diameter, and other things.

In the absence of experiments several arbitrary assumptions have to be made to arrive at a probable value for the effectiveness of the suggested method.

I assume a device having 10 electron beams, each of them modulated at a frequency f_1 of say 100 megacycles. The proper frequency of the resonator R should therefore be 1,000 megacycles. At these frequencies and at the beam velocity chosen, the gap between the two shells of the resonator will be of the order of about 3 cm. Now for efficiency, the thickness σ of the bunch should be much smaller than the gap, say, one-fifth.

This gives, with $U_0 = 10{,}000$ V, a $\frac{\Delta a}{T}$ of about 10^{-2}.

Taking $m = 0.2$ we get from formula (7) an optimum drift tube length S' of about 90 cm. This dimension is not impracticable. (Of course, the higher the original frequency f_1, the shorter that distance will be).

The depth of focus ΔS we can get from the graph on Fig. 7 (giving a $\frac{\Delta t}{\Delta a}$ of about 11) and formula (15); it is about 16.5 cm.

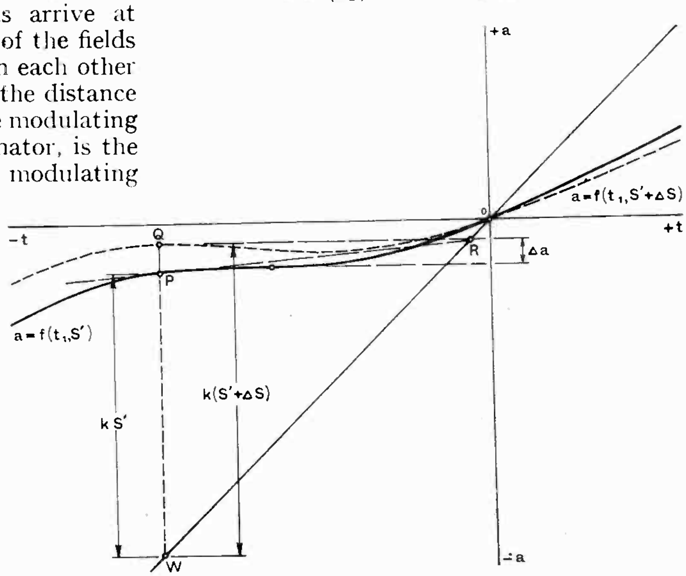

Fig. 8.—*Graphical method for finding "depth of focus ΔS" from a given Δa.*

The distance K_0 beteeen successive bunches of one beam is about 60 cm., which is considerably more than ΔS. Only when that distance is about equal to the depth of focus ΔS, is the method (b) practicable. Therefore we have to use the first method, i.e. modulate each beam separately, with an equal and constant phase shift of 36°, which can be accomplished outside the tube with the use of suitable circuits.

The useful part oj tha whole cycle is $\Delta t \cong 11 \Delta a$ (from Fig. 7) that is 0.11 T or about 40°. It will be advantageous to chop (to modulate the intensity of) the electron beams, perhaps by means of a Wehnelt-electrode or a grid, and nine-tenths of the beam current can thus be saved.

If each beam carries a current of 100 mA, about one-tenth of it will be effective, and with 10 beams electrons with an alternating current component of a highly peaked wave shape, 10,000 V energy and 110 mA will pass through the resonator. Assuming an energy transfer of 50 per cent., we get an output of about 550 watts, at 1,000 megacycles (30 cm); oscillations of constant frequency, easily modulated by a signal (which can be impressed or superimposed on the Wehnelt-electrodes or grids without disturbing the stability of the oscillations).

Fig. 9 shows (diagrammatically only) the arrangement outlined above.

At the relatively longer wavelengths it might be advantageous to leave the resonator (dismountable) outside the vacuum tube to enable easy adjustments or changes to be made. Within certain limits, the frequency which can be generated by one and the same tube can be varied at will by choosing different values for U_0 and m.

For the relatively shorter wavelengths (below 20 cm.) the number of beams may be increased, and as it may be difficult then to obtain the necessary exact phaseshifts for each of their modulating fields, the staggering of the arrival times of the bunches at the resonator will be better carried out by varying the respective distances between modulating fields and tank according to method (b). Lower values for m may then be used, which will improve the $\frac{\Delta t}{\Delta a}$ factor, so that the efficiency of the method need not fall with increasing frequencies.

the formulae used for evaluating certain parameters of the frequency multiplier described above. But the basic assumptions will nevertheless be correct in the orders of magnitude. It may be possible that a mode of operation will be found more profitable, where the resonator is placed at that point of the tube at which the hindmost peak of a split-bunch coalesces with the foremost peak of the following split-bunch.

(6) Suggestions for an Improved Image Dissector (with Line Storage)

The present-day television pick-up tubes in use, such as the Iconoscope, Emitron or Super-Emitron, suffer from the unavoidable appearance of various interferences, random shadings, etc., while the Image Dissector as developed by Farnsworth—not suffering from the above-mentioned defects—is relatively very insensitive. To develop a device which is free from shading effects, etc., and which at the same time makes use of the storage principle, resulting in a greatly increased sensitivity has long been a desirable goal.

An idea will now be described which represents an approach to this goal. It is fully realised that for the time being the idea is not practicable; but it might happen

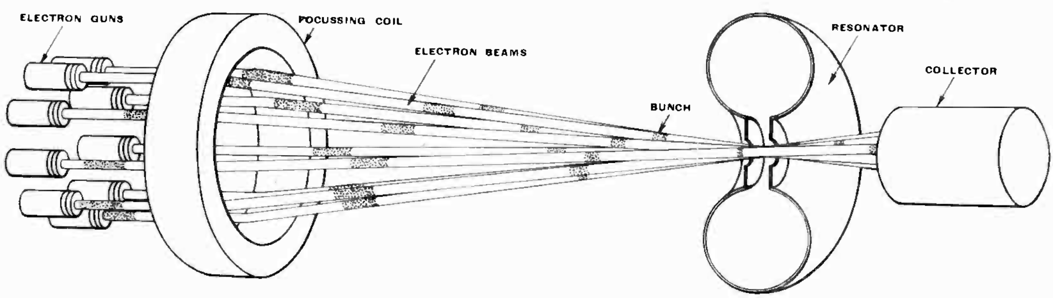

Fig. 9.—*Diagrammatic sketch of frequency multiplier.*

Many difficulties will have to be surmounted before the above methods can be expected to work effectively. The necessity of providing an oscillator, working at a frequency about an order of magnitude below the output frequency does not seem to be a serious drawback.

It is understood that with beam currents of 100 mA, space charge effects will play a very important part; they will invalidate

again that ideas not practicable at one time become so a few years later.

Light from the scene is allowed to fall on a photo-sensitive surface C (Fig. 10) where it forms an optical image. Electrons will be emitted in proportion to the illumination at each point and an accelerating field will draw them away. An axial magnetic field is assumed to constrain the electrons on paths substantially parallel to the axis.

Deflecting devices D_1, D_2 working at the picture frequency are provided to deflect the electron stream in such a way as to displace it upwards and downwards, while the electrons continue to move axially. The electron stream is thus swept over an electrode A provided with a horizontal slit aperature H which lets through a part of the electron stream representing a line of the image to be scanned. This flat electron stream now passes through a modulating field M (or phase lens) which influences the velocities of the electrons in such a way, that substantially all of them are concentrated (bunched, focused or compressed) into a very thin narrow band of electrons at a distance S' further down.

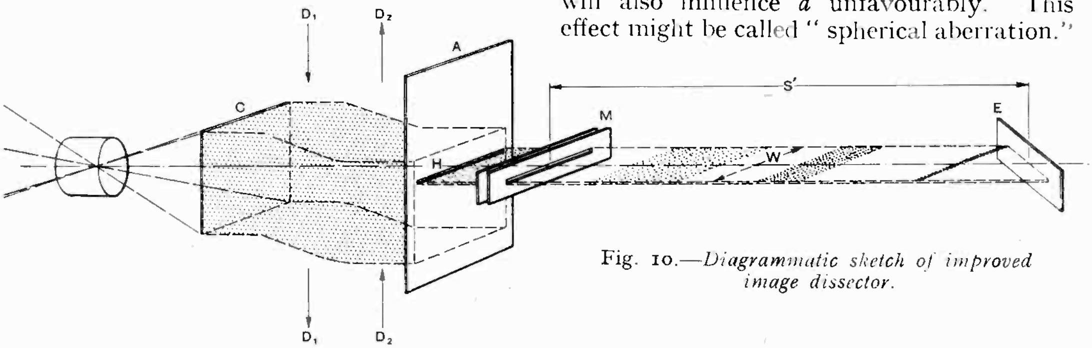

Fig. 10.—*Diagrammatic sketch of improved image dissector.*

Now let us assume that the depth of focus ΔS is about equal to the width of the band W and moreover that the distance between successive bunches K_0 is also equal to W. Finally let the "aperture" $\frac{\Delta t}{T}$ of the modulating field (not necessarily sinusoidal) be about unity.

Then the number of electrons, or the current impinging on a plane electrode E, called the signal electrode and inclined at an angle of, say, 45° to the axis and the electron band, will be directly proportional to the electron distribution over the electron band. That current will be the signal current, and it will be composed of nearly all the electrons emitted by the various image elements of a line during the whole of the time T needed for the scanning of a line. Thus storage can be utilised for the whole time occupied by a line (as against storage for a whole picture with the Iconoscope type tube).

The number of image elements per line is limited by the so-called "chromatic dispersion" of the photo-electrons, i.e. by their non-uniformity of initial velocities and directions and their relation to the acceleration potential. This will influence the actual thickness d of the electron band and the number of elements will be given by the quotient W/d. Any deviation of the modulating saw-tooth wave from the ideal shape will also influence d unfavourably. This effect might be called "spherical aberration."

So much for the principle: What are the practical limitations for employing the method?

If we try to employ this device in connection with television standards in use in this country until the outbreak of war (that is 405 lines, 25 pictures/sec. interlaced), the method turns out to be quite impracticable, using a modulating field as shown on Fig. 3, and taking U_0 as 25 volt.

When we anticipate a very much more advanced standard of television technique, that is:

Picture frequency: 100/sec. (to reduce flicker);

Number of lines: 2,000 (without interlacing);

Stereoscopic Transmission in three colours;

we get $f = 100 \times 2{,}000 \times 3 \times 2 = 1.2$ Mc/s. Inserting this into the formula for the optimum drift tube length

$$S' = 6.10^7 . \sqrt{U_0} . \frac{2}{f}$$

we get $S' = 500$ cm. This differs from an acceptable dimension only by a factor 5 to 10; that means, it is still impracticable, but not very far from practical realisation.

It is possible that a change of the present methods of scanning an image could be favourable for the employment of the device described above, but it would be useless to speculate on it just now.

Although it is thought that the lowest accelerating voltage which could safely be employed in view of the "chromatic" aberration might be 25, experiment might prove a still lower voltage useful. The number of lines could be increased still further, while reducing the number of elements per line.

The photo-sensitivity required would perhaps be just within the limit attainable at present.

Nevertheless the method must seem Utopian at the present time, not only because of the definition in question, but also for the frequencies which would be involved in transmitting such a signal.

If a kind of photo-emission could be found where ions are emitted instead of electrons, or a way by which the movement of ions could be influenced by photo-emission, the idea outlined above would at once become a practical proposition.

I am indebted to Mr. G. Hamburger for many helpful discussions.

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"Currents induced by electron motion in electrodes," Simon Ramo, *Proc. Inst. Rad. Eng.*, 1939, p. 584.

"The electronic-wave theory of velocity-modulated tubes," Simon Ramo, *Proc. Inst. Rad. Eng.*, 1939, p. 757.

"Small signal theory of velocity-modulated electron beams," W. C. Hahn, *Gen. Elec. Review*, 1939, Vol. 42, p. 258.

"Wave energy and Transconductance of velocity modulated electron beams," W. C. Hahn, *Gen. Elec. Review*, 1939, Vol. 42, p. 497.

"High frequency oscillator and amplifier," R. Varian and S. Varian, *Journ. of Applied Phys.*, May, 1939, Vol. 10.

"On Resonators suitable for Klystron oscillators," W. W. Hansen and R. D. Richmeyer, *Journ. of Applied Phys.*, 1939, Vol. 10, p. 189.

"Cathode-ray bunching," David L. Webster, *Journ. of Applied Phys.*, 1939, Vol. 10, p. 501.

"The theory of Klystron oscillations," David L. Webster, *Journ. of Applied Phys.*, 1939, Vol. 10, p. 864.

"Space-charge effects in electron beams," A. V. Haeff, *Proc. Inst. Rad. Eng.*, 1939, p. 586.

"U.H. frequency power amplifier," A. V. Haeff, *Electronics*, 1939, p. 30.

"A wide-band inductive-output amplifier," A. V. Haeff and L. S. Neergaard, *Proc. Inst. Rad. Eng.*, March, 1940, p. 127.

"On velocity-modulated electronic tubes," J. Bethenod, *Comptes Rendus*, 1940, p. 103.

"Velocity-modulated beams (The electron density distribution)," D. Martineau Tombs, *Wireless Engineer*, February, 1940, Vol. 17, p. 55.

"Ballistic models of velocity modulated transit-time apparatus," H. E. Hollmann, *Hochf:tech. u. Elek:akus.*, March, 1940, p. 73.

I.E.E. Meetings Suspended

THE Council of the Institution of Electrical Engineers has decided that it would be inadvisable to hold the usual programme of evening meetings in London, during the first half of the present session, for the reading and discussion of papers. As an alternative, copies of those papers that would have been read will be available for members on application to the secretary. The submission of comments on the papers will be welcomed with a view to publication in the *Journal*. All papers will be published in abstract in Part I of the sub-divided *Journal* which commences in January, and they will also appear subsequently in full, together with the written comments, in Part II or III.

The following two papers of wireless interest appear in the list of those which were to have been read during the first half of the 1940–41 session: "The Applications and Use of Quartz Crystals in Tele-communications" by C. F. Booth, and "Broadcast Receivers: A Review" by N. M. Rust, O. E. Keall, J. F. Ramsay, M.A., and K. R. Sturley, Ph.D., B.Sc. The approximate dates on which a limited number of these two papers will be available are December 19th and January 8th, respectively. It should be pointed out that separate application must be made for each paper.

The Industry

WORKERS in vacuum physics will be interested to learn that W. Edwards & Co. (London), Ltd., Southwell Road, London, S.E.5, are in a position to supply a complete range of jointing waxes, greases and cements, many of which were formerly of a type imported from abroad. Particulars of these new products and a useful reference card showing the properties of standard Apiezon waxes are obtainable from the makers.

Two new Ferris signal generators for ultra-high frequencies are announced. The Model 18c is similar to the 18b but has a frequency range from 3 to 175 Mc/s. In the Model 40A the upper limit is 250 Mc/s. Full details are available from Leland Instruments, Ltd., 21, Bedford Row, London, W.C.1.

We have received a copy of the Reference Sheet No. 1 issued by Multicore Solders, Ltd., Bush House, London, W.C.2. This gives much useful information, including advice on the choice of alloys of suitable melting point for different types of work.

Abstracts and References

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

PROPAGATION OF WAVES

4189. THE USE OF THE WAVE GUIDE FOR MEASUREMENT OF MICRO-WAVE DIELECTRIC CONSTANTS [and Some Measurements on Wavelengths of 15–25 cm].—Lamont. (*See* 4373.)

4190. THE ACOUSTICAL TUBE AS A HIGH-PASS FILTER [including Analogy with Hyperfrequency Wave-Guides].—L. Brillouin. (*Rev. d'Acoustique*, Fasc. 1/3, Vol. 8, 1939, pp. 1–11.)

"Ordinarily, in a tube employed in acoustics, only the most simple mode of transmission is considered, in which a section of a plane uniform wave is propagated along the axis of the tube. There exist, however, other types of transmission, in which the tube is traversed by waves presenting nodal lines in the cross section: the tube then functions as a high-pass filter. These waves can be generated by exciting the tube, at one end, by pistons in push-pull." For the experimental work of Hartig & Swanson, discussed in section 5 as confirming the present writer's theoretical conclusions, *see* 620 of 1939.

4191. CALCULATION OF SKIN-EFFECT BY THE METHOD OF PERTURBATIONS [including the Determination of the Heat developed (used in Study of Absorption of Electromagnetic Waves in Tubes) and the Case of an Inhomogeneous Conductor (Propagation of Waves above the Ground or Surface of Sea)].—S. M. Rytov. (*Journ. of Phys.* [of USSR], No. 3, Vol. 2, 1940, pp. 233–242: in French.)

Author's summary:—"An approximate method is given for the calculation of skin-effect: it is a method of perturbations. A field at the exterior of perfect conductors having the same form and disposition as the given real conductors is considered as the initial approximation (sections 1–3). It is shown that in an approximation of zero order a simple expression in the form of a surface integral is obtained (section 4) for the heat developed in the conductor [it is this that serves as a basis for the author's simple method of calculating the absorption of micro-waves in metal guides, etc: *see* 2860 of August].

"A solution is given for the case of a conductor limited by an infinite plane surface (section 5), and the conditions are given in which a zero-order approximation can be used [section 6: this section shows the difference (as regards frequency limits) between the case of metals, where σ is of the order of 10^{16}–10^{17}, and of the ground, where it is of the order of 10^6–5×10^7: the case of a vertical dipole is touched on]. A solution of the problem is also given for the most general case of an inhomogeneous conducting medium (section 7)." Here, it is pointed out, "the whole method of calculation explained in sections 2–4 can be applied easily and gives an asymptotic solution (when $\sigma_0 \rightarrow \infty$) which approaches the solution for the perfect conductor."

4192. WIRELESS WAVES AT THE EARTH'S SURFACE [treated as a Skin-Effect Problem by Telephone Transmission Formulae: Calculation of Power dissipated in Soil, Depth of Penetration, etc.].—G. W. O. H. (*Wireless Engineer*, Sept. 1940, Vol. 17, No. 204, pp. 385–387.) Editorial: an extension of Howe's work in the 1916 *Journ. I.E.E.*

4193. REFLECTION CURVES AND PROPAGATION CHARACTERISTICS OF RADIO WAVES ALONG THE EARTH'S SURFACE [Extension of Previously Described Method (1769 of 1938) to Angles of Incidence greater than 80°: Simple Ray Theory Not Applicable at Grazing Incidence for Transmitter or Receiver Heights Very Small compared with Wavelength—Field corresponding to Sommerfeld "Surface Wave" must be Added (of Much Greater Importance for Vertically Polarised Waves than for Horizontally): etc.].—J. S. McPetrie & A. C. Stickland. (*Journ. I.E.E.*, Aug. 1940, Vol. 87, No. 524, pp. 135–145.) For the Discussion on this and the two other papers dealt with below *see* pp. 159–162.

4194. AN EXPERIMENTAL INVESTIGATION OF THE PROPAGATION OF RADIATION HAVING WAVE-LENGTHS OF 2 AND 3 METRES [for Optical Ranges over Land: Fading never greater than $\pm$ 3 db: for Heights Small compared with Distance but Not compared with Wavelength, $\epsilon = 90\sqrt{P} . h_T h_R / \lambda d^2$, for both Horizontal & Vertical Polarisation: etc.].—J. S. McPetrie & J. A. Saxton. (*Journ.I.E.E.*, Aug. 1940, Vol. 87, No. 524, pp. 146–153.)

4195. RADIO DIRECTION-FINDING ON WAVELENGTHS BETWEEN 2 AND 3 METRES (100 TO 150 Mc/s).—Smith-Rose & Hopkins. (*See* 4294.)

4196. REFLECTION, REFRACTION, AND ABSORPTION CHARACTERISTICS OF ELECTROMAGNETIC WAVES ON ROCKS [Equations for Attenuation Constant, Reflection Coefficient, Reflection Coefficient at Boundary Surface, Depth of Penetration until Amplitude attenuates to $1/e$: All Values decrease as Decrease in Wavelength. in Region 200–5 m].—M. Kodawaki. (*Electrotech. Journ.*, Tokyo, July 1940, Vol. 4, No. 7, p. 168.) For previous work *see* 4793 of 1939.

4197. THE CALCULATION OF RADIO SKY-WAVE TRANSMISSION [Practical Application of F-Region Critical Frequencies (with Help of Simple Charts obtained by Geometrical Optics) to derive Relation between Frequency, Range, & Angle of Incidence for Each Season: Examples of Use—Manila/Tokyo, 3100 km, and Shinking/Tokyo, 1560 km].—K. Maeda & T. Kohno. (*Nippon Elec. Comm. Eng.*, April 1940, No. 20, pp. 236–246.)

For previous work *see* 908 of March. The ionosphere measurements at the Electrotechnical Laboratory, Tokyo, fit in (for the higher frequencies) with eqn. 14 for the electron density: $N = (N_F)_{max}\{2(z - z_0)/z_d - (z - z_0)^2/z_d^2\}$, where z is the height of the reflecting point, z_0 that of the lower edge of the layer, and z_d the height of the max. electron density above the lower edge. "Thus . . . the electron density distribution in F region is expressed by a hyperbolic curve whose vertex corresponds to the point of max. electron density": the writer considers that the distribution in the E layer follows the same form, with a z_d of about 20–25 km and a z_0 of about 90 km. For Appleton & Beynon's treatment of the problem *see* 3290 of September.

4198. IONOSPHERE STORMS AND RADIO TRANSMISSION BETWEEN NORTH AMERICA AND EUROPE [Observations on Long-Distance Broadcast Transmission between South America & North America or Europe furnish Explanation of the "North Atlantic Anomaly"].—J. H. Dellinger & A. T. Cosentino. (*Tech. News Bull. Nat. Bur. of Stds.*, Aug. 1940, No. 280, pp. 63–64.) Summary of paper at Eighth American Scientific Congress.

4199. PREDICTIONS OF USEFUL DISTANCES FOR AMATEUR COMMUNICATION [with Charts for Aug. & Sept. 1940].—N. Smith & S. S. Kirby. (*QST*, Sept. 1940, Vol. 24, No. 9, pp. 26–27.) Similar articles will be published quarterly.

4200. ON POSSIBLE CHANGES IN THE SOLAR "CONSTANT" [Thorough Periodogram Analysis of Abbot's Mean Values: 10 Pronounced Harmonic Components (Some differing from Abbot's), the 6 Longest apparently Fourier Components of a 10.2-Year Period (practically equal to Average Sunspot Period for the Examined Years): Real Changes in Solar Constant are Probable].—T. E. Sterne & others: Abbot. (*Proc. Nat. Acad. Sci.*, June 1940, Vol. 26, No. 6, pp. 399–406.)

"Pending the publication by Abbot of revised material, this point should not be regarded as settled." For previous work *see* 1321 of April and 3733 of October: *cf.* Hulme, 3311 of September.

4201. ON SOLAR FACULAE AND SOLAR CONSTANT VARIATIONS.—H. Arctowski: Abbot. (*Proc. Nat. Acad. Sci.*, June 1940, Vol. 26, No. 6, pp. 406–411.)

". . . But now I have the necessary data to prove, at least to my own satisfaction, not only that the processes in the solar photosphere—which produce changes in the extent of faculae, observed from day to day or from one group of days to another—directly affect the measured values of the solar constant, but also that in our atmosphere the changes of solar radiation, expressed by the figures of solar-constant variations, are the direct cause of anomalies in the distribution of temperature and of all the complexity of the meteorological phenomena depending on temperature anomalies." *See* also 2893 of August.

4202. THE CORONAVISER, AN INSTRUMENT FOR OBSERVING THE SOLAR CORONA IN FULL SUNLIGHT [Report of First Practical Trial, at the Cook Observatory].—A. M. Skellett. (*Proc. Nat. Acad. Sci.*, June 1940, Vol. 26, No. 6, pp. 430–433.) *See* also Stokley, 3735 of October, and 2896 of August.

4203. THE LOCAL VARIATION OF ATMOSPHERIC POTENTIAL GRADIENT DURING FOUR SOLAR ECLIPSES AT TAIHOKU [Field Fluctuations ascribed to Influence of Change in Meteorological Conditions: Changes in Ionosphere do Not affect Atmosphere near Earth's Surface].—K. Ogasahara. (*Sci. Abstracts*, Sec. A, 25th Aug. 1940, Vol. 43, No. 512, p. 614.)

4204. AN AURORA IN A TEST TUBE.—W. H. Barton, Jr. (*Scientific Monthly*, Sept. 1940, Vol. 51, No. 3, pp. 289–291.)

4205. NEW STUDIES ON ACTIVE NITROGEN: I—BRIGHTNESS OF THE AFTER-GLOW UNDER VARIED CONDITIONS OF CONCENTRATION AND TEMPERATURE: II—INCANDESCENCE OF METALS, ETC.—Rayleigh. (*Proc. Roy. Soc.*, Ser. A, 28th Aug. 1940, Vol. 176, No. 964, pp. 1–15: pp. 16–27.) The full paper, a summary of which was referred to in 3738 of October.

4206. A STUDY OF TIME-VARIATIONS IN COSMIC-RAY INTENSITY AT HIGH ALTITUDES [Indication of Combined Effects of Magnetic Fields of Earth & Sun], *and* FINE STRUCTURE IN THE DIRECTIONAL INTENSITY OF COSMIC RAYS.—W. P. Jesse: D. Cooper. (*Phys. Review*, 15th Aug. 1940, Vol. 58, No. 4, pp. 281–287: pp. 288–292.)

4207. DETERMINATION OF THE VELOCITY OF LIGHT, USING THE KERR EFFECT AND A PHOTO-ELECTRIC CELL AS A PHASE-DEPENDENT RECTIFIER.—A. Hüttel. (*Ann. der Physik*, 1st May 1940, Ser. 5, Vol. 37, No. 5/6, pp. 365–402.)

4208. DARK BANDS IN THE SPECTRA OF DOUBLE DIFFRACTION GRATINGS [Disagreement with Bär's Explanation: Lommel's Treatment: a New Explanation].—R. A. Houston. (*Phil. Mag.*, July 1940, Vol. 30, No. 198, pp. 68–78.) The use of these bands as a means of measuring supersonic wavelengths is mentioned.

4209. THE INFLUENCE OF INITIAL STRESS ON ELASTIC WAVES [Rigorous Treatment of Propagation in an Elastic Continuum, taking Initial Stress into Account].—M. A. Biot. (*Journ. of Applied Phys.*, Aug. 1940, Vol. 11, No. 8, pp. 522–530.)

4210. A PATHOLOGICAL CASE IN THE NUMERICAL SOLUTION OF INTEGRAL EQUATIONS [primarily in Seismic Propagation Problems].—C. L. Pekeris. (*Proc. Nat. Acad. Sci.*, June 1940, Vol. 26, No. 6, pp. 433–437.)

"An integral equation of the first kind . . . is cited for which a trial solution which is totally inacceptable reproduces the given function on the left-hand side to within 2% . . ."

ATMOSPHERICS AND ATMOSPHERIC ELECTRICITY

4211. A THEORETICAL DETERMINATION OF BREAK-DOWN VOLTAGE FOR SPHERE-GAPS [on Streamer Theory].—J. M. Meek. (*Journ. Franklin Inst.*, Aug. 1940, Vol. 230, No. 2, pp. 229–242.) The full paper, a summary of which was dealt with in 3740 of October. *See* also below.

4212. THE MECHANISM OF SPARK DISCHARGE IN AIR AT ATMOSPHERIC PRESSURE: I [Classical Theory: Nature of Mechanism which must be active at Higher Pressures]: II [including Modification of Meek's Theory].—Loeb & Meek. (*Journ. of Applied Phys.*, June & July 1940, Vol. 11, Nos. 6 & 7, pp. 438–447 and 459–474.) With bibliography of 63 items.

4213. LIGHTNING CURRENT IN ARRESTERS AT STATIONS [Results of Cooperative Field Investigation, 1936/1939].—I. W. Gross & W. A. McMorris. (*Elec. Engineering*, Aug. 1940, Vol. 59, No. 8, Transact. pp. 417–422.)

4214. ENCLOSED SPARK GAPS [and the Presence & Effect of Ionising Radiation: Tests on Low Impulse Ratio observed on Rutile-Spacer Gaps: etc.].—W. E. Berkey. (*Elec. Engineering*, Aug. 1940, Vol. 59, No. 8, Transact. pp. 429–432.)

4215. LIGHTNING AND LIGHTNING PROTECTION ON DISTRIBUTION SYSTEMS.—R. C. Bergvall & E. Beck. (*Elec. Engineering*, Aug. 1940, Vol. 59, No. 8, Transact. pp. 442–448.)

4216. AIR ELECTRICITY WARNS PLANES WHEN APPROACHING MOUNTAINS.—Gunn. (*See* 4297.)

4217. THE LOCAL VARIATION OF ATMOSPHERIC POTENTIAL GRADIENT DURING FOUR SOLAR ECLIPSES AT TAIHOKU.—Ogasahara. (*See* 4203.)

4218. USE OF A GRID TO REDUCE OPERATING VOLTAGE IN GEIGER-MÜLLER COUNTERS [particularly for Radiosonde Working].—Korff & Ramsey. (*Review Scient. Instr.*, Aug. 1940, Vol. 11, No. 8, pp. 267–269.)

PROPERTIES OF CIRCUITS

4219. CALCULATION OF SKIN-EFFECT BY THE METHOD OF PERTURBATIONS.—Rytov. (*See* 4191.)

4220. THEORY OF COUPLED PARALLEL-WIRE SYSTEMS [Self- & Mutual Inductances calculated by Usual Methods, Self- & Mutual Capacities with help of Maxwell's Equations for Static Voltage: "Unexpectedly Uniform Circuit Characteristics": Applicable to Band-Pass Filters, Matching Link between Feeder & Aerial, etc.].—R. Usui. (*Electrotech. Journ.*, Tokyo, July 1940, Vol. 4, No. 7, pp. 156–158.)

4221. APPLICATION OF THE PROPERTIES OF THREE TYPES OF DETERMINANTS TO THE CALCULATION OF THE NATURAL FREQUENCIES OF COUPLED OSCILLATING SYSTEMS [usually obtained by Operational Calculus: including a Terminated T-Filter].—M. Parodi. (*Sci. Abstracts*, Sec. B, 25th Aug. 1940, Vol. 43, No. 512, p. 338.)

4222. FILTER DESIGN CHARTS: I [for Various Types of Constant-k Filter Sections].—J. Borst. (*Electronics*, Aug. 1940, Vol. 13, No. 8, pp. 35–36.)

4223. FILTER NETWORKS IN WHICH CORRESPONDING ELEMENTS OF SUCCESSIVE SECTIONS ARE CHANGED BY A CONSTANT FACTOR [Theoretical Investigation prompted by Problem of Sound Insulation, but carried out in Electrical Notation: Special Properties of Such Filters: Problem of the Exponential Horn: Acoustic Filters (Pressure, Rate-of-Flow, & Velocity Amplification)].—J. Brillouin. (*Rev. d'Acoustique*, Fasc. 1/3, Vol. 8, 1939, pp. 79–96: long summary in *Journ. Acous. Soc. Am.*, July 1940, Vol. 12, No. 1, pp. 207–208.)

4224. ON THE INTEGRAL EQUATIONS OF CONTINUOUS DYNAMICAL SYSTEMS [with Application to Damped Vibrating String & Electrical Transmission Line].—W. H. Ingram. (*Phil. Mag.*, July 1940, Vol. 30, No. 198, pp. 16–38.)

4225. TRANSIENT THEORY OF TWO PARALLEL LINE CIRCUITS [Extension, to Transients, of Method of Analysis based on Resolution into Two Wholly Independent Lines, Each having the Proper Equivalent Voltage allotted to It at the Sending End].—T. Hirota. (*Nippon Elec. Comm. Eng.*, April 1940, No. 20, pp. 265–266: summary only.) For previous work *see* 3161 of 1938 and 2943 of August.

4226. TRANSIENT ANALYSIS OF SYMMETRICAL NETWORKS BY THE METHOD OF SYMMETRICAL COMPONENTS [and Laplacian Transformations: Great Simplification].—L. A. Pipes. (*Elec. Engineering*, Aug. 1940, Vol. 59, No. 8, Transact. pp. 457–459.)

4227. FUNDAMENTAL THEORY OF LINEAR MODULATION NETWORK [Network whose Linear Elements vary Periodically, in Modulation or Transformation of Angular Frequency: Solution of Stationary State: Linear-Modulation Mutual Impedance & Admittance: Applicability of Kirchhoff's Law, Law of Superposition, & Hō-Thévenin Theorem: Extension of Reciprocity Theorem: etc.].—M. Akiyama. (*Nippon Elec. Comm. Eng.*, April 1940, No. 20, pp. 201–205.)

4228. THEORETICAL CONSIDERATION OF LINEAR MODULATION FOUR-TERMINAL NETWORK.—M. Akiyama. (*Nippon Elec. Comm. Eng.*, April 1940, No. 20, pp. 247–260.) The simplest of the multi-terminal networks considered above (4227) is dealt with.

4229. TUNED-GRID TUNED-PLATE OSCILLATOR [Factors involved in Production of Oscillations caused by Feedback through Plate/Grid Capacitance].—Mouromtseff. (*See* 4244.)

4230. THE INVERTED AMPLIFIER [with Earthed Grids, Driving Excitation applied to Cathodes: Advantages for Short & Ultra-Short Waves (Screening by Grid between Input & Output Circuits, Reduction of Output-Circuit Capacitance, etc.): Example of 50 kW Short-Wave Broadcasting Transmitter].—C. E. Strong. (*Electronics*, July 1940, Vol. 13, No. 7, pp. 14–16 and 55, 56.) *See* also 3384 of September.

4231. RELATIONS BETWEEN ATTENUATION AND PHASE IN FEEDBACK AMPLIFIER DESIGN [Relations between Loop Gain & Loop Phase used to establish a Definite Method of Design, to show how Over-All Loop Characteristics should be Modified when Cut-Off Interval approaches Limiting Band-Width established by Parasitic Elements of Circuit, and to determine Max. Realisable Feedback in Any Given Situation: etc.].—H. W. Bode. (*Bell S. Tech. Journ.*, July 1940, Vol. 19, No. 3, pp. 421–454.) A rather shorter version of the methods developed in the writer's U.S.A. Patent No. 2 123 178.

4232. DISTORTION IN COMPENSATED AMPLIFIERS [of Resistance-Coupled Wide-Band Type: including Suggestions on a Quantitative Terminology for Distortion in terms of Reproduced Wave-Forms], *and* THE EFFECT OF NON-LINEAR DISTORTION IN MULTI-CHANNEL AMPLIFIERS.—J. D. Trimmer & Y. J. Liu: B. B. Jacobsen. (*Electronics*, July 1940, Vol. 13, No. 7, pp. 22–24 and 61, 62: *Elec. Communication*, July 1940, Vol. 19, No. 1, pp. 29–54.) For previous work by Trimmer & Liu *see* 525 of February.

4233. AMPLIFIER CHARACTERISTICS AT LOW FREQUENCIES, WITH PARTICULAR REFERENCE TO A NEW METHOD OF FREQUENCY COMPENSATION OF SINGLE STAGES.—Edwards & Cherry. (*See* 4365.)

4234. GAIN CONTROL OF RADIO-FREQUENCY AMPLIFIERS: ITS EFFECT ON THE INPUT ADMITTANCE.—Lockhart. (*See* 4260.)

4235. THE MAGNETIC VOLTAGE AMPLIFIER.—A. A. Feldbaum. (*Automatics & Telemechanics* [in Russian], No. 5, 1939, pp. 29–36.)

A theoretical and experimental investigation of the magnetic amplifier proposed by Steenbeck & Schmutz (Fig. 1: special issue, 1935, of *Siemens-Zeitschr.*). The operation of the amplifier is discussed, with particular attention to the case with a capacitative load under the condition of resonance at the first harmonic. An analysis of equation (3), determining the output voltage U for this case, is given; characteristic curves of a typical amplifier using iron cores are plotted (Fig. 4). Various factors affecting the stability are considered, and a number of practical suggestions for raising this are made. It is stated that an amplification factor of 300 000 was obtained when using permalloy cores. *Cf.* Lamm, 3771 of October.

4236. A GENERAL SOLUTION OF THE HELMHOLTZ EQUATION, TAKING INTO ACCOUNT THE EFFECT OF IRON.—V. I. Kovalenkov. (*Automatics & Telemechanics* [in Russian], No. 2, 1939, pp. 3–26.)

Equations (3) and (4) are considered determining respectively the building-up and dying-out of the current in a toroid circuit when a constant e.m.f. is switched on and off (Fig. 1 and 2). In a previous paper equation (1) was derived showing the relationship between the instantaneous values of the magnetic flux and the current in the circuit. Using this equation, solutions (5 and third line at the bottom of p. 21) of equations (3) and (4) are found. From a numerical analysis of these solutions curves are plotted showing the variation of the current with time for different degrees of the magnetic saturation of the toroid core. The accuracy of these curves is confirmed by a comparison with those obtained experimentally.

4237. CONSTANT CURRENT SOURCES [unaffected by Load Changes: allow Elimination of Ballast Resistors, Chokes, etc: improve Stability (so that Power Input may be Increased): Circuits based on That given by Steinmetz, and Their Practical Appplication (*e.g.* to Oscillators & Rectifiers of Cyclotrons): etc.].—L. C. Green & J. B. H. Kuper. (*Review Scient. Instr.*, Aug. 1940, Vol. 11, No. 8, pp. 250–256.)

4238. A VACUUM-TUBE ALTERNATING-VOLTAGE COMPENSATOR [primarily for Circuit for Absolute Measurement of Resistance: Current Pulsations (from Rotating Commutator) in 1-Ohm Resistor reduced to One Millionth of Average Current by Combination of Air-Gapped Inductor & Two 2-Valve Amplifiers].—Cooter, Wenner, & Peterson. (*Journ. of Res. of Nat. Bur. of Stds.*, July 1940, Vol. 25, No. 1, pp. 41–45.)

4239. A DESIGN OF ATTENUATION EQUALISER [Two-Terminal Design without Consideration for Circuit Impedance (in Contrast to Zobel Four-Terminal Type): Use of "Long Disregarded" Inter-Valve Equalising].—K. Wake. (*Nippon Elec. Comm. Eng.*, April 1940, No. 20, pp. 268–269: summary only.)

TRANSMISSION

4240. ELECTRONIC GENERATION OF ELECTROMAGNETIC OSCILLATIONS [General Formulation of Problem of Transfer of Power from Electron Beam to Oscillating Circuit by Moving Charged Particles, with Application to Klystron Oscillator ("Bunching" Not an Essential Part of Operation: Estimation of Efficiency: etc.)].—E. U. Condon. (*Journ. of Applied Phys.*, July 1940, Vol. 11, No. 7, pp. 502–506.) "The method used here is familiar to students of quantum theory, but its use in this connection is believed to be new." *See* also 3779 of October.

4241. A CONTINUOUSLY VARIABLE OSCILLATOR FOR PARALLEL-LINE MEASUREMENTS AT 100 TO 1000 MEGACYCLES.—King. (*See* 4374.)

4242. THE INVERTED AMPLIFIER [Advantages for Short & Ultra-Short Waves: Example of Short-Wave Broadcasting Transmitter].—Strong. (*See* 4230.)

4243. STUDIES ON ULTRA-SHORT-WAVE [4 m] TRANSMITTERS FOR MULTIPLEX TELEPHONY [and the Use of Rectified Negative Feedback for Reduction of Non-Linear Distortion: the Question of the Reduction of Stability: etc.]—S. Yonezawa & N. Tanaka. (*Nippon Elec. Comm. Eng.*, April 1940, No. 20, pp. 220–231.)

4244. TUNED-GRID TUNED-PLATE OSCILLATOR [Graphical Analysis of Factors involved in Production of Oscillations (Useful or Parasitic) caused by Feedback through Plate/Grid Capacitance: Prediction of Limiting Conditions: etc.].—I. E. Mouromtseff. (*Communications*, Aug. 1940, Vol. 20, No. 8, pp. 7–9 and 22.)

Of importance for the generation of ultra-high frequencies and also for the reduction of the tendency towards parasitic oscillations in amplifiers.

4245. FREQUENCY MODULATION: ITS PRODUCTION BY PHASE-SHIFTING THE SIDEBANDS OF AN AMPLITUDE-MODULATED WAVE [(1) Shift by a Fixed Angle with respect to Carrier (including Armstrong's Method): (2) Shift made to Vary Sinusoidally at Modulation Frequency (giving Very Small Distortion)].—D. I. Lawson. (*Wireless Engineer*, Sept. 1940, Vol. 17, No. 204, pp. 388–393.)

4246. SYNCHRONISED FREQUENCY MODULATION [Development used in the Western Electric Type 503A-1 Transmitter: Constancy of Mean Frequency obtained by Frequency Division (*e.g.* to 5000 c/s) and Rotating Magnetic Field acting on Armature geared to Tuning Condenser].—Doherty. (*Communications*, Aug. 1940, Vol. 20, No. 8, pp. 12–14.) Based on Doherty's article in *Pick-Ups*, Aug. 1940.

4247. FREQUENCY *versus* PHASE MODULATION [Discussion of Difference, for Sinusoidal Modulation: Difference more Pronounced for Trapezoidal Modulating Wave: Case when Phase-Modulated Wave coincides with Unmodulated Wave, so that No Physical Measurement could detect the Difference: etc.].—H. J. Scott. (*Communications*, Aug. 1940, Vol. 20, No. 8, pp. 10–11.)

4248. FUNDAMENTAL THEORY OF LINEAR MODULATION NETWORK.—Akiyama. (*See* 4227.)

4249. THEORETICAL CONSIDERATION OF LINEAR MODULATION FOUR-TERMINAL NETWORK.—Akiyama. (*See* 4228.)

4250. THEORY OF FREQUENCY-CONTROLLED OSCILLATORS [with Controlling Signal injected directly into the Non-Linear Element of Oscillator Circuit].—S. Sabaroff. (*Journ. of Applied Phys.*, Aug. 1940, Vol. 11, No. 8, pp. 538–540.)

Author's summary:—"A solution of the oscillator equation is obtained in which is indicated the basic mechanism involved in the frequency control of oscillators. The well-known fact that the control of an oscillator is possible when the ratio of controlling frequency to oscillator frequency is m/n, where m and n are integral, is theoretically demonstrated." For previous work *see* 3766 of October.

4251. AUTOMATIC TUNING FOR THE AMATEUR TRANSMITTER: MECHANICAL ALIGNMENT FOR ALL TYPES OF CIRCUIT LAY-OUTS.—W. M. B. Atkins & C. T. Read. (*QST*, Sept. 1940, Vol. 24, No. 9, pp. 30–31 and 83 . . 85.)

RECEPTION

4252. FREQUENCY-MODULATION RECEIVERS: DESIGN AND PERFORMANCE.—M. Hobbs. (*Electronics*, Aug. 1940, Vol. 13, No. 8, pp. 22–25.) From the E. H. Scott Laboratories.

4253. FREQUENCY-MODULATION LIMITER PERFORMANCE: EXPERIMENTAL DETERMINATION OF OPTIMUM OPERATING CONDITIONS FOR WEAK-SIGNAL RECEPTION.—G. H. Browning. (*QST*, Sept. 1940, Vol. 24, No. 9, pp. 19–21 and 85 . . 87.)

4254. PROBLEMS OF H.F. DESIGN [Wavelengths down to 5 m], *and* THE REDUCTION OF LOSSES IN SHORT-WAVE RECEIVERS [Inductance Effects as Serious as Effects of Low Effective Input Impedance of Valves: the Use of Multiple By-Pass Connections: Multiple Cathode-Connections in New Types: Earth Returns to Cathode Pin: Use of Copper Strip: etc.].—O. J. Russell. (*E. & Television & S-W.W.*, June 1940, Vol. 13, No. 148, pp. 267–268: Aug. 1940, No. 150, pp. 358 and 360.)

4255. SOME NOTES ON DIODE DETECTION.—A. Preisman. (*Communications*, Aug. 1940, Vol. 20, No. 8, pp. 18–20 and 22, 23.)

4256. ON THE EFFECT OF PHASE CHARACTER IN RECEIVER UPON A MODULATED WAVE [Investigation of Cause of Previous Unsatisfactory Nature of Selectivity Measurements on Short-Wave Receivers: Non-Linear Phase Characteristic causes "Dead Points" in Boundary Region between Pass-Band & Attenuation Band: Critical Value (depending on Max. Curvature of Phase Characteristic) for Modulated Frequency, below which No Dead Point exists: etc.].—M. Morita, H. Seki, & others. (*Nippon Elec. Comm. Eng.*, April 1940, No. 20, pp. 232–235.)

4257. ADJACENT-CHANNEL REJECTION: A MEANS OF SECURING EXTREME SELECTIVITY [Special Coupling Stages in I.F. Amplifier, with Opposing Couplings which cancel out at Frequencies separated by Given Amount from Required I.F.].—R.C.A. (*E. & Television & S-W.W.*, Aug. 1940, Vol. 13, No. 150, pp. 378–379.)

4258. EFFECT OF ANTENNA CIRCUIT UPON THE FREQUENCY CHARACTERISTIC OF REGENERATION [as in Broadcast Receivers: Condition for Zero Effect].—S. Kanazawa. (*Nippon Elec. Comm. Eng.*, April 1940, No. 20, p. 269: short summary.)

4259. BAND-SPREADING: ITS EFFECT ON THE "TUNING RATE" [Desirability of Straight-Line-Frequency Tuning: Disadvantages of Series-Condenser Circuits: Merits of Circuit with Condensers tapped across Varying Amounts of the Winding].—F. H. Woodbridge. (*Wireless Engineer*, Sept. 1940, Vol. 17, No. 204, pp. 394–397.)

4260. GAIN CONTROL OF RADIO-FREQUENCY AMPLIFIERS: ITS EFFECT ON THE INPUT ADMITTANCE [Over-All Response affected by Gain through Change in (1) Regeneration, (2) Input Resistance, (3) Input Capacitance (by Space-Charge Variation), (4) Input Admittance (Miller Effect): Countermeasures].—C. Lockhart. (*E. & Television & S-W.W.*, Aug. 1940, Vol. 13, No. 150, pp. 365–368).

4261. VOLUME EXPANSION WITH A TRIODE [Excellent Dynamic Action & Low Distortion, taking Advantage of the Characteristics of a Type 6K7 Valve connected as a Triode].—C. G. McProud. (*Electronics*, Aug. 1940, Vol. 13, No. 8, pp. 17–18.) Prompted by Levy's work (1859 of 1938).

4262. Q.A.V.C. USING A RELAY ["Squelch" Circuit for Introduction into Communications-Type Receiver].—(*E. & Television & S-W.W.*, June 1940, Vol. 13, No. 148, pp. 271–272.) From a *Radio* article.

4263. RADIO INTERFERENCE SUPPRESSION: NEW AND REVISED SPECIFICATIONS [B.S. 905 & Revised B.S. 613].—British Standards Institution. (*Wireless Engineer*, Sept. 1940, Vol. 17, No. 204, p. 393.) *See* also 3395 of September. The revised specification deals with components for suppression devices.

4264. HIGH-FREQUENCY INTERFERENCE WITH SERVICE RADIO: PERMITS REQUIRED FOR H.F. APPARATUS.—(*Electrician*, 13th & 20th Sept. 1940, Vol. 125, pp. 144 & 148.)

4265. A LOW-FREQUENCY CONVERTER: 500 to 3300 METRES ON YOUR COMMUNICATIONS RECEIVER.—R. W. Woodward. (*QST*, Sept. 1940, Vol. 24, No. 9, pp. 15–18.)

4266. BOOTLEG CATCHER [used by F.C.C. for Final Tracking of Unlicensed Transmitter: Aerial down Trouser-Leg].—(*QST*, Sept. 1940, Vol. 24, No. 9, p. 81.)

AERIALS AND AERIAL SYSTEMS

4267. AERIAL AND REFLECTOR SYSTEM FOR ULTRA-SHORT (4 m) WAVES, TO WITHSTAND HIGH WINDS AND SNOW.—Matsumae & others. (*See* 4460.)

4268. SIMPLE ANTENNAS AND RECEIVER INPUT CIRCUITS FOR ULTRA-HIGH FREQUENCIES.—R. S. Holmes & A. H. Turner. (In book dealt with in 4509, below.)

4269. USE OF COUPLED PARALLEL-WIRE SYSTEMS FOR MATCHING BETWEEN ULTRA-SHORT WAVE AERIAL AND ITS FEEDER.—Usui. (*See* 4220.)

4270. THE T-MATCHED ANTENNA: FEEDING THE RADIATOR WITH AN UNTUNED LINE [where it is more Convenient to keep Transmission Line Uniformly Spaced to within Short Distance of Aerial].—J. D. Kraus & S. S. Sturgeon. (*QST*, Sept. 1940, Vol. 24, No. 9, pp. 24–25.) As opposed to the "Y" or fanned-out end-section.

4271. CALCULATION OF SKIN-EFFECT BY THE METHOD OF PERTURBATIONS.—Rytov. (*See* 4191.)

4272. INCREASING RADIATION EFFICIENCY AT LOW FREQUENCIES [around 3 Mc/s: for Patrol-Car Service in Mountainous Districts where Ultra-Short Waves are Unsuitable: Discussion of Current Distributions in Short Vertical Aerial for Various Reactances at Top & Bottom: Increased Radiation with Special "Tube, Coil, & Whip" Aerial].—M. G. Morgan. (*Electronics*, July 1940, Vol. 13, No. 7, pp. 33–34 and 67, 68.)

4273. EFFECT OF ANTENNA CIRCUIT UPON THE FREQUENCY CHARACTERISTIC OF REGENERATION [as in Broadcast Receivers: Condition for Zero Effect].—S. Kanazawa. (*Nippon Elec. Comm. Eng.*, April 1940, No. 20, p. 269: short summary.)

4274. THE SPACE DIRECTIVE CHARACTERISTICS OF SINGLE-WIRE RECEIVING ANTENNAS [of Arbitrary Length, taking Earth Reflection Coefficient into Consideration].—K. Miya. (*Nippon Elec. Comm. Eng.*, April 1940, No. 20, pp. 261–264.)

Relation between reciprocity theorem and directive characteristics of transmitting and receiving aerials: general representation of the directive characteristics of a receiving aerial: examples of calculation (by eqn. 14) of the directive characteristics of two aerials ($h = \lambda/2$ and $5\lambda/4$), assuming, for the sake of simplicity, excitation by a single ray of sky waves, and equality of field intensities in plane of incidence and perpendicular to that plane. The fuller Japanese paper deals also with radiation resistance, position of loading point, etc.

VALVES AND THERMIONICS

4275. RECTILINEAR ELECTRON FLOW IN BEAMS [and Special Electrode Design].—J. R. Pierce. (*Journ. of Applied Phys.*, Aug. 1940, Vol. 11, No. 8, pp. 548–554.) A summary was dealt with in 3424 of September.

4276. ELECTROSTATIC FIELD AND CAPACITANCE BETWEEN SPLIT ANODES OF A MAGNETRON [required in Design of Generator for Type B Oscillations: Formulae derived by Conformal Representation: Measured Values are Larger (by Constant Amount) than Calculated, owing to End Effect: the Case of Asymmetrical Anodes].—Y. Omoto & K. Morita. (*Electrotech. Journ.*, Tokyo, July 1940, Vol. 4, No. 7, pp. 147–150.)

4277. NEW TRANSMITTING TUBE: THE RCA 825 INDUCTIVE-OUTPUT AMPLIFIER [Cathode-Ray-Type Valve for Ultra-Short Waves: with Magnetic Field to compensate Divergence of Electron Stream caused by R.F. Electric Field: 35 W Output above 300 Mc/s as Power Amplifier: etc.].—R.C.A. (*QST*, Sept. 1940, Vol. 24, No. 9, pp. 78 and 80.)

4278. NEW VALVES: ULTRA-HIGH-FREQUENCY PUSH-PULL TRANSMITTING PENTODE [Type 829, containing "Two Beam Tetrodes": Output 83 W at about 200 Mc/s].—R.C.A. (*E. & Television & S.-W.W.*, Aug. 1940, Vol. 13, No. 150, p. 381.) *See* also *ibid.*, June 1940, No. 148, p. 272.

4279. THE GAS-FILLED TETRODE [and Its Important Possibilities: Data of the RCA 2050 & 2051: operated by Photocell without Amplifying Valve].—G. Windred. (*E. & Television & S-W.W.*, Aug. 1940, Vol. 13, No. 150, pp. 359–360.)

4280. "R.C.A. TUBE DATA HANDBOOKS" [Book Review].—R.C.A. (*E. & Television & S-W.W.*, Aug. 1940, Vol. 13, No. 150, pp. 374 and 376.)

4281. DESIGN CONSIDERATIONS OF THE AUGETRON SECONDARY-EMISSION AMPLIFIER [Discussion of Previous Types, and the Advantages of the Augetron Design: Anode Current around 10 mA without Injury to Secondary Emitters, etc.].—Vacuum Science Products. (*E. & Television & S-W.W.*, Aug. 1940, Vol. 13, No. 150, pp. 350 and 351.)

4282. AN INTERESTING RANGE OF POWER AMPLIFIER VALVES [Types 4694, 4699, 4654, & EL51, ranging between 10 and 250 Watts].—Philips Company. (*Journ. Assoc. of Engineers*, Calcutta, June 1940, Vol. 16, No. 2, pp. 54–59.)

4283. OSRAM VARIABLE-MU SCREENED TETRODE KTW73M [primarily for Final I.F. Amplifier].—Osram. (*E. & Television & S-W.W.*, June 1940, Vol. 13, No. 148, p. 266.)

4284. DETERMINATION OF THE AVERAGE LIFE OF VACUUM TUBES [and the Procedure in analysing Trial Data: Some Results].—D. K. Gannett. (*Bell Lab. Record*, Aug. 1940, Vol. 18, No. 12, pp. 378–382.)

4285. SOME NOTES ON DIODE DETECTION.—A. Preisman. (*Communications*, Aug. 1940, Vol. 20, No. 8, pp. 18–20 and 22, 23.)

4286. TEMPERATURE EFFECTS IN SECONDARY EMISSION [from Iron, Nickel, Cobalt, & Molybdenum], *and* THE EFFECTS OF ORDER AND DISORDER ON SECONDARY ELECTRON EMISSION [Attempt to observe Change in S.E. Properties at Order/Disorder Transition in Alloy].—D. E. Wooldridge: and C. D. Hartman. (*Phys. Review*, 15th Aug. 1940, Vol. 58, No. 4, pp. 316–321: p. 381.) A summary of the first paper was dealt with in 3426 of September.

4287. MOLYBDENUM-THORIUM ACTIVATION.—H. Nelting. (*Zeitschr. f. Physik*, 4th May 1940, Vol. 115, No. 7/8, pp. 469–480.)

4288. RECENT EXPERIMENTS ON THE THERMIONIC PROPERTIES OF DIFFERENT CRYSTAL DIRECTIONS OF THE SAME METAL [Résumé].—(*Journ. of Applied Phys.*, May 1940, Vol. 11, No. 5, pp. 337–338.)

4289. "SOME PROBLEMS IN ADSORPTION" [chiefly of Oxygen & Hydrogen on Tungsten: Statistical Theory, etc: Book Review].—J. K. Roberts. (*Gen. Elec. Review*, Aug. 1940, Vol. 43, No. 8, p. 348.)

4290. THE THEORY OF ADSORPTION ON SQUARE LATTICES [including New Conclusion that Film of Hydrogen adsorbed on Tungsten need Not be Immobile].—Roberts. (*Nature*, 14th Sept. 1940, Vol. 146, pp. 372–374.) For a letter on parahydrogen conversion on tungsten see *ibid.*, 21st Sept. 1940, pp. 401–402 (Eley & Rideal).

4291. DIFFUSION OF HYDROGEN FROM WATER THROUGH STEEL [Measurements with the Type 6C5 Metal Triode connected as Ionisation Gauge, with Protective Paint sand-blasted off: Results important for Water-Cooled Valves, Rectifiers, etc.].—F. J. Norton. (*Journ. of Applied Phys.*, April 1940, Vol. 11, No. 4, pp. 262–267.)

4292. STUDY ON THE TEMPERATURE DISTRIBUTION SURROUNDING SOME BODIES HEATED ELECTRICALLY.—Shimizu & Nishifuji. (*See* 4421.)

4293. SPECIAL ISSUE ON THE MEASUREMENT AND CONTROL OF TEMPERATURE [including Papers on Optical Pyrometry, Temperature-Radiation Emissivities & Emittances, etc.].—(*Journ. of Applied Phys.*, June 1940, Vol. 11, No. 6, pp. 371–437.) For an "Apparatus Directory" *see* pp. iv–xx.

DIRECTIONAL WIRELESS

4294. Radio Direction-Finding on Wavelengths between 2 and 3 Metres (100 to 150 Mc/s).—R. L. Smith-Rose & H. G. Hopkins. (*Journ. I.E.E.*, Aug. 1940, Vol. 87, No. 524, pp. 154–158.) The full preliminary paper, a summary of which was dealt with in 2602 of July: for Discussion *see* pp. 159–162.

4295. A New Omni-Directional Radio Beacon [for Aircraft: 10–50 Electrical Revolutions/Second: with Direct-Reading Meter (Receiving System added as Auxiliary Unit to Ordinary Receiver): indicates "Any Number of Routes in Their Respective Directions"].—T. Amisima, M. Okada, & S. Yonezawa. (*Nippon Elec. Comm. Eng.*, April 1940, No. 20, pp. 266–267: summary only.)

4296. Flying Beacons for Alaska [Island Beacons remotely controlled by 250-Watt Frequency-Modulated Transmitters on Mainland].—C.A.A. (*Gen. Elec. Review*, Aug. 1940, Vol. 43, No. 8, p. 345: paragraph only.)

4297. Air Electricity warns Planes when approaching Mountains [and over Level Ground tells when Plane is flying on a Level: making use of Equipotential Surfaces, by Detectors at Front & Tail].—R. Gunn. (*Sci. News Letter*, 24th Aug. 1940, Vol. 38, No. 8, p. 124.) Note on U.S. Pat. No. 2 210 932.

ACOUSTICS AND AUDIO-FREQUENCIES

4298. Visible Sound Waves [Dark Bars running along Exhaust Trials during Air Fighting].—A. Blackie. (*Nature*, 14th Sept. 1940, Vol. 146, p. 369.)

4299. Dark Bands in the Spectra of Double Diffraction Gratings.—Houston. (*See* 4208.)

4300. Propagation of Sound in a Homogeneous Atmosphere [and Deductions from an Expression for Compression in Terms of Altitude].—Y. Rocard. (*Sci. Abstracts*, Sec. A, 25th Aug. 1940, Vol. 43, No. 512, p. 633.)

4301. Heavy-Water Rochelle-Salt Crystals [and Their Advantage in retaining Piezo-electric Properties to 95° instead of 75° F.].—A. N. Holden. (*Bell Lab. Record*, Aug. 1940, Vol. 18, No. 12, p. 368.) *See* also 1536 of April.

4302. Monitor Speaker with Wide Frequency Range [Model 64-B Loudspeaker with Double Voice Coil & 100-Degree Arc at 10 kc/s: 10 W Rating].—R.C.A. (*Journ. of Applied Phys.*, May 1940, Vol. 11, No. 5, p. vi: paragraph only.)

4303. A Loudspeaking Telephone System.—A. Herckmans. (*Bell Lab. Record*, Aug. 1940, Vol. 18, No. 12, pp. 369–373.)

4304. "The Acoustic Air-Jet Generator" [Book Review].—J. Hartmann. (*Journ. Acous. Soc. Am.*, July 1940, Vol. 12, No. 1, p. 213.)

For recent papers *see* 2306 of June. "The device owes its chief interest to the fact that it makes possible the conversion of as much as 50 to 100 watts into sound."

4305. Exciting Flames for Fog Signalling [Experimental Investigations, including Description of a Transportable Phase-Meter.]—Z. Carrière. (*Rev. d'Acoustique*, Fasc. 1/3, Vol. 8, 1939, pp. 47–78.)

4306. Power Transmission Loss in Exponential Horns and Pipes with Wall Absorption [Computed Loss Curves for Various Absorption Coefficients: Measurements on Pine & Fir Wood Horns].—W. D. Phelps. (*Journ. Acous. Soc. Am.*, July 1940, Vol. 12, No. 1, pp. 68–74.)

4307. Filter Networks in which Corresponding Elements of Successive Sections are Changed by a Constant Factor [Investigation prompted by Problem of Sound Insulation: Problem of the Exponential Horn: Acoustic Filters: etc.].—Brillouin. (*See* 4223.)

4308. The Acoustical Tube as a High-Pass Filter [including Analogy with Hyper-frequency Wave-Guides].—Brillouin. (*See* 4190.)

4309. Attenuation of Sound in Tubes [measured by a Precision Method: Confirmation of Kirchhoff's Tube-Wall Effect: Unexpectedly Large Effect depending on First Power of Frequency].—R. D. Fay. (*Journ. Acous. Soc. Am.*, July 1940, Vol. 12, No. 1, pp. 62–67.)

4310. On the Integral Equations of Continuous Dynamical Systems [Application to Damped Vibrating String, etc.].—Ingram. (*See* 4224.)

4311. Analysis of the Vibration of a Clamped Circular Plate which is subjected to Internal Resistance.—T. Hayasaka. (*Nippon Elec. Comm. Eng.*, April 1940, No. 20, p. 266: short summary.)

4312. A Simple Method of finding Poisson's Ratio [in terms of Ratio of Two Natural Frequencies of Vibrating Square Plate].—M. D. Waller. (*Proc. Phys. Soc.*, 1st Sept. 1940, Vol. 52, Part 5, pp. 710–713.)

4313. The Absolute Noise Level of Microphones: a Definition proposed for Discussion.—H. G. Baerwald. (*Journ. Acous. Soc. Am.*, July 1940, Vol. 12, No. 1, pp. 131–139.) From the Brush Development Company.

4314. New Hysteresis Model [giving Quantitative Results: developed in connection with Straining of Granular Carbon in Microphones].—F. S. Goucher. (*Bell Lab. Record*, Aug. 1940, Vol. 18, No. 12, pp. 358–361 and Frontispiece.)

4315. A New Film Gramophone [One-&-a-Half Hours' Playing from One Film (in Endless Strip feeding from Centre & continually re-wound round Periphery): using Selenium Barrier-Layer Photocells].—Wender: Electro-Physical Laboratories. (*E. & Television & S-W.W.*, Aug. 1940, Vol. 13, No. 150, p. 349.) Using the photocells dealt with in 3970 of October.

4316. Experiments on copying Sound Tracks onto Narrow Steel Tapes for Magnetic Reproduction [Enamelling-Etching Technique].—(*E. & Television & S-W.W.*, Aug. 1940, Vol. 13, No. 150, p. 379: paragraph only.)

4317. Embossing [of Gramophone Records] at Constant Groove Speed: a New Recording Technique.—E. E. Griffin. (*Electronics*, July 1940, Vol. 13, No. 7, pp. 26–27 and 62..64.)

4318. Volume Expansion with a Triode.—McProud. (*See* 4261.)

4319. Starting Characteristics of Speech Sounds [of Interest for the Design of Background-Noise Reduction Devices in Sound-on-Film Recording, Voice-Controlled Switching, Automatic Volume Control, etc.].—R. O. Drew & E. W. Kellogg. (*Journ. Acous. Soc. Am.*, July 1940, Vol. 12, No. 1, pp. 95–103.)

"The voice mechanism seems more like a relaxation oscillator that does not carry over any energy from one cycle to the next."

4320. Correlation between Hearing-Loss Measurements by Air Conduction on Eight Tones, *and* Characteristics and Distribution of Impaired Hearing in the Population of the United States.—W. C. Beasley. (*Journ. Acous. Soc. Am.*, July 1940, Vol. 12, No. 1, pp. 104–113: pp. 114–121.)

4321. Problems in the Analysis of the Tone of an Open Organ Pipe.—P. A. Northrop. (*Journ. Acous. Soc. Am.*, July 1940, Vol. 12, No. 1, pp. 90–94.)

4322. Some Notes on End-Corrections.—L. C. Tyte. (*Phil. Mag.*, Sept. 1940, Vol. 30, No. 200, pp. 173–184.)

4323. The Effect of Wall Materials on the Steady-State Acoustic Spectrum of Flue Pipes [and the Disputed Point of the "Tone" of Wind Instruments of Different Materials: Free-Field Analyses and Conclusions].—C. P. Boner & R. B. Newman. (*Journ. Acous. Soc. Am.*, July 1940, Vol. 12, No. 1, pp. 83–89.)

4324. Further Applications of Our Direct-Reading Pitch and Intensity Recorder [to Study of Performances of Famous Coloratura Sopranos (from Gramophone Records), etc.].—J. Obata & R. Kobayashi. (*Journ. Acous. Soc. Am.*, July 1940, Vol. 12, No. 1, pp. 188–192.) *See* 4522 of 1939 and back reference.

4325. The International Standard of Musical Pitch.—E. G. Richardson. (*Journ. Roy. Soc. of Arts*, 20th Sept. 1940, Vol. 88, pp. 851–859: Discussion pp. 859–864.)

4326. "Sound: Third Edition" [Book Review].—E. G. Richardson. (*Proc. Phys. Soc.*, 1st Sept. 1940, Vol. 52, Part 5, p. 721.)

4327. A Note on Just Intonation: a Correction.—Ll. S. Lloyd. (*Journ. Acous. Soc. Am.*, July 1940, Vol. 12, No. 1, p. 206.) *See* 3073 of August.

4328. "The Musical Ear" [a Collection of Essays: Book Review].—Ll. S. Lloyd. (*Proc. Phys. Soc.*, 1st Sept. 1940, Vol. 52, Part 5, p. 724.)

4329. Sound-Control Apparatus for the Theatre.—H. Burris-Meyer. (*Journ. Acous. Soc. Am.*, July 1940, Vol. 12, No. 1, pp. 122–126.)

4330. The 14C Programme Amplifier [as Bridging Amplifier at Branching Points, & for Other Purposes].—S. T. Meyers. (*Bell Lab. Record*, Aug. 1940, Vol. 18, No. 12, pp. 362–364.)

4331. Crosstalk in Coaxial Cables—Analysis based on Short-Circuited and Open Tertiaries, *and* Crosstalk between Coaxial Conductors in Cable.—K. E. Gould: R. P. Booth & T. M. Odarenko. (*Bell S. Tech. Journ.*, July 1940, Vol. 19, No. 3, pp. 341–357: pp. 358–384.)

4332. High-Accuracy Heterodyne Oscillators.—Slonczewski. (*See* 4382.)

4333. Sound Pressure on Spheres [Application of King's Theory to Experimental Work].—F. E. Fox: King. (*Journ. Acous. Soc. Am.*, July 1940, Vol. 12, No. 1, pp. 147–149.) *See* King, 473 of 1935.

4334. On the Expressions for Energy in Acoustics [Incorrectness of Rayleigh's, Lamb's, & Other Expressions for Energy Flow & Density: the Correct Formulae].—N. Andrejew [Andreev]. (*Journ. of Phys.* [of USSR], No. 4, Vol. 2, 1940, pp. 305–311: in German.)

4335. Absolute Measurement of Sound without a Primary Standard [based on Schottky's Application of Reciprocity Principle to Electroacoustic Transducers: Theoretical Basis relevant to the Calibration of Microphones & Loudspeakers].—W. R. MacLean. (*Journ. Acous. Soc. Am.*, July 1940, Vol. 12, No. 1, pp. 140–146.)

4336. Sound-Measurement Objectives and Sound-Level Meter Performance [including Possible Courses of Action in regard to Present Limitations].—J. M. Barstow. (*Journ. Acous. Soc. Am.*, July 1940, Vol. 12, No. 1, pp. 150–166.)

4337. Sound-Level Meters from the User's Viewpoint [Data considered both from the ASA ± 2.5 db Tolerance Standard and from the Desirable ± 0.5 db Tolerance].—P. Huber & J. M. Whitmore. (*Journ. Acous. Soc. Am.*, July 1940, Vol. 12, No. 1, pp. 167–172.)

4338. The Sound Spectra of Condenser Discharges and Pistol Reports, and Applications in Electroacoustic Measurements.—W. Weber. (*Journ. Acous. Soc. Am.*, July 1940, Vol. 12, No. 1, pp. 210–213.) Long summary of the German paper dealt with in 1072 of March.

4339. Shock Waves in Air and Characteristics of Instruments for Their Measurement.—L. Thompson. (*Journ. Acous. Soc. Am.*, July 1940, Vol. 12, No. 1, pp. 198–204.) For previous work *see* 1090 of March and 3328 of September.

4340. Properties of Linear Systems used in Vibration-Measuring Instruments.—J. D. Trimmer. (*Journ. Acous. Soc. Am.*, July 1940, Vol. 12, No. 1, pp. 127–130.)

4341. Variable Boundary Impedance for Room-Acoustics Investigations [with Wide Range of Values in Magnitude & Phase Angle: Structure giving up to 99% Normal-Incidence Absorption Coefficients].—R. H. Bolt & R. L. Brown. (*Journ. Acous. Soc. Am.*, July 1940, Vol. 12, No. 1, pp. 31–38.)

"The present study may, furthermore, lead to information of practical interest, suggesting highly absorptive structures or new lines in the development of acoustic materials."

4342. Precision Measurement of Acoustic Impedance [Advantages & Disadvantages of 9 Previously Published Techniques: a New Variable-Length Method using High-Impedance Source & Point Pressure Detector].—L. L. Beranek. (*Journ. Acous. Soc. Am.*, July 1940, Vol. 12, No. 1, pp. 3–13.)

4343. Acoustic Impedance of Commercial Materials and the Performance of Rectangular Rooms with One Treated Surface.—L. L. Beranek. (*Journ. Acous. Soc. Am.*, July 1940, Vol. 12, No. 1, pp. 14–23.) Using the measuring method dealt with in 4342, above.

4344. Non-Uniform Acoustical Boundaries in Rectangular Rooms [Approximation Theory (by Perturbation Method): Normal Modes of Vibration—Exact Theory: Experimental Investigations: etc.].—D. Y. Maa. (*Journ. Acous. Soc. Am.*, July 1940, Vol. 12, No. 1, pp. 39–52.)

4345. The Absorption of Sound by Small Areas of Absorbing Material [Mathematical & Experimental Investigation].—J. R. Pellam & R. H. Bolt. (*Journ. Acous. Soc. Am.*, July 1940, Vol. 12, No. 1, pp. 24–30.) Further development of the work dealt with in 2630 of July.

4346. Erratum: Sound Diffraction and Absorption by a Strip of Absorbing Material.—J. R. Pellam. (*Journ. Acous. Soc. Am.*, July 1940, Vol. 12, No. 1, p. 206.) *See* 2630 of July, and 4345, above.

4347. Sound Prevention Mechanism of Non-Porous Materials: Part I [Relation between Mechanical Vibration and Transmission Loss (Thin Plates)—Theory (Davis) & Experimental Investigation].—S. Kawashima. (*Journ. Acous. Soc. Am.*, July 1940, Vol. 12, No. 1, pp. 75–82.)

"Therefore, in the expression of the transmission loss of building materials, not only the weight per unit area of the material but also the boundary conditions play a very important rôle which should be given full consideration."

4348. The Transmission of Sound through Single and Double Glass Surfaces.—L. Renault. (*Rev. d'Acoustique*, Fasc. 1/3, Vol. 8, 1939, pp. 12–46: long summary in *Journ. Acous. Soc. Am.*, July 1940, Vol. 12, No. 1, pp. 208–210.)

4349. "Sound Transmission in Buildings: Practical Notes for Architects and Builders" [Book Reviews].—R. Fitzmaurice & W. Allen. (*Proc. Phys. Soc.*, 1st Sept. 1940, Vol. 52, Part 5, p. 716: *Nature*, 28th Sept. 1940, Vol. 146, p. 417.)

4350. Room Noise at Subscribers' Telephone Locations [Measurements at Residences, Business Locations, & Factories].—D. F. Seacord. (*Journ. Acous. Soc. Am.*, July 1940, Vol. 12, No. 1, pp. 183–187.) A paper under practically the same title was referred to in 3459 of September.

4351. Some Acoustical Source/Observer Problems [in connection with Reduction of Noise: Barriers, Enclosure of Source, Enclosure of Observer].—S. W. Redfearn. (*Phil. Mag.*, Sept. 1940, Vol. 30, No. 200, pp. 223–236.)

4352. The Absorption of Noise in Ventilating Ducts.—Sabine. (*Journ. Acous. Soc. Am.*, July 1940, Vol. 12, No. 1, pp. 53–57.)

4353. Measurements of the Noise from Aerofoils and Streamline Wires.—W. F. Hilton. (*Phil. Mag.*, Sept. 1940, Vol. 30, No. 200, pp. 237–246.)

4354. Propeller Rotation Noise due to Torque and Thrust.—A. F. Deming. (*Journ. Acous. Soc. Am.*, July 1940, Vol. 12, No. 1, pp. 173–182.)

4355. Harmonic Theory of Noise in Induction Motors.—W. J. Morrill. (*Elec. Engineering*, Aug. 1940, Vol. 59, No. 8, Transact. pp. 474–480.)

4356. Acoustical Investigations of Joseph Henry as viewed in 1940.—Snyder. (*Journ. Acous. Soc. Am.*, July 1940, Vol. 12, No. 1, pp. 58–61.)

4357. ULTRASONICS AND ELASTICITY [Elastic Properties of Solids (including Temperature Dependence) determined by Ultrasonic Method].—H. F. Ludloff. (*Journ. Acous. Soc. Am.*, July 1940, Vol. 12, No. 1, pp. 193–197.) For previous work *see* 1932 of May and back reference.

PHOTOTELEGRAPHY AND TELEVISION

4358. TELEVISION [Review of Development, Present Status].—G. R. Town. (*Elec. Engineering*, Aug. 1940, Vol. 59, No. 8, pp. 313–322.)

4359. TELEVISION COMMITTEE ORGANISES [Note on the National Television Systems Committee]. —(*Electronics*, Aug. 1940, Vol. 13, No. 8, p. 34.)

4360. RECENT PROGRESS IN TELEVISION STUDIO TECHNIQUE.—(*E. & Television & S-W.W.*, June 1940, Vol. 13, No. 148, pp. 275–276 and 288, iii.)

4361. RING FOCUSING OF NEGATIVE IONS IN A CATHODE-RAY BEAM: CORRECTION.—C. H. Bachman: Woodcock. (*Journ. of Applied Phys.*, April 1940, Vol. 11, No. 4, p. 240.) *See* 1515 of April: attention is drawn to a 1931 paper by Woodcock on "The Emission of Negative Ions under the Bombardment of Positive Ions."

4362. A PICTURE SIGNAL GENERATOR: IV [Advantages of Short, Magnetically-Focused Tube: etc.].—Wilder & Brustman. (*Electronics*, July 1940, Vol. 13, No. 7, pp. 28–31.) For previous parts *see* 3962 of October; the final part appears in the August issue, pp. 30–33.

4363. A NEW PROJECTION SYSTEM FOR LARGE-SCREEN TELEVISION RECEIVERS [Spherical-Cylindrical Lens Combination giving Primary Image (satisfying Illumination Conditions for Viewers near Screen) & Secondary Image (for More Distant Viewers)].—(*E. & Television & S-W.W.*, Aug. 1940, Vol. 13, No. 150, p. 372.)

4364. A SIMPLE COUPLING TRANSFORMER UNIT FOR TELEVISION RECEIVERS [*e.g.* for Feeder/Input-Circuit Coupling: a Convenient Construction: Components useful for Rejector Traps].—R.C.A. (*E. & Television & S-W.W.*, Aug. 1940, Vol. 13, No. 150, pp. 371–372.)

4365. AMPLIFIER CHARACTERISTICS AT LOW FREQUENCIES, WITH PARTICULAR REFERENCE TO A NEW METHOD OF FREQUENCY COMPENSATION OF SINGLE STAGES [of Special Interest in Vision Output Stages, where D.C. Component is required: Method suggested by Similarity of Form of Frequency Characteristics introduced by Cathode, Screen, & Anode Circuits: etc.].—G. W. Edwards & E. C. Cherry. (*Journ. I.E.E.*, Aug. 1940, Vol. 87, No. 524, pp. 178–188.) From the General Electric laboratories.

4366. A FLEXIBLE SYNCHRONISING-PULSE GENERATOR [as Master Generator for Television Transmitting Stations: Type 203].—DuMont. (*E. & Television & S-W.W.*, June 1940, Vol. 13, No. 148, pp. 264 and 283, 284.)

4367. SEPARATING SYNC. PULSES AND PICTURE SIGNALS IN TELEVISION RECEIVERS: DETAILS OF A NEW SCHEME [Two Separating Circuits connected in Cascade through an Amplifier].—R.C.A. Laboratories. (*E. & Television & S-W.W.*, Aug. 1940, Vol. 13, No. 150, pp. 363–364.)

4368. DESIGN CONSIDERATIONS OF THE AUGETRON SECONDARY-EMISSION AMPLIFIER.—Vacuum Science Products. (*See* 4281.)

4369. THE PROPERTIES OF PHOTOCELLS WITH MULTI-STAGE CURRENT AMPLIFICATION OPERATING WITH ALTERNATING VOLTAGE.—P. V. Timofeev. (*Automatics & Telemechanics* [in Russian], No. 3, 1939, pp. 97–108.)

To increase the output current, photocells with multi-stage amplification utilising secondary-electron emission have been developed. The drawback of these cells is the necessity for a h.t. supply of the order of 2000 v. To simplify the power-supply circuits the author has investigated the possibility of operating the cells with an alternating voltage. The circuits used and the measurements carried out are described in detail and a number of experimental curves are shown. A theoretical discussion of the results obtained is also given. The main conclusion reached is that this type of cell is quite suitable for practical purposes, although certain conditions must be observed and the sensitivity of the cell is smaller than when operating with a d.c. voltage.

4370. A NEW HIGH-SENSITIVITY PHOTO-SURFACE [New Caesium Surface ("S-4") with High Sensitivity in Green, Blue, & Near Ultra-Violet, Negligible in Red: "At Least Ten Times as Sensitive to Daylight as Caesium/Caesium-Oxide S-2": the RCA-929 Phototube & Its Uses].—A. M. Glover & R. B. Janes. (*Electronics*, Aug. 1940, Vol. 13, No. 8, pp. 26–27.) Average daylight sensitivity is 120 μA/lumen.

4371. ELECTRONIC THEORY OF CRYSTALLINE COMPOUNDS OF THE CUPROUS-OXIDE TYPE.—H. Dressnandt. (*Zeitschr. f. Physik*, 4th May 1940, Vol. 115, No. 7/8, pp. 369–409.)

4372. ELECTRICAL PHOTO-ENGRAVING [Means of obtaining Almost Perfect Copies without Costly "Retouching" & "Fine Etching": Beam through Photographic Original is spread onto 3 Photocells, One giving Straight-Line Reproduction over Most of Inner Tones, Another recording High-Light Tones, & Third adding Densities to Shadows].—T. Thorne Baker. (*Elec. Review*, 23rd Aug. 1940: summary in *Nature*, 14th Sept. 1940, Vol. 146, p. 372.)

MEASUREMENTS AND STANDARDS

4373. The Use of the Wave Guide for Measurement of Micro-Wave Dielectric Constants [Advantages over Lecher-Wire Methods: Measurements on Wavelengths 15–25 cm: Methods based on Drude's First Method & on his Second Method (but giving Absolute instead of only Relative Values)].—H. R. L. Lamont. (*Phil. Mag.*, July 1940, Vol. 30, No. 198, pp. 1–15.) For previous work *see* 3281 of September. The present paper includes some experimental verifications of deductions made in that theoretical work.

4374. A Continuously Variable Oscillator for Parallel-Line Measurements at 100 to 1000 Megacycles [fulfilling Requirements that Coupling to Lecher System should be Short & Close (Geometrically) but Loose (Electrically): using Valves whose Electrodes are Open-End Sections of a Parallel-Wire Line].—R. King. (*Review Scient. Instr.*, Aug. 1940, Vol. 11, No. 8, pp. 270–271.)

Based on the papers dealt with in 723 of February and 2194 of June: the requirements are readily fulfilled by maintaining an "inverted or sine-symmetrical field distribution along the parallel wires." An example of the type of valve employed is the Western Electric 1020Y (Samuel, 126 of 1938).

4375. Theory of Coupled Parallel-Wire Systems.—Usui. (*See* 4220.)

4376. A Vacuum-Tube Voltmeter for Coaxial-Line Measurements.—G. L. Usselman. (*Electronics*, July 1940, Vol. 13, No. 7, pp. 32 and 79, 80.) From the R.C.A. laboratories.

4377. A New Method for Measurement of Ultra-High-Frequency Impedance.—S. W. Seeley & W. S. Barden. (In book dealt with in 4509, below.)

4378. Some Measurements of High-Frequency Permeability [Frequencies 1–10 Mc/s].—Jackson. (*See* 4425.)

4379. A Precision Frequency-Meter of Range 0 to 2000 Mc/s [Previous Equipments fail to make Full Use of Ease of Frequency Division: New Method & Equipment in which Both *a* & *b* can be Varied over a Limited Range ($n.af/b$ being Series of Harmonics): Resulting Simplification in Apparatus & Technique and Improvement in Range & Accuracy].—L. Essen. (*Proc. Phys. Soc.*, 1st Sept. 1940, Vol. 52, Part 5 pp. 616–624.)

4380. High-Precision Frequency Comparisons [Resolution of 1 in 10^{10}, primarily for Comparison of Two 100-kc/s Bridge-Stabilised Crystal Oscillators having Variations suspected of being Less than 1 in 10^9: giving Frequent Readings of nearly Instantaneous Values].—L. A. Meacham. (*Bell Tel. S. Tech. Pub.*, Monograph B-1232, 8 pp.) Technique developed from Marrison's method (1929 Abstracts, p. 518).

4380 *bis*. Wavemeter Type R.502 [for Routine Measurements between 6.5 and 3000 Metres].—Standard Telephones & Cables. (*Elec. Communication*, July 1940, Vol. 19, No. 1, p. 65.)

4381. Theory of Frequency-Controlled Oscillators [with Controlling Signal injected directly into the Non-Linear Element of Oscillator Circuit].—Sabaroff. (*See* 4250.)

4382. High-Accuracy Heterodyne Oscillators [Requirements for Carrier-Frequency Applications: Study of Sources of Error (including Scale Errors, and a Cinema-Film Scale Design): Accuracy of Usual Instrument increased Ten Times by Use of Double Frequency Check (High as well as Low): Design of High-Precision Oscillator for Range 1–150 kc/s, with Accuracy within ± 25 c/s].—T. Slonczewski. (*Bell S. Tech. Journ.*, July 1940, Vol. 19, No. 3, pp. 407–420.)

4383. Heavy-Water Rochelle-Salt Crystals.—Holden. (*See* 4301.)

4384. A Visual Selectivity Meter with a Uniform Decibel Scale [for Work on R.F. Filters & Tuned Circuits: Cathode-Ray-Tube Equipment using Automatic Gain Control Action to give Logarithmic Delineation of Frequency Response].—K. R. Sturley & R. P. Shipway. (*Journ. I.E.E.*, Aug. 1940, Vol. 87, No. 524, pp. 189–194.) From the Marconi laboratories.

4385. A Dual Bridge for the Measurement of Self-Inductance in Terms of Resistance and Time [Theory, Construction, & Experimental Results: Primary Bridge (with Unidirectional Pulsating Current) and Detector Bridge (with Direct Current): Inductances of 1 Henry experimentally measured within 1 Part in 1000: Much Higher Accuracy is Possible].—H. L. Curtis & L. W. Hartman. (*Journ. of Res. of Nat. Bur. of Stds.*, July 1940, Vol. 25, No. 1, pp. 1–13.)

An alternative method (requiring an intermediary capacitance) is described in a paper on the absolute determination of the ohm (Curtis, Moon, & Sparks), *ibid.*, Vol. 16, 1936.

4386. Deflecting Instrument for Use in A.C. Bridge Networks [for Unskilled Operation in Industry, *e.g.* for Comparison of an Inductance with a Standard: Use of Dynamometer-Type Voltmeter to indicate Error: Variations due to Voltage-Supply Fluctuations avoided by replacing Control Spring by Iron Vane].—A. E. Hampton. (*Sci. Abstracts*, Sec. B, 25th Aug. 1940, Vol. 43, No. 512, p. 338.)

4387. Signal Generator: the RCA "Signalyst" [for Radio & Television Alignment].—R.C.A: Rider. (*Journ. of Applied Phys.*, April 1940, Vol. 11, No. 4, p. 254.) Companion to the "Chanalyst" and "VoltOhmist" (*see* 1847 of May).

4388. STANDARD RESISTORS [Information based on Bureau's Experience in comparing Precision Resistors with Its Own Standards: Precision of Bridge Measurements, etc.].—F. Wenner. (*Tech. News Bull. Nat. Bur. of Stds.*, Aug. 1940, No. 280, pp. 65–66.) Summary of paper in August *Journ. of Res. of Nat. Bur. of Stds.*

4389. CIRCUIT CONSTANTS FOR THE PRODUCTION OF IMPULSE TEST WAVES.—J. R. Eaton & J. P. Gebelein. (*Gen. Elec. Review*, Aug. 1940, Vol. 43, No. 8, pp. 322–332.)

4390. THE TAYLOR UNIVERSAL TEST METER, MODEL 90.—Taylor Elec. Instruments. (*E. & Television & S-W.W.*, June 1940, Vol. 13, No. 148, p. 282.)

4391. SPECIAL THERMOELECTRIC ALLOYS AND THEIR PROPERTIES.—A. M. Kalinin & F. N. Stepanov. (*Automatics & Telemechanics* [in Russian], No. 2, 1939, pp. 61–78.)

The requirements imposed on thermoelectric materials are discussed and the properties of various materials (including copel, chromel, alumel, etc.) examined from this point of view. A large number of experimental curves and tables are shown.

4392. ELECTRICAL APPARATUS OF UNIT COMPONENT CONSTRUCTION ["Munit" System].—Muirhead. (*Journ. of Scient. Instr.*, Sept. 1940, Vol. 17, No. 9, p. 233.)

SUBSIDIARY APPARATUS AND MATERIALS

4393. RECTILINEAR ELECTRON FLOW IN BEAMS [and Special Electrode Design].—Pierce. (*Journ. of Applied Phys.*, Aug. 1940, Vol. 11, No. 8, pp. 548–554.) A summary was dealt with in 3424 of September.

4394. MAGNETOSTATIC FOCUSING OF ELECTRON BEAMS.—Mynall. (*E. & Television & S-W.W.*, July 1940, Vol. 13, No. 149, pp. 297–301.) For corrections *see* August issue, p. 372.

4395. ON THE PARAMETERS OF MODERN CATHODE-RAY TUBES USED IN ELECTRON COMMUTATORS [for Remote Control, etc.].—Zernov. (*See* 4524.)

4396. "R.C.A. TUBE DATA HANDBOOKS" [Book Review].—R.C.A. (*E. & Television & S-W.W.*, Aug. 1940, Vol. 13, No. 150, pp. 374 and 376.)

4397. AMPLIFIER—TIME-BASE [for C-R Tubes operating at Anode Voltages up to 10 kV.]—Southern Instruments. (*Journ. of Scient. Instr.*, Sept. 1940, Vol. 17, No. 9, pp. 233–234.)

4398. STUDY OF THE PERFORMANCE OF VARIOUS CAPACITIVE POTENTIAL DIVIDERS [for Transient-Phenomena Investigations with Cathode-Ray Oscillograph: Large Errors with H.T.-Insulators/L.T.-Condenser Dividers: Advantages of H.T. Parallel-Plate Condenser: etc.].—Mauduit. (*Sci. Abstracts*, Sec. B, 25th Aug. 1940, Vol. 43, No. 512, p. 342.)

4399. CONTINUOUS-FEED CAMERA FOR USE WITH CATHODE-RAY OSCILLOGRAPHS [using 6 in. wide Paper].—Southern Instruments. (*Journ. of Scient. Instr.*, Sept. 1940, Vol. 17, No. 9, p. 234.)

4400. THE ACTION OF ELECTRONS AND X RAYS ON PHOTOGRAPHIC EMULSIONS [Similarity between High-Velocity Electrons & X-Ray Photons, and between Low-Velocity Electrons & Light Photons: Theory, based on Exponential Type of Absorption, represents Observed Phenomena Very Closely].—Charlesby. (*Proc. Phys. Soc.*, 1st Sept. 1940, Vol. 52, Part 5, pp. 657–700.)

4401. INVESTIGATION OF METALLIC OXIDE SMOKES WITH THE ELECTRON MICROSCOPE [with Resolving Power of 3×10^{-6} mm].—von Ardenne. (*Sci. Abstracts*, Sec. A, 25th Aug. 1940, Vol. 43, No. 512, p. 640.) *Cf.* Mahl, 2102 of May; Fries & Müller, 3660 of September; *see* also von Ardenne, 3153 of August.

4402. "ELEKTRONEN-UEBERMIKROSKOPIE: PHYSIK — TECHNIK — ERGEBNISSE" [Electron-Microscopy: Physics, Technique, & Results: Book Review].—von Ardenne. (*Bull. Assoc. suisse des Élec.*, No. 15, Vol. 31, 1940, pp. 338–339.)

4403. ULTRA-VIOLET AND ELECTRON MICROSCOPY [including a Discussion of the Limits of Resolution].—Martin. (*Nature*, 31st Aug. 1940, Vol. 146, pp. 288–292.)

4404. ON THE FORMATION OF IMAGES OF TRANSPARENT OBJECTS IN THE [Optical] MICROSCOPE [and the Little-Understood Formation of Sharp Bands due to Interference].—Rogestwensky. (*Journ. of Phys.* [of USSR], No. 4, Vol. 2, 1940, pp. 323–346: in English.)

4405. USE OF BERYLLIUM FLUORIDE GLASSES AS BINDERS FOR FLUORESCENT SCREENS.—E.M.I. Laboratories. (*E. & Television & S-W.W.*, June 1940, Vol. 13, No. 148, p. 268.)

4406. ENERGY TRANSFORMATION IN CRYSTAL PHOSPHORS.—Möglich & Rompe. (*Physik. Zeitschr.*, 10th May 1940, Vol. 41, No. 9/10, pp. 236–242.)

4407. QUANTUM YIELD OF OPTICAL TRANSFORMATION OF *F'* CENTRES IN ALKALI-HALIDE CRYSTALS, *and* THE INCORPORATION OF FOREIGN SUBSTANCES IN ALKALI-HALIDE CRYSTALS.—Pick: Akpinar. (*Ann. der Physik*, 1st May 1940, Ser. 5, Vol. 37, No. 5/6, pp. 421–428: pp. 429–441.)

4408. THE PHOTOMETRIC PROPERTIES OF SOME LUMINESCENT MATERIALS [Paints & Lacquers].—Harper & others. (*Sci. Abstracts*, Sec. B, 25th Aug. 1940, Vol. 43, No. 512, p. 352.)

4409. TRENDS IN DESIGN OF FRACTIONATING PUMPS [including the Two-Jet, Water-Cooled Oil-Diffusion Pump for Exhaustion of Electronic Devices].—Hickman. (*Journ. of Applied Phys.*, May 1940, Vol. 11, No. 5, pp. 303–313.) For previous reference *see* 3300 of 1939.

4410. AN IONISATION-GAUGE CIRCUIT [Rugged & Stable Balanced Amplifier with Negative Feedback & Gaseous-Discharge Voltage Regulators, etc.].—Bowie. (*Review Scient. Instr.*, Aug. 1940, Vol. 11, No. 8, pp. 265–267.)

For use with the improved vacuum gauge dealt with in 2405 of June. "Although a number of amplifiers and supply circuits have been described [10 literature references are given], none was found to be entirely suitable." *Cf.* 4411 & 4537, below.

4411. A BALANCED DIRECT-CURRENT AMPLIFIER FOR ALTERNATING-CURRENT OPERATION.—Stair & Hand. (*See* 4541.)

4412. A VACUUM-TUBE ALTERNATING-VOLTAGE COMPENSATOR.—Cooter, Wenner, & Peterson. (*See* 4238.)

4413. APPARATUS FOR GENERATING A DIRECT OR ALTERNATING CURRENT PROPORTIONAL TO A GIVEN A.C. EFFECT [*e.g.* for Automatic Regulation of the A.C. Source].—Bengtsson & Slettenmark. (*Sci. Abstracts*, Sec. B, 25th Aug. 1940, Vol. 43, No. 512, p. 343.)

4414. CONSTANT CURRENT SOURCES [unaffected by Load Changes].—Green & Kuper. (*See* 4237.)

4415. DIFFUSION OF HYDROGEN FROM WATER THROUGH STEEL.—Norton. (*See* 4291.)

4416. THE NATURE OF THE IONS EMITTED BY HEATED FILAMENTS AND SALTS [Positive (No Negative) Ions from W, Ta, & Mo near Melting Point: Presence of Na & K Ions: Alkali Halides: etc.].—Toubes & Rollefson. (*Sci. Abstracts*, Sec. A, 25th Aug. 1940, Vol. 43, No. 512, p. 642.)

4417. THE GAS-FILLED TETRODE [Data of the RCA 2050 & 2051].—Windred. (*See* 4279.)

4418. BACK-FIRING IN MERCURY-ARC RECTIFIERS [Criticism of Various Opposing Theories: New Evidence].—White. (*Journ. of Applied Phys.*, July 1940, Vol. 11, No. 7, p. 507.)

4419. ELECTRONIC THEORY OF CRYSTALLINE COMPOUNDS OF THE CUPROUS-OXIDE TYPE.—Dressnandt. (*Zeitschr. f. Physik*, 4th May 1940, Vol. 115, No. 7/8, pp. 369–409.)

4420. SEMICONDUCTORS IN STRONG ELECTRIC FIELDS [Investigations on Cuprous Oxide, Selenium, Vanadium Pentoxide, etc., at Fields up to 10^5 V/cm and Temperatures $-180°$ to $+20°$ C: Discussion of General Theories on the Increase in Conductivity in Strong Fields: Criticism in Light of Present Results].—Joffe & Joffe. (*Journ. of Phys.* [of USSR], No. 4, Vol. 2, 1940, pp. 283–304: in English.)

4421. STUDY ON THE TEMPERATURE DISTRIBUTION SURROUNDING SOME BODIES HEATED ELECTRICALLY [Investigations with Michelson Interferometer: Results include Limit of Application of Langmuir's Film Theory, Comparison of Current-Carrying Properties of Single & Stranded Wires: etc.].—S. Shimizu & I. Nishifuji. (*Electrotech. Journ.*, Tokyo, July 1940, Vol. 4, No. 7, pp. 158–163.)

4422. MANGANAMRON WIRE [Alternative to German Manganin].—Scott I.W. Company. (*E. & Television & S-W.W.*, June 1940, Vol. 13, No. 148, p. 266.)

4423. NEW COLOUR CODES FOR RESISTORS AND FIXED CONDENSERS.—R.M.A. (*Wireless Engineer*, Sept. 1940, Vol. 17, No. 204, p. 399.)

4424. COMPRESSED POWDERED MOLYBDENUM PERMALLOY FOR HIGH-QUALITY INDUCTANCE COILS.—Legg & Given. (*Bell S. Tech. Journ.*, July 1940, Vol. 19, No. 3, pp. 385–406.)

4425. SOME MEASUREMENTS OF HIGH-FREQUENCY PERMEABILITY [of Mumetal, Stalloy, etc.: Frequencies 1–10 Mc/s: Preliminary Report: Disagreement with Dannatt's Results].—Jackson. (*Phil. Mag.*, Sept. 1940, Vol. 30, No. 200, pp. 247–251.) *See* Dannatt, 1579 of 1937 and back reference.

4426. PERMANENT MAGNETS [and the Revolution caused by the Method of Cooling in a Magnetic Field].—Kayser. (*Engineer*, 20th Sept. 1940, Vol. 170, p. 183.) The method based on the work of Oliver & Shedden (4136 of 1938) and the Philips patent (Br. Pat. No. 522 731).

4427. A NEW METHOD FOR THE MATHEMATICAL REPRESENTATION OF "AFTER-EFFECT" PHENOMENA, AND IN PARTICULAR OF HYSTERESIS.—Kovalenkov & Machinski. (*See* 4495.)

4428. NEW HYSTERESIS MODEL [giving Quantitative Results].—Goucher. (*See* 4314.)

4429. A GENERAL SOLUTION OF THE HELMHOLTZ EQUATION, TAKING INTO ACCOUNT THE EFFECT OF IRON.—Kovalenkov. (*See* 4236.)

4430. THE MAGNETIC VOLTAGE AMPLIFIER.—Feldbaum. (*See* 4235.)

4431. THE LAWS OF THE DISTRIBUTION OF THE MAGNETIC FLUX IN ELECTROMAGNETIC DEVICES, USING THE LINEAR METHOD OF INTERPRETATION.—Livshits. (*Automatics & Telemechanics* [in Russian], No. 3, 1936, pp. 39–58.)

A differential equation of the second order with non-linear variable coefficients (3) determining the magnetic flux ϕ in an electromagnetic circuit is derived and an analysis of the relationship $\phi = f(x)$ is given, based on the integration of linear differential equations of the second order. The limits of the applicability of the method are established and a number of practical circuits are considered.

4432. ON THE TIME ANALYSIS OF THE ARMATURE MOVEMENT IN ELECTROMAGNETIC DEVICES.—Livshits. (*Automatics & Telemechanics* [in Russian], No. 2, 1939, pp. 45–60.)

A method is proposed for the double graphical integration of non-linear equations of the second order. The method enables the duration of the armature movement to be determined with precision for any operating conditions. The method can also be used for an exact investigation of the building-up and dying-out of the current in the windings of electromagnetic devices.

4433. THE DESIGN OF DETECTOR RELAYS.—Vitenberg. (*Automatics & Telemechanics* [in Russian], No. 3, 1939, pp. 19–38.)

A d.c. electromagnetic relay connected in a copper-oxide rectifier-bridge circuit (Fig. 2) is considered : detailed methods are indicated for the design of this circuit.

4434. THE INVESTIGATION AND DESIGN OF AN UNBALANCED BRIDGE CONTROLLING THE OPERATION OF A SERVO-MOTOR.—Rubin. (*See* 4525.)

4435. ELECTRONIC CONTROLLING DEVICES WITHOUT CONTACTS.—Klyuev. (*See* 4526.)

4436. RELAYS FOR ELECTRONIC CIRCUITS [Illustrated Survey of Various Types].—(*Electronics*, Aug. 1940, Vol. 13, No. 8, pp. 13–16 and 87.)

4437. BROWN BOVERI RELAYS [in Protection Technique].—Stöcklin & Schneider. (*Sci. Abstracts*, Sec. B, 25th Aug. 1940, Vol. 43, No. 512, p. 343.)

4438. THE EFFECT OF HIGHER HARMONICS ON THE OPERATION OF AN INDUCTION-CURRENT RELAY WITH A SHORT-CIRCUITED TURN.—Bul'. (*Automatics & Telemechanics* [in Russian], No. 5, 1939, pp. 3–14.)

4439. AN INTERVAL METER AND ITS APPLICATION TO STUDIES OF GEIGER COUNTER STATISTICS.—Driscoll & others. (*See* 4532.)

4440. ENCLOSED SPARK GAPS [and the Presence & Effect of Ionising Radiation : Tests on Low Impulse Ratio observed on Rutile-Spacer Gaps : etc.].—Berkey. (*Elec. Engineering*, Aug. 1940, Vol. 59, No. 8, Transact. pp. 429–432.)

4441. BREAKDOWN IN COMPRESSED GASES AT HIGH PRESSURES AND SMALL DISTANCES [Measurements on Nitrogen up to 90 kg/cm^2, with 1.5×10^6 V/cm for 0.3 mm Electrode Spacing : Effect of Very Small Surface Roughnesses : Agreement between Theory & Experiment : the Question of the Rôle of Cold Emission].—Blochinzev & others. (*Journ. of Phys.* [of USSR], No. 3, Vol. 2, 1940, pp. 216–232 : in English.)

4442. A THEORETICAL DETERMINATION OF BREAKDOWN VOLTAGE FOR SPHERE-GAPS [on Streamer Theory].—Meek. (*See* 4211.)

4443. THE MECHANISM OF SPARK DISCHARGE IN AIR AT ATMOSPHERIC PRESSURE.—Loeb & Meek. (*See* 4212.)

4444. "ELECTRONIC PROCESSES IN IONIC CRYSTALS" [Book Review].—Mott & Gurney. (*Proc. Phys. Soc.*, 1st Sept. 1940, Vol. 52, Part 5, p. 725.) "This book will probably be the standard, and only, one in its field for many years to come . . ."

4445. ELECTRIC BREAKDOWN OF ALKALI HALIDES.—Seeger & Teller. (*Phys. Review*, 1st Aug. 1940, Ser. 2, Vol. 58, No. 3, pp. 279–280.) *See* also 349 of January.

4446. THE ["Intrinsic"] ELECTRIC STRENGTH OF SOME SOLID DIELECTRICS [Experimental Investigation of Fröhlich's Theory : Measurements on Mica, Quartz, Alkali Halides, Complex Organic Dielectrics : Effects of Temperature & Thickness].—Austen & Whitehead : Fröhlich. (*Proc. Roy. Soc.*, Ser. A, 28th Aug. 1940, Vol. 176, No. 964, pp. 33–50.) Based on Report Reference L/T 114 of the E.R.A. *See* Fröhlich, 4138 of 1939 and 349 of January.

4447. ELECTRICAL CONDUCTION AND RELATED PHENOMENA IN SOLID DIELECTRICS [Survey, with Long Bibliography].—Manning & Bell. (*Reviews of Mod. Phys.*, July 1940, Vol. 12, No. 3, pp. 215–256.)

4448. "ANNUAL REPORTS OF THE SOCIETY OF CHEMICAL INDUSTRY" [including Papers on Plastics : Book Review].—(*Journ. Roy. Soc. Arts*, 6th Sept. 1940, Vol. 88, p. 849.)

4449. EXTRUDED TUBING IN PLASTICS [Recent Development].—Irvington Company. (*Journ. of Applied Phys.*, July 1940, Vol. 11, No. 7, p. 508 : paragraph only.)

4450. SOME RELATIONS BETWEEN MOLECULAR STRUCTURE AND PLASTICISING EFFECT.—Kirkpatrick. (*Journ. of Applied Phys.* April 1940, Vol. 11, No. 4, pp. 255–261.)

4451. MEASUREMENT OF THE FLOW TEMPERATURE OF THERMOPLASTIC MOULDING MATERIALS.—Meyer. (*ASTM Bulletin*, Aug. 1940, No. 105, pp. 23–26.)

4452. CERAMIC MATERIALS : THEIR PHYSICAL AND ELECTRICAL PROPERTIES—SOME CONTINENTAL OBSERVATIONS [Regulations, etc., issued by German Electrical Porcelain Manufacturers].—(*Electrician*, 13th Sept. 1940, Vol. 125, pp. 137–138.)

4453. DIELECTRIC LOSS FACTORS OF CERAMIC MATERIALS FOR A.C. AT COMMERCIAL FREQUENCIES, AT 100–500° C.—Richter. (*Physik. Zeitschr.*, 10th May 1940, Vol. 41, No. 9/10, pp. 229–233.)

4454. THE INVESTIGATION OF SYNTHETIC LINEAR POLYMERS BY X-RAYS [and the Inner Structure of Polystyrene, Chloroprene, etc.].—Fuller. (*Bell Tel. S. Tech. Pub.*, Monograph B-1235, 25 pp.)

4455. RUBBER-LIKE PROPERTIES OF POLYBUTENE.—Sparks & others. (*Sci. Abstracts*, Sec. B, 25th Aug. 1940, Vol. 43, No. 512, p. 337.)

4456. SYNTHETIC RUBBERS : A REVIEW OF THEIR COMPOSITIONS, PROPERTIES, AND USES.—Wood. (*Tech. News Bull. Nat. Bur. of Stds.*, Aug. 1940, No. 280, pp. 66–67.) Summary of *Circular C* 427.

4457. WATER SOLUTION IN HIGH-VOLTAGE DIELECTRIC LIQUIDS.—Clark. (*Elec. Engineering*, Aug. 1940, Vol. 59, No. 8, Transact. pp. 433–441.)

4458. TESTING INSULATORS: SUBSTITUTION OF VACUUM GLOW-DISCHARGE FOR WATER AS INTERIOR ELECTRODE.—Subak. (*Elec. Review*, 13th Sept. 1940, Vol. 127, pp. 217 and 218.)

4459. THE ELECTROSTATIC GENERATOR [Discussion of Possible Designs of Rotary Generators for High Voltages: Multi-Cylinder & Multi-Disc Types].—Joffe & Hochberg. (*Journ. of Phys.* [of USSR], No. 3, Vol. 2, 1940, pp. 243–252: in English.) *See* also 3167 of August.

STATIONS, DESIGN AND OPERATION

4460. MULTIPLEX CARRIER TELEPHONY ON ULTRA-SHORT WAVES AT THE STRAIT OF TSUGARU [between Ishizaki & Tobetsu (61 km): Six Channels (34–64 kc/s) on 72 & 76 Mc/s Waves: Aerial System (with Reflectors) to withstand High Winds, Snow, etc: Transmitters (with Rectified Feedback), Receivers (Superheterodyne), & Terminal Equipment: Field Strengths, Noise, Cross-talk, etc.].—Matsumae, Yonezawa, & Kurokawa. (*Nippon Elec. Comm. Eng.*, April 1940, No. 20, pp. 206–219.)

Further development of the work referred to in 2570 of 1939. Excellent results have been obtained in the experimental trials: the characteristics were found to be "not inferior to those of the non-loaded cable when used as a part of a long-distance toll line." *See* also 4461, below.

4461. STUDIES ON ULTRA-SHORT-WAVE [4 m] TRANSMITTERS FOR MULTIPLEX TELEPHONY.—Yonezawa & Tanaka. (*See* 4243.)

4462. *QST* VISIT RIVERHEAD AND ROCKY POINT ["the World's Largest Receiving & Transmitting Stations": including Ultra-Short-Wave Equipments].—(*QST*, Sept. 1940, Vol. 24, No. 9, pp. 8–14 and 74 . . 78.)

4463. AN AUTOMATIC WEATHER STATION [as at Naval Air Station, Anacostia].—Diamond & Hinman. (*Tech. News Bull. Nat. Bur. of Stds.*, Aug. 1940, No. 280, pp. 64–65.) Summary of paper in August *Journ. of Res. of Nat. Bur. of Stds*: see also 4087 of October.

4464. SECRET MESSAGES BY RADIOTELEPHONE [Noise, photoelectrically generated by Saw-Tooth Disc, superposed on Speech].—Kotowski & Dannehl. (*Sci. News Letter*, 24th Aug. 1940, Vol. 38, No. 8, p. 124.) Note on U.S. Pat. No. 2 211 132.

GENERAL PHYSICAL ARTICLES

4465. MODIFICATION OF A RELATIVITY POSTULATE.—Sulaiman. (*Phil. Mag.*, July 1940, Vol. 30, No. 198, pp. 49–54.)

4466. THE RATE OF A MOVING CLOCK.—Dingle. (*Nature*, 21st Sept. 1940, Vol. 146, pp. 391–393.)

4467. SURFACES OF MINIMAL CAPACITY [Given a Closed Curve s in Space, does there exist, among the Surfaces of which s is the Complete Boundary, One for which the Capacity is a Minimum ?].—Evans. (*Proc. Nat. Acad. Sci.*, Aug. 1940, Vol. 26, No. 8, pp. 489–491.)

4468. A FIRST-ORDER WAVE EQUATION FOR THE POTENTIAL OF A RADIATION FIELD.—Molière. (*Ann. der Physik*, 1st May 1940, Ser. 5, Vol. 37, No. 5/6, pp. 415–420.)

4469. ON A METHOD OF SOLVING THE FUNDAMENTAL PROBLEM OF ELECTROSTATICS AND RELATED PROBLEMS: II [Modification of Method previously Suggested, to simplify Solution of Certain Classes of Problem].—Grünberg. (*Journ. of Phys.* [of USSR], No. 3, Vol. 2, 1940, pp. 213–216: in English.) *See* 798 of 1939.

4470. A NEW TREATMENT OF ELECTRIC AND MAGNETIC INDUCTION.—Burmiston Brown. (*Proc. Phys. Soc.*, 1st Sept. 1940, Vol. 52, Part 5, pp. 577–615.)

4471. PAIR PRODUCTION OF MESOTRONS AT 29 000 FEET [Slow Positive & Slow Negative Mesotrons].—Herzog & Bostick. (*Phys. Review*, 1st Aug. 1940, Ser. 2, Vol. 58, No. 3, p. 278.)

4472. "ELECTRONIC PROCESSES IN IONIC CRYSTALS" [Book Review].—Mott & Gurney. (*Proc. Phys. Soc.*, 1st Sept. 1940, Vol. 52, Part 5, p. 725.) "This book will probably be the standard, and only, one in its field for many years to come . . ."

MISCELLANEOUS

4473. SIR J. J. THOMSON, O.M., F.R.S.—(*Nature*, 14th Sept. 1940, Vol. 146, pp. 351–357.) "A man whom posterity will envy us for having known."

4474. THE LATE SIR JOSEPH THOMSON, O.M., F.R.S.—(*Engineering*, 6th Sept. 1940, Vol. 150, pp. 193–194: *Elec. Review*, 6th Sept. 1940, Vol. 127, p. 202.)

4475. AN ANALOGY BETWEEN THE THEORIES OF POTENTIAL AND VIBRATIONS [with a Section on the Testing of Sensitivity of Recording Apparatus by applying Harmonic Disturbances and recording Magnification & Phase Shift].—Jeffreys. (*Phil. Mag.*, Aug. 1940, Vol. 30, No. 199, pp. 161–167.)

4476. SOLUTION OF THE ["Hystero-Differential"] EQUATION $f'(x) = f(1/x)$.—Silberstein. (*Phil. Mag.*, Sept. 1940, Vol. 30, No. 200, pp. 185–186.)

4477. ON LAGUERRE SERIES [and Certain Convergence Properties].—Greenwood. (*Proc. Nat. Acad. Sci.*, July 1940, Vol. 26, No. 7, pp. 466–471.)

4478. SOME INTEGRAL REPRESENTATIONS OF THE ASSOCIATED LEGENDRE FUNCTIONS.—Erdélyi. (*Phil. Mag.*, Aug. 1940, Vol. 30, No. 199, pp. 168–171.)

4479. A PATHOLOGICAL CASE IN THE NUMERICAL SOLUTION OF INTEGRAL EQUATIONS.—Pekeris. (*See* 4210.)

4480. ON THE INTEGRAL EQUATIONS OF CONTINUOUS DYNAMICAL SYSTEMS [with Application to Damped Vibrating String & Electrical Transmission Line].—Ingram. (*Phil. Mag.*, July 1940, Vol. 30, No. 198, pp. 16–38.)

4481. A METHOD FOR THE DOUBLE GRAPHICAL INTEGRATION OF NON-LINEAR EQUATIONS OF THE SECOND ORDER [applied to Transient Processes in Windings].—Livshits. (In paper dealt with in 4432, above.)

4482. THE POLYNOMIAL OF MITTAG-LEFFLER [used in Analytical Representation of a Linear Homogeneous Differential Equation].—Bateman. (*Proc. Nat. Acad. Sci.*, Aug. 1940, Vol. 26, No. 8, pp. 491–496.)

4483. APPLICATION OF THE PROPERTIES OF THREE TYPES OF DETERMINANTS TO THE CALCULATION OF THE NATURAL FREQUENCIES OF COUPLED OSCILLATING SYSTEMS.—Parodi. (*See* 4221.)

4484. TRANSIENT ANALYSIS OF SYMMETRICAL NETWORKS BY THE METHOD OF SYMMETRICAL COMPONENTS [and Laplacian Transformations: Great Simplification].—Pipes. (*Elec. Engineering*, Aug. 1940, Vol. 59, No. 8, Transact. pp. 457–459.)

4485. MATRICES AND DYADICS [and the Valuable Properties of the Latter not shared by the Former, in Analysis of Three-Phase Circuits].—Sah. (*Elec. Engineering*, Aug. 1940, Vol. 59, No. 8, pp. 329–330.)

4486. PARTIAL DERIVATIVES OF DERIVATIVES: PART I—THE PARTIAL DERIVATIVES OF THE SLOPE OF A STRAIGHT LINE [by Parallel Displacement].—Kimball. (*Phil. Mag.*, Sept. 1940, Vol. 30, No. 200, pp. 190–222.)

4487. THE CONFORMAL THEORY OF CURVES [in a Riemann Space: using a New Kind of Tensor Differentiation with a Conformal Meaning].—Fialkow. (*Proc. Nat. Acad. Sci.*, June 1940, Vol. 26, No. 6, pp. 437–439.)

4488. "TWO-DIMENSIONAL POTENTIAL PROBLEMS CONNECTED WITH RECTILINEAR BOUNDARIES" [including Generalisation of Conformal Representation Method, Use of Methods of Images & of Conjugate Functions, etc: Book Review].—Seth. (*Current Science*, Bangalore, July 1940, Vol. 9, No. 7, p. 341.)

4489. "THE THEORY AND USE OF THE COMPLEX VARIABLE" [for Technical Problems: Book Review].—Green. (*Gen. Elec. Review*, Aug. 1940, Vol. 43, No. 8, p. 348.)

4490. "'AN INTRODUCTION TO VECTOR ANALYSIS" [Book Review].—Hague. (*Communications*, Aug. 1940, Vol. 20, No. 8, p. 15.)

4491. "ADVANCED CALCULUS" [Book Review], *and* "ADVANCED CALCULUS" [Book Review].—Sokolnikoff: Stewart. (*Proc. Phys. Soc.*, 1st Sept. 1940, Vol. 52, Part 5, p. 714: p. 714.)

4492. "AMERICAN MATHEMATICAL SOCIETY SEMICENTENNIAL PUBLICATIONS" [Book Review].—(*Phil. Mag.*, July 1940, Vol. 30, No. 198, pp. 79–81.)

4493. MATHEMATICAL TABLES [and the Work of the "Project for the Computation of Mathematical Tables"].—Nat. Bureau of Standards. (*Wireless Engineer*, Sept. 1940, Vol. 17, No. 204, p. 393.)

4494. "TABLES OF THE EXPONENTIAL FUNCTION e^x" [Book Review].—Nat. Bureau of Standards. (*Communications*, Aug. 1940, Vol. 20, No. 8, p. 15.)

4495. A NEW METHOD FOR THE MATHEMATICAL REPRESENTATION OF "AFTER-EFFECT" PHENOMENA, AND IN PARTICULAR OF HYSTERESIS.—Kovalenkov & Machinski. (*Automatics & Telemechanics* [in Russian], No. 3, 1939, pp. 3–18.)

It is pointed out that ordinary many-valued functions are not adequate for representing certain physical processes in which each stage is determined by the previous "history," and in which a reversal of direction produces different results from the preceding stage; *e.g.* magnetisation and demagnetisation. Accordingly a conception is introduced of "reversible" functions with whose aid hysteresis curves, for example, can be plotted.

4496. THE DISTRIBUTION OF THE ROOT-MEAN-SQUARE OF THE SECOND TYPE OF THE MULTIPLE CORRELATION COEFFICIENT.—Roy & Bose. (*Sci. & Culture*, Calcutta, July 1940, Vol. 6, No. 1, p. 59.)

4497. A MECHANICAL APPLIANCE FOR THE SMOOTHING OF TIME SERIES.—Schumann. (*Phil. Mag.*, July 1940, Vol. 30, No. 198, pp. 39–48 and Plates.)

4498. SQUARE ROOT EXTRACTOR [Cam-&-Pulley Device for extracting a Root or obtaining a Power of Successive Ordinate Values of Curves: useful for Hot-Wire-Meter Measurements, Flow Records, etc.].—Green. (*Review Scient. Instr.*, Aug. 1940, Vol. 11, No. 8, pp. 262–264.)

4499. THE BUSH DIFFERENTIAL ANALYSER AND ITS APPLICATIONS.—Hartree. (*Nature*, 7th Sept. 1940, Vol. 146, pp. 319–323.)

4500. SOME SIGNIFICANT TRENDS IN ELECTRICAL ENGINEERING.—Sublet. (*Journ. Inst. Eng. Australia*, July 1940, Vol. 12, No. 7, pp. 211–220.)

4501. INSTITUTE PUBLICATION PROCEDURE MODIFIED TO IMPROVE SERVICE [Reduction of Time Lags, Authors encouraged to be Brief, etc.], *and* "WRITING THE TECHNICAL REPORT" [Book Review].—A.I.E.E: Nelson. (*Elec. Engineering*, Aug. 1940, Vol. 59, No. 8, pp. 331–332: *Nature*, 28th Sept. 1940, Vol. 146, p. 419.)

4502. THE 15TH ANNUAL CONVENTION OF THE INSTITUTE OF RADIO ENGINEERS, AT BOSTON.—(*Electronics*, July 1940, Vol. 13, No. 7, pp. 17–21 and 75 . . 78.)

4503. "THE SCIENTIFIC JOURNAL OF THE ROYAL COLLEGE OF SCIENCE, VOL. X" [Book Review].—(*Proc. Phys. Soc.*, 1st Sept. 1940, Vol. 52, Part 5, p. 717.)

4504. "CONTRIBUTIONS FROM THE PHYSICAL LABORATORIES OF HARVARD UNIVERSITY FOR THE YEAR 1938" [Collection of Reprints: Book Review].—(*Proc. Phys. Soc.*, 1st Sept. 1940, Vol. 52, Part 5, p. 728.)

4505. "SCIENCE SINCE 1500: A SHORT HISTORY OF MATHEMATICS, PHYSICS, CHEMISTRY, AND BIOLOGY" [Book Review].—Pledge. (*Proc. Phys. Soc.*, 1st Sept. 1940, Vol. 52, Part 5, p. 723.)

4506. "ELECTRONIC STRUCTURE AND CHEMICAL BINDING" [Book Review].—Rice. (*Electronics*, July 1940, Vol. 13, No. 7, p. 35.)

4507. "ELECTRICAL COMMUNICATION: SECOND EDITION" [Book Review].—Albert. (*Proc. Phys. Soc.*, 1st Sept. 1940, Vol. 52, Part 5, p. 720.)

4508. "DRAKE'S CYCLOPEDIA OF RADIO AND ELECTRONICS" [Book Review].—Manly & Gorder. (*Elec. Review*, 20th Sept. 1940, Vol. 127, p. 249.)

4509. "RADIO AT ULTRA-HIGH FREQUENCIES" [Book Review].—R.C.A. Laboratories. (*Wireless Engineer*, Sept. 1940, Vol. 17, No. 204, p. 398.) A collection including two hitherto unpublished papers (*see* 4268 & 4377, above).

4510. REFLECTION, REFRACTION, AND ABSORPTION CHARACTERISTICS OF ELECTROMAGNETIC WAVES ON ROCKS.—Kodawaki. (*See* 4196.)

4511. VARIABLE-FREQUENCY STIMULATOR [for Neuro-Surgery & Research: from 1 Stimulus every 2 Seconds to 1500 per Sec.].—DuMont Laboratories. (*Journ. of Applied Phys.*, July 1940, Vol. 11, No. 7, p. 508.)

4512. "EXPERIMENTS IN TELEPATHY" [Book Review].—Warcollier. (*Journ. Roy. Soc. Arts*, 6th Sept. 1940, Vol. 88, pp. 848–849.)

4513. "ELEKTRONEN - UEBERMIKROSKOPIE: PHYSIK—TECHNIK — ERGEBNISSE" [Electron-Microscopy: Physics, Technique, & Results: Book Review].—von Ardenne. (*Bull. Assoc. suisse des Élec.*, No. 15, Vol. 31, 1940, pp. 338–339.)

4514. INVESTIGATION OF METALLIC-OXIDE SMOKES WITH THE ELECTRON MICROSCOPE.—von Ardenne. (*See* 4401.)

4515. ULTRA-VIOLET AND ELECTRON MICROSCOPY [including a Discussion of the Limits of Resolution].—Martin. (*Nature*, 31st Aug. 1940, Vol. 146, pp. 288–292.)

4516. "LIVING LIGHT" [with Data on Intensity, Quality, & Efficiency of Animal Light: Book Review].—Harvey. (*Journ. Franklin Inst.*, Aug. 1940, Vol. 230, No. 2, pp. 273–274.)

4517. THE ACTION OF ELECTRONS AND X RAYS ON PHOTOGRAPHIC EMULSIONS.—Charlesby. (*See* 4400.)

4518. "PHOTOGRAPHY BY INFRA-RED: ITS PRINCIPLES AND APPLICATIONS" [Book Review].—Clark. (*Current Science*, Bangalore, July 1940, Vol. 9, No. 7, pp. 341–342.) From the Kodak Laboratories.

4519. TRANSMISSION OF INFRA-RED RADIATION THROUGH FOG [Energy Measurements using the Hayes Radiometer: Definite Positive Results on Wavelengths above 3μ].—Smith & Hayes. (*Journ. Opt. Soc. Am.*, Aug. 1940, Vol. 30, No. 8, pp. 332–337.) *See* also 375 of 1938 and back reference.

4520. METHOD FOR OBTAINING LONG OPTICAL PATHS [of Several Hundred Feet in Limited Space, for Absorption-Spectra Studies, etc.].—Smith & Marshall. (*Journ. Opt. Soc. Am.*, Aug. 1940, Vol. 30, No. 8, pp. 338–342.)

4521. CONTROL OF INDUCTIVE INTERFERENCE TO TELEGRAPH SYSTEMS.—Milnor. (*Elec. Engineering*, Aug. 1940, Vol. 59, No. 8, Transact. pp. 469–474.)

4522. A SPARK TESTER FOR RUBBER-INSULATED ELECTRIC CABLES [R.F. Currents generated at Fault indicate Position].—Savage. (*Journ. of Scient. Instr.*, Sept. 1940, Vol. 17, No. 9, pp. 229–230.)

4523. MONTHLY BIBLIOGRAPHY OF PAPERS AND PATENT SPECIFICATIONS OF INTEREST IN AUTOMATICS AND TELEMECHANICS.—(*Automatics & Telemechanics* [in Russian], No. 1, 1940, pp. 136–145.) A monthly feature, in the various languages.

4524. ON THE PARAMETERS OF MODERN CATHODE-RAY TUBES USED IN ELECTRON COMMUTATORS.—Zernov. (*Automatics & Telemechanics* [in Russian], No. 2, 1939, pp. 27–44.)

In the first section of the paper the operation of electron commutators, *i.e.* of tubes in which the cathode ray plays the part of an inertialess current distributor, is discussed in detail both from the theoretical and the practical point of view. This is followed by a description of existing types of commutator, including those developed in Russia, and the operating constants of these as well as various parameters are shown. Some of the typical commutator circuits (Fig. 25–27) are then considered and examples of their practical use are given. In conclusion further possible applications of the commutator are discussed.

4525. THE INVESTIGATION AND DESIGN OF AN UNBALANCED BRIDGE CONTROLLING THE OPERATION OF A SERVO-MOTOR.—Rubin. (*Automatics & Telemechanics* [in Russian], No. 2, 1939, pp. 51–60.)

Various aspects of the operation of the bridge (Fig. 1) are discussed, such as the necessary limiting values of the variable arms, the resistance of the diagonal required fof obtaining the maximum output, regulation of the sensitivity, etc. The discussion covers bridges using sectional as well as continuous resistances.

4526. ELECTRONIC CONTROLLING DEVICES WITHOUT CONTACTS.—Klyuev. (*Automatics & Telemechanics* [in Russian], No. 3, 1939, pp. 83–88.)

Automatic controlling devices using electronic valves and operating without mechanical contacts are now widely used. In these devices a potential difference is obtained at the output terminals by varying the capacity or inductance of a h.f. tuned circuit. The operation of a typical device (Fig. 1) is discussed, and a new method is proposed in which use is made of the less inclined portions of the resonance curve to the right and left of the peak frequency. Several circuits (Fig. 8, 9, 12 & 13) embodying this principle and having two separate outputs are suggested. In some of these circuits use is made of copper-oxide rectifiers.

4527. A CURRENT-COMPENSATING CIRCUIT FOR REMOTE INDICATION, OPERATING DIRECTLY FROM A.C. MAINS.—Evdokimov. (*Automatics & Telemechanics* [in Russian], No. 3, 1939, pp. 89–96.)

The theory of the remote-indication apparatus manufactured by two American firms (Fig. 3 and 4) is discussed, and a new circuit (Fig. 8) is proposed in which use is made of the grid currents of the valves. This circuit employs fewer components than those considered above.

4528. REMOTE CONTROL OF A MODEL BOAT [at the Franklin Institute: Single-Channel (in 5 m Band) Transmitter with Automatic-Telephone Dial].—West. (*Electronics*, Aug. 1940, Vol. 13, No. 8, pp. 19–21.)

4529. EXCITING FLAMES FOR FOG SIGNALLING [Experimental Investigations, including Description of a Transportable Phase-Meter.]—Carrière. (*Rev. d'Acoustique*, Fasc. 1/3, Vol. 8, 1939, pp. 47–78.)

4530. PROPERTIES OF LINEAR SYSTEMS USED IN VIBRATION - MEASURING INSTRUMENTS.—Trimmer. (*Journ. Acous. Soc. Am.*, July 1940, Vol. 12, No. 1, pp. 127–130.)

4531. SHOCK WAVES IN AIR AND CHARACTERISTICS OF INSTRUMENTS FOR THEIR MEASUREMENT.—Thompson. (*See* 4339.)

4532. AN INTERVAL METER AND ITS APPLICATION TO STUDIES OF GEIGER COUNTER STATISTICS [sorts Time-Intervals into Size-Classes: discriminates between Intervals differing by only Few Tenths of 1%].—Driscoll & others. (*Review Scient. Instr.*, Aug. 1940, Vol. 11, No. 8, pp. 241–250.)

4533. THE PRECISION CHECKING OF DIMENSIONS BY ELECTRICAL METHODS [Survey].—Feldbaum. (*Automatics & Telemechanics* [in Russian], No. 1, 1940, pp. 95–106.)

4534. THE INTERNAL FRICTION OF SINGLE METAL CRYSTALS [measured by the "Composite Piezoelectric Oscillator" Method].—Read. (*Phys. Review*, 15th Aug. 1940, Vol. 58, No. 4, pp. 371–380.)

4535. ELECTROMAGNETIC LEVITATION [at New Zealand Centennial Exhibition: Floating Frying Pan].—(*Nature*, 21st Sept. 1940, Vol. 146, p. 398: paragraph only.) For previous references to the subject *see* 4267 & 4268 of 1939 and back reference.

4536. SPECIAL ISSUE ON THE MEASUREMENT AND CONTROL OF TEMPERATURE.—(*See* 4293.)

4537. TEMPERATURE MEASUREMENT WITH BLOCKING-LAYER PHOTOCELLS [in Steel Furnaces, etc: including a Patented Water-Cooled Fixture].—Larsen & Shenk. (*Journ. of Applied Phys.*, Aug. 1940, Vol. 11, No. 8, pp. 555–560.)

For the lower ranges of temperature (*e.g.* around 2000° F) amplification is necessary: in this connection it is remarked that "many of the amplifiers described in recent years have been sadly deficient in the fulfilment of these requirements [foolproofness and fidelity]. The design developed by Gilbert [1651 of 1936] represents an important advance in this line." *Cf.* Bowie, 4410, above.

4538. A NEW HIGH-SENSITIVITY PHOTO-SURFACE [High Sensitivity in Green, Blue, & Near Ultra-Violet, Negligible in Red].—Glover & Janes. (*See* 4370.)

4539. THE PROPERTIES OF PHOTOCELLS WITH MULTI-STAGE CURRENT AMPLIFICATION OPERATING WITH ALTERNATING VOLTAGE.—Timofeev. (*See* 4369.)

4540. PHOTOELECTRIC MEASUREMENT OF SCALE MARKS AND SPECTRUM LINES [New "Maximum Picker" Equipment using All-Electric Balancing Network (instead of Electro-Optical Balancing): Greatly Increased Simplicity in Adjustment: etc.].—Harrison & Molnar. (*Journ. Opt. Soc. Am.*, Aug. 1940, Vol. 30, No. 8, pp. 343–347.)

4541. A BALANCED DIRECT-CURRENT AMPLIFIER FOR ALTERNATING-CURRENT OPERATION [primarily for Photoelectric Measurements on Ultra-Violet Solar Radiation, Ozone Variations, etc: Entirely Satisfactory for Photocurrents not less than 10^{-13} A].—Stair & Hand. (*Review Scient. Instr.*, Aug. 1940, Vol. 11, No. 8, pp. 257–259.) For Vollrath's somewhat similar amplifier *see* 1139 of March.

4542. AREA DETERMINER [for Maps, Printed Designs, Indicator Diagrams, Plant Leaves, etc: Optical & Photoelectric Instrument].—American Instrument. (*Scient. American*, Sept. 1940, Vol. 163, No. 3, p. 123.)

4543. ELECTRICAL PHOTO-ENGRAVING [giving Almost Perfect Copies without Costly "Retouching" & "Fine Etching"].—Thorne Baker. (*See* 4372.)

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

523 412.—Electro-magnetic vibrational device or pick-up for use with direct-contact deaf-aids, or throat microphones.

Electrical Research Products Inc. Convention date (U.S.A.) 11th January, 1938.

523 482.—Construction and arrangement of the logarithmic horn and driving-unit of a loud speaker.

A. E. C. Snell and G. R. Fountain. Application date 5th January, 1939.

523 543.—Public-address installation fitted with means whereby its efficiency can be tested at intervals.

Standard Telephones and Cables; S. S. Hill; and L. J. Outram. Application date 3rd January 1939.

AERIALS AND AERIAL SYSTEMS

522 822.—Arrangement of the dipole elements of a short-wave aerial about a central mast, so as to give a circular radiation-field horizontally.

E. C. Cork and J. L. Pawsey. Application date 19th December, 1938.

523 074.—Matched impedance transformer-coupling between a dipole aerial and its transmission line.

Kolster-Brandes; W. A. Beatty; and P. K. Chatterjea. Application date 23rd December, 1938.

524 457.—Short-wave aerial consisting of a number of radiating arms which diverge from their point of connection to the feed-line so as to present a constant impedance over the working band of frequencies.

Marconi's W.T. Co. (assignees of P. S. Carter). Convention dates (U.S.A.) 29th January and 5th, 15th, and 17th February, 1938.

DIRECTIONAL WIRELESS

523 093.—D.F. installation operating as an automatic radio compass, or as a radio "course" indicator, or for homing on to a distant transmitter.

Sperry Gyroscope Co. Inc. (assignees of F. L. Moseley). Convention date (U.S.A.) 22nd October, 1937.

523 641.—Network of parallel half-wave aerials designed to radiate two beams of energy extending in opposite directions.

Philips' Lamp Co. Convention date (Netherlands) 14th January, 1938.

523 953.—Combination of a radio direction-finder and a servomotor for automatically keeping a frame aerial in the "minimum" position on a moving craft.

Sperry Gyroscope Co., Inc. (assignees of F. L. Moseley). Convention date (U.S.A.) 22nd October, 1937.

524 360.—Method of "terminating" a directional aerial which is more than one wavelength long and which carries a progressive as distinct from a stationary wave-system.

Marconi's W.T. Co. and O. Böhm. Application date 28th January, 1939.

524 361.—Method of winding the field and search coils of a radiogoniometer so as to reduce any coupling capacities between them.

Marconi's W.T. Co. and C. S. Cockerell. Application date 28th January, 1939.

524 526.—"Monitoring" arrangement for a "blind landing" system of the kind using signals which merge together along the approach line.

Standard Telephones and Cables and L. J. Heaton-Armstrong. Application date 31st January, 1939.

524 652.—Crossed-frame direction-finding aerial designed so that it can be withdrawn inside the hull, say, of a submarine.

Telefunken Co. Convention date (Germany) 2nd February, 1938.

524 653.—Synchronous switching arrangement for a direction-finder utilising "crossed" frame aerials, particularly suitable for short-wave working.

Telefunken Co. Convention date (Germany) 2nd February, 1938.

RECEIVING CIRCUITS AND APPARATUS

(*See also under Television*)

522 946.—Arrangement of a multiple high-frequency tuning-unit comprising condensers and inductances with movable powdered-iron cores.

Johnson Laboratories Inc. (assignees of P. K. McGall). Convention date (U.S.A.) 24th December, 1937.

522 975.—Wireless receiver in which means are provided to prevent the automatic frequency control from operating when the tuning is being changed from one station to another.

G. D. Barraclough. Application date 22nd December, 1938.

523 154.—Press-button tuning system with means for preventing the over-running of the motor, and for facilitating the alternative use of manual tuning control.

E. K. Cole and F. W. O. Kennedy. Application date 26th November, 1938.

523 484.—Combination of high-frequency conductors, e.g. for the chassis of a wireless set, and a wire-gauze foundation suitable for screening them.

Marconi's W.T. Co. and J. S. Swift. Application date 6th January, 1939.

523 697.—" Muting " circuit designed to allow a receiver to be tuned at will to different transmitters even when these are close together on the frequency scale.

Marconi's W.T. Co. and O. E. Keall. Application date 12*th January*, 1939.

523 742.—Broadcast receiver in which one of a number of stations is selected by directing a ray of polarised light on to the corresponding unit of a bank of piezo-electric crystals.

Standard Telephones and Cables (assignees of Le Matériel Téléphonique Soc. Anon.). Convention date (France) 3*rd February*, 1938.

523 772.—Spring-controlled lever and cam-rod mechanism for operatiing the tuning elements of a press-button receiver.

E. K. Cole and A. Shackell. Application date 14*th November*, 1938.

523 881.—Switch-tuned wireless set of the kind in which the desired station is selected by means of a keyboard device.

Philips' Lamp Co. Convention date (Germany) 18*th March*, 1938.

523 883.—Superhet set in which negative feed-back is used to prevent undesired interaction, or cross-modulation, between the H.F. circuits and the mixer stage.

Philips' Lamp Co. Convention date (Netherlands) 17*th May*, 1938.

524 049.—Frequency-changing or modulating circuits utilising secondary-emission feed-back in an electron multiplier.

Kolster-Brandes ; D. S. B. Shannon ; and P. K. Chatterjea. Application date 20*th January*, 1939.

524 073.—The application of a potential-variable capacity device, such as is shown in the Johnsen-Rahbeck effect, to an automatic tuning control system for a wireless receiver.

Marconi's W. T. Co. ; N. M. Rust ; J. D. Brailsford ; A. L. Oliver ; and J. F. Ramsay. Application date 12*th November*, 1938.

524 094.—Volume control operated by a push-button and plunger device similar in appearance to the push-button used for station-selection.

Philco Radio and Television Corpn. (assignees of G. J. Barry). Convention date (U.S.A.) 25*th January*, 1938.

524 193.—Receiver designed to " suppress " aperiodic disturbances even when these are smaller than twice the carrier-wave amplitude of the desired signal.

Philips' Lamps. Convention date (Netherlands) 24*th June*, 1938.

524 225.—Multi-range heterodyne oscillator arranged so that a single-scale calibration can be used for each subdivision of the whole tuning range.

Standard Telephones and Cables and R. M. Barnard. Application date 24*th January*, 1939.

524 245.—Motor-operated push-button control, with provision for stopping and reversing the motor-drive at a reduced speed near the tuning point.

E. K. Cole and A. W. Martin. Application date 25*th January*, 1939.

524 298.—Valve amplifier circuit, including positive and negative reaction paths, the attenuation along one of the paths being automatically controlled by the incoming signal.

J. Lawton. Application date 26*th January*, 1939.

524 314.—Switching means for compensating and calibrating valve oscillators and amplifiers of the kind which make use of phase-shifting networks.

E. R. Wigan. Application date 27*th January*, 1939.

524 340.—Negative feed-back amplifier with means for changing the overall " gain " whilst maintaining the other circuit conditions constant.

Standard Telephones and Cables (assignees of I. G. Wilson). Convention date (U.S.A.) 29*th March*, 1938.

TELEVISION CIRCUITS AND APPARATUS

For Transmission and Reception

523 359.—Manufacture and composition of a luminescent screen for reducing " halation " effects in television.

Marconi's W.T. Co. (assignees of R. R. Law). Convention date (U.S.A.) 31*st December*, 1937.

523 372.—Arrangement and mounting of the chassis and circuit components of a television receiver.

D. Jackson and Pye. Application date 3*rd January*, 1939.

523 439.—Gimbal mounting for the magnetic focusing coil of a cathode-ray television receiver.

D Jackson and Pye. Application date 3*rd January*, 1939.

523 441.—Saw-toothed oscillation-generator comprising two series-connected gas-filled tubes arranged across a pair of discharge condensers.

Philips' Lamps. Convention date (Germany) 1*st June*, 1938.

523 457.—Time-base circuit for ensuring exact repetition of the saw-toothed voltages used in interlaced scanning systems.

Fernseh Akt. Convention date (Germany) 30*th December*, 1937.

523 476.—Saw-toothed oscillation-generator in which one transformer serves both as a feed-back link and as a coupling element to the scanning coils.

Marconi's W.T. Co. (assignees of H. E. Rhea). Convention date (U.S.A.) 31*st December*, 1937.

523 611.—Television set in which the cathode-ray tube is situated at a point remote from the receiver proper and is connected to it by only one screened concentric cable.

B. J. Edwards and Pye. Application date 9*th January*, 1939.

523 780.—Time-base circuit, including a gas-filled discharge tube designed to give accurate registration of the synchronising voltages in an interlaced scanning system.

C. L. Hirshman and Metropolitan-Vickers Electrical Co. Application date 15*th December*, 1938.

523 831.—Circuit for applying a linear saw-toothed voltage to a low-impedance scanning-coil which is transformer-coupled to the time-base oscillator.

The British Thomson-Houston Co. and D. J. Mynall. Application date 5th August, 1938.

523 862.—Superposing the picture signals and synchronising-impulses used in television separately on two branches of the same carrier-wave which are subsequently merged.

G. Weiss. Convention date (Germany) 17th January, 1938.

524 038.—Means for varying or interrupting a high-voltage direct-current supply, say to the anode of an image-dissector as used in television.

Baird Television and T. C. Nuttall. Application date 20th January, 1939.

TRANSMITTING CIRCUITS AND APPARATUS

(*See also under Television*)

523 281.—Electron discharge tube for generating oscillations by secondary emission under the control of a steady magnetic field and an applied pulsating potential.

Standard Telephones and Cables (assignees of A. M. Skellett). Convention date (U.S.A.) 31st December, 1937.

523 353.—Modulating system of the absorption type, particularly suitable for television or wide-band signalling.

Marconi's W.T. Co. (assignees of J. L. Finch). Convention date (U.S.A.) 31st December, 1937.

523 405.—Phase-changing device and modulating circuit, particularly for a wired-wireless signalling system.

Telephone Manufacturing Co. and L. H. Paddle. Application date 3rd January, 1939.

523 434.—Means for reducing "parasitic" or "reflection" distortion of the signal components in a radio or wired-wireless system.

Standard Telephones and Cables (assignees of Le Matériel Téléphonique Soc. Anon.). Convention date (France) 25th January, 1938.

523 575.—Generating pulses of sound or similar waves by the periodic deflection of a beam of electrons across a target.

Kolster-Brandes and W. A. Beatty. Application date 6th January, 1939.

523 604.—Radio transmission system in which a "pilot" or separate frequency is radiated in order to allow a distant receiver to inform or control the transmitter with the object of ensuring the most favourable operating conditions.

Kolster-Brandes and W. A. Beatty. Application date 6th January, 1939.

523 712.—Means for producing high-frequency oscillations by controlling the velocity of the electrons in an electron stream.

The Board of Trustees of the Leland Stanford Junior University (assignees of R. H. Varian). Convention date (U.S.A.) 11th October, 1937.

523 897.—Double balanced modulating circuit for a suppressed carrier-wave signalling system.

Standard Telephones and Cables (assignees of R. S. Caruthers). Convention date (U.S.A.) 3rd March, 1938.

524 588.—Two-valve power amplifier, of which one valve supplies power to the load during the whole of a cycle of modulation, whilst the other valve alternately adds and absorbs power.

E. K. Sandeman and H. L. Kirke. Application date 1st February, 1939.

524 671.—Method of transmitting signals by utilising the leading or trailing edges of a time-modulated train of impulses.

Kolster-Brandes and W. A. Beatty. Application date 7th February, 1939.

CONSTRUCTION OF ELECTRONIC-DISCHARGE DEVICES

523 542.—Arrangement and assembly of the electrodes in a multi-grid valve with the object of preventing secondary emission.

Standard Telephones and Cables and F. D. Goodchild. Application date 3rd January, 1939.

523 574.—Method of mounting a valve-filament so as to prevent it from giving rise to undesired secondary emission from the glass walls of the tube.

Standard Telephones and Cables and W. T. Gibson. Application date 6th January, 1939.

523 863.—Construction and assembly of the secondary-emission electrodes in an electron-multiplier tube.

G. Weiss. Convention date (Germany) 17th January, 1938.

523 982.—Method of producing or "surfacing" target or secondary-emission electrodes with vaporised Beryllium for use in electron multipliers.

The British Thomson-Houston Co. Convention date (Germany) 18th January, 1938.

524 458.—Arrangement and assembly of the electrodes of a discharge tube, particularly a full-wave rectifier.

Marconi's W.T. Co. (assignees of N. H. Green). Convention date (U.S.A.) 29th January, 1938.

524 417.—Electrode arrangement in a discharge tube for varying the concentration of an electron stream against a secondary-emission surface.

Telefunken Co. Convention date (Germany) 28th January, 1938.

SUBSIDIARY APPARATUS AND MATERIALS

522 752.—Method of manufacturing a photo-sensitive surface by diffusing an alloy of antimony and caesium upon a supporting layer.

Baird Television and A. Sommer. Application dates 15th December, 1938, *and 3rd January and 15th May,* 1939.

522 808.—Valve relay circuit with a predetermined delay between the time of initiation and coming into action.

The General Electric Co. and J. Scowcroft. Application date 17th December, 1938.

522 929.—Echo-sounding apparatus utilising a sensitive unit built up of magneto-strictive elements.

Marconi's W.T. Co. and N. P. Hinton. Application date 21st December, 1938.

523 440.—Means for holding or clipping the screening-cans in position on the chassis of a set.

D. Jackson and Pye. Application date 3rd January, 1939.