THE
WIRELESS
ENGINEER

VOL. XVII. MAY, 1940 No. 200

Editorial

Amplitude, Frequency and Phase Modulation

IN *The Wireless Engineer* of November last we drew attention to some correspondence that had been published in *The Wireless World* concerning the correct description of a system of modulation proposed by Armstrong. We pointed out that if, instead of considering a sinusoidal modulation, one assumed a rectangular modulating wave, the difference between frequency and phase modulation was brought out very clearly. In the former any sudden jump in the modulating wave causes a sudden change in the angular velocity of the radio-frequency rotating vector and a consequent gradual change in the phase with reference to the value that the phase would have in the absence of modulation, whereas in the latter any sudden jump in the modulating wave causes the radio-frequency rotating vector to spring forward or backward with equal suddenness. In either case the changes of frequency and phase are interrelated, one being the integral or the differential of the other, as was pointed out in a letter in the December *Wireless Engineer*. This latter fact indicates at once what is otherwise fairly obvious, namely that if one is sinusoidal the other must also be sinusoidal. If the radio-frequency rotating vector has a slow sinusoidal oscillation superposed upon its uniform rotation so that its position is given by $\sin(\omega_0 + \delta\hat{\omega} \sin pt)t$, the angular velocity or cyclical frequency varies between $\omega_0 + \delta\hat{\omega}$ and $\omega_0 - \delta\hat{\omega}$ at the audio frequency $p/2\pi$. From $pt = 0$ to $pt = \pi$ the angular velocity is above the mean, and when $pt = \pi$ the forward displacement reaches its maximum value $\hat{\theta} = \frac{\delta\hat{\omega}}{p}$ and ω has its mean value ω_0.

We have returned to the subject again in order to draw attention to an article by Dr. L. E. C. Hughes in *The Electrician* of March 8, in which he makes some very interesting statements. If the extreme phase modulation $\hat{\theta}$ exceeds one radian, the band-spread is equal to twice the modulating frequency multiplied by $\hat{\theta}$, but if $\hat{\theta}$ is less than one radian the band-spread is stated to be independent of it and simply equal to twice the modulation frequency. From what we have said above it will be seen that the actual frequency covers a range of $2\delta\hat{\omega} = 2p\hat{\theta}$, but according to Dr. Hughes, an analysis of the variable frequency wave into its Fourier components exhibits some critical peculiarity when $\hat{\theta}$ is equal to one radian. It is also stated, however, that if the extreme frequency modulation $\delta\hat{\omega}$ exceeds p, the band-spread is theoretically infinite but practically confined to twice the modulation frequency, whilst for smaller values of

$\delta\hat{\omega}$ it is equal to twice the modulation frequency. It seems difficult to reconcile these statements, since the condition that $\delta\hat{\omega}$ should exceed p is also the condition for $\hat{\theta}$ exceeding one radian.

In the same article Dr. Hughes makes the remarkable claim that it is possible to have a frequency-modulated programme and an ordinary amplitude-modulated programme on the same carrier frequency at the same time, and to use independent receivers for demodulating, that is, detecting or receiving, the two programmes. He says that "this can be done without cross-talk, thus using the same carrier allocation for two programmes without doubling the power required for transmitting the normal amplitude-modulated wave," but he adds "this does not appear to have been practised." The possibility of being able to do this without mutual interference looks so improbable that it is to be hoped that Dr. Hughes will give some information concerning the methods of reception whereby each receiver responds to the waves intended for it, and turns a deaf ear to those of the same or a closely neighbouring frequency intended for the other receiver.

G. W. O. H.

Dielectric Losses in Radio Circuits*

By A. G. Bogle

(1) Introduction

It is well known that skin-effect causes the high-frequency resistance of a coil to increase as the square root of the frequency and hence it follows that the power-factor $F \equiv R/2\pi fL$ varies as $f^{-\frac{1}{2}}$: the constant of variation depends on the shape of the coil and the spacing between turns, and has been calculated by S. Butterworth and others.

Experiment shows, however, that the power-factor of a complete circuit does not decrease continuously as the frequency increases, but passes through a minimum value. Fig. 1 is typical of the result which is always obtained when F is plotted as a function of the wavelength λ: the dotted curve in the same figure is the parabola $F \propto \lambda^{\frac{1}{2}}$ which would obtain if energy loss occurred only in the conductors of the coil. Thus suppose the measured value of F is given by the intercept AC in Fig. 1: then only the portion AB is due to true ohmic losses and the residue BC represents some other loss which is not easy to account for or to locate. It follows that if CB is a considerable fraction of CA then improvements to the coil will cause very little net benefit and it is of greater practical importance to try to reduce BC. The portion BC has crept in as a kind of interloper and has become a dominant factor in fixing the degree of selectivity obtainable: it is due to the integrated effect of dielectric losses and leakage in the tuning condenser proper, in the coil former, and in components such as valve-holders and valves attached to the circuit. The higher the frequency the smaller the tuning condenser employed and hence the greater relative importance of the imperfect capacitance contributed by valve-holders and the like.

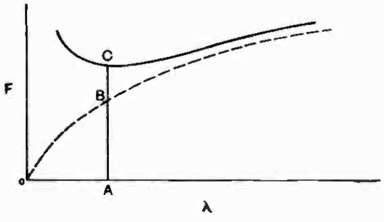

Fig. 1.

The purpose of these notes is to record some measured values of the power-factors of valves and holders, condensers, etc.: it is hoped the information will be of practical use in the design and construction of highly selective circuits.

(2) Experimental Method

The measurements were made with a calibrated dynatron generator adjusted to

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

be at the threshold of oscillation; mostly with a self-contained and specially constructed instrument which will be referred to as the " ρ-meter." Details of the instrument do not concern us here; suffice it to say that great care and much research has been devoted to the method of calibration and to proving its validity.

(3) Losses in Valve-holders and Valves (cold)

Let the dynamic resistance of a given circuit at a given frequency be R_1, as measured by the ρ-meter. If a valve-holder is then connected in parallel with the condenser, which has been adjusted to restore the original frequency, the dynamic resistance of the whole combination will have a smaller value R_2. It follows that the valve-holder has an " equivalent leakage resistance " R' at that frequency, given by

$$R' = \frac{R_1 \times R_2}{R_1 - R_2}.$$

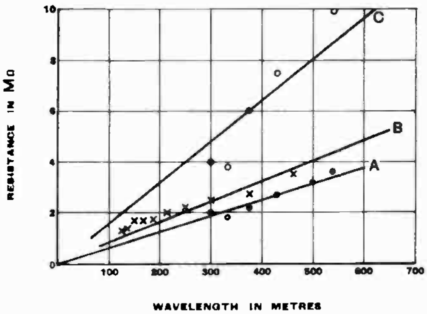

Fig. 2.—*Equivalent leakage resistance between adjacent sockets of various valve holders. A—old ebonite base-board pattern; B—modern ebonite base-board pattern; C—paxolin chassis pattern.*

The results of such a measurement between adjacent sockets of three typical valve-holders are exhibited in Fig. 2: the observation points lie close to the three straight lines drawn in the figure, showing that the power-factor of these holders is substantially independent of frequency. The value of this was 17×10^{-3} for the chassis pattern paxolin holder; 44×10^{-3} for an ebonite base-board holder of modern pattern; and 49×10^{-3} for an older pattern. The equivalent leakage resistance of a high-frequency model made of " frequentite " was too large to measure (i.e. certainly greater than 10 megohms) at all frequencies up to 2.4 Mc/s.

The evil effect of a valve-holder such as *A* in Fig. 2 is well illustrated by the following numerical example:—if it were placed in parallel with a circuit having an inherent dynamic impedance of 470 kilohms and a Q of 200 at a frequency of 1 Mc/s, it would reduce the Q to 160.

The equivalent leakage resistance is much reduced when a valve is inserted in the holder, even though the cathode is cold. The observed results for the various electrodes of a typical screen-grid tetrode are shown in Fig. 3. It will be noticed that the equivalent leakage resistance of a metallised valve is much less than that of a valve with a clear glass envelope. However, calculations of power-factor, using the measured values of the respective inter-electrode capacitances, showed that the power-factor of either type was between 5×10^{-3} and 7×10^{-3} for all electrodes. So the inter-electrode medium may be regarded as a dielectric of constant power-factor, and the lower value of equivalent leakage resistance for the metallised valve may be regarded as due only to the greater capacitance of the metallised envelope.

When the base and pins were removed from the clear glass valve it was found that the leakage resistance was sensibly doubled, showing that the losses are shared about equally between the base and the valve pinch. On the other hand, the power-factor

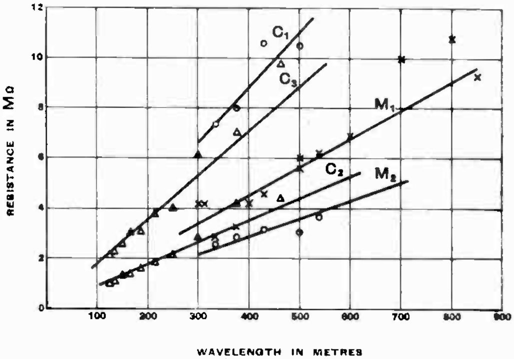

Fig. 3.—*Equivalent leakage resistance between valve electrodes. Clear-glass valve: C_1—anode/cathode; C_2—screen/cathode; C_3—screen/cathode without base. Metallised valve: M_1—anode/cathode; M_2—screen/cathode.*

of the pinch was only about one-fourth that of the pins and base.

(4) Input Resistance of Thermionic Voltmeter

The power-factor of a Cambridge Instrument Co., pattern A, Moullin voltmeter (instrument range 1.5 v. and instrument range 0.5 v.) at a deflection of 0.2 v. (grid current then negligible) was found to be sensibly independent of frequency and equal to about 7×10^{-3}. Expressed as leakage resistance this becomes $R' = 9\lambda_m$ kilohms for the 1.5 v. instrument and $R' = 4.5\lambda_m$ kilohms for the 0.5 v. instrument.

(5) Input Resistance of the ρ-metre (cold)

Since two identical self-contained ρ-meters were available it was possible to observe the effect of connecting one cold and unexcited meter in parallel with a circuit. The power-factor was found to be independent of frequency and equal to about 2.6×10^{-3} ($R' = 13\lambda_m$ kilohms).

(6) Power Factor of Tuning Condensers

A tuning condenser may be regarded as a perfect air-condenser of variable capacitance in parallel with an imperfect condenser of fixed capacitance, due largely to the bushings and terminals: in accordance with our experience, with valve-holders and the like, it may be expected that the power-factor of the imperfect condenser is sensibly independent of frequency and temperature so long as direct conductive leakage is negligible.

Two distinct approaches have been used. In one the condenser to be tested was set at its minimum value and connected in parallel with a circuit energised by the ρ-meter. The circuit condenser was then decreased in capacitance until the original frequency was restored, and it was assumed that this was a decrease of capacitance of a perfect condenser since it was a change only of the air portion of the circuit condenser. The dynamic resistance of the circuit will be decreased by connecting the test-condenser (set at its minimum value) in parallel with it; the equivalent leakage resistance then deduced was deemed to be that of the imperfect portion of the condenser being tested, at that frequency. This test was made both with a good quality laboratory condenser mounted on ebonite and also with a best quality laboratory standard. In both cases the power-factor at minimum setting was found to be constant and equal respectively to 2.7×10^{-3} and 0.56×10^{-3}.

Assuming that the air portion is perfect, the power-factor of these two condensers is expressed by the relations:

$$\left.\begin{aligned} &F' = \frac{53}{C} \times 10^{-3} \times 2.7 \\ \text{and}\quad &F' = \frac{77}{C} \times 10^{-3} \times 0.56 \end{aligned}\right\} \quad \ldots \quad \ldots \quad (1)$$

where C is the total capacitance in $\mu\mu$F of the condenser at any setting.

The other method of approach is that described some years ago by Moullin[1] and used also by Willis Jackson[2], and consists in using two or more coils which differ only in the metal used in their winding. When a copper wire coil is replaced by a similar coil with, say, brass wire, the circuit losses are changed only by the losses in the conductors of the coil. If the total circuit resistance at any frequency is plotted as a function of the square root of the resistivity of the wire the points should be on a straight line which does not pass through the origin. The intercept on the resistance axis gives the resistance which would remain if the coil itself had zero resistance: the residue is due to the condenser and other attached components.

In the present measurements two pairs of coils were used:—

(*a*) 16-gauge brass and copper wire, $d = 10.2$ cm, $l = 4.9$ cm, $L = 42$ μH. These coils were almost entirely self-supporting and should have very low dielectric loss.

(*b*) 24-gauge brass and copper wire, $d = 6$ cm, $l = 10$ cm, $L = 384$ μH. Wound on an ebonite spider-former which should have low dielectric loss.

For the first pair, the well-known parameter Z ($\equiv \sqrt{8\pi f / r_0}$) was always > 8 for the frequencies used.

Therefore $r_f / r_0 \propto Z$,

and hence $r_f \propto \rho Z$, i.e. $\propto \sqrt{\rho f}$;

and if the frequency is kept constant, and

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[1] *Proc. Roy. Soc.* (A), 1932, Vol. 137, p. 116.

[2] *Journ. I.E.E.* 1937, Vol. 80, p. 440.

only the material of the wire is changed,

$$r_f \propto \sqrt{\rho}.$$

Here : r_0 = D.C. resistance of the wire in c.g.s. units/cm.

r_f = A.C. resistance of the wire in c.g.s. units/cm. at frequency f cycles/sec.

ρ = resistivity of the wire material in c.g.s. units.

For the second pair, at some frequencies, $Z < 3$, so Butterworth's formula :—

$$r_f/r_0 = \left\{\alpha[1 + F(Z)] + G(Z)[\beta u_1 + \gamma u_2]\frac{d^2}{D^2}\right\},$$

was used to calculate the resistance against which the measured resistance was plotted for each frequency. In this formula, $F(Z)$ and $G(Z)$ are functions of Z ; α, β and γ are functions of Z and $\frac{d}{D}$ (the ratio of wire diameter to separation distance) ; u_1 and u_2 are functions of the length-to-diameter ratio of the coil.

In Fig. 4 are recorded the results for the first condenser, used with coils (a).

The residual series resistance ranges from 0.27 ohms at 1,000 kc/s to 1.45 ohms at 2,400 kc/s : not all of this however is due to the tuning condenser, since some of it is due to the ρ-meter. In an attempt to separate these two components it is convenient to express the residue as an equivalent shunt resistance R_r. Then if R_M is the equivalent shunt resistance of the ρ-meter, the equivalent shunt resistance of the condenser is given by

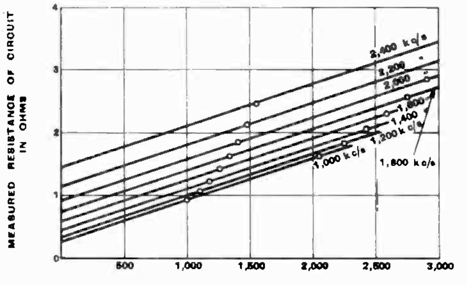

Fig. 4.—*Example of extrapolation for obtaining residual circuit resistance.*

$$R = \frac{R_r \times R_M}{R_M - R_r}.$$

It is not possible to measure R_M in the working conditions and one can do no more than use the value found for it when cold and unexcited.

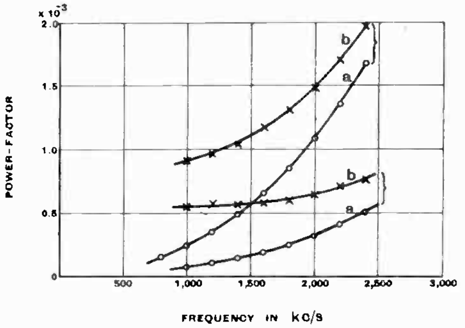

Fig. 5.—*Condenser power factors.* (*a*) *from equations* (1) ; (*b*) *from method of extrapolation.*

When this is done the power-factors shown in Fig. 5 are obtained. On the same graph curves are drawn showing the power-factor of these two condensers as represented by equations (1). It is seen that the results of the second method lie on a curve which does not pass through the origin and which is considerably different from that derived from the first method.

The discrepancy can be accounted for by the loss in the ρ-meter under working conditions, a loss which does not interfere with the results of the first method but which cannot be allowed for in the second method, being widely different from the loss of the cold unexcited ρ-meter. However the discrepancy, while proportionately fairly large at the lower frequencies, is of small absolute magnitude ($< 1.0 \times 10^{-3}$) ; at the higher frequencies the two sets of results do not differ widely, so it is possible to arrive at a reasonable estimate of the correct condenser power-factor. The values at 2.4 Mc/s :— 1.8×10^{-3} and 0.6×10^{-3} respectively, form a good basis for comparison between the two condensers.

It is of interest to refer to the results tabulated by Jackson in his paper. Although he was concerned principally with coil resistance it is possible to deduce from his measurements the order of condenser power-factor which he encountered. He was using special coils of low dielectric loss, of the same construction as coils (*a*) above, and high-grade condensers; the voltmeter was tapped across a short length of coil and thus had negligible damping effect, so that practically all residual loss was attributable to the condenser. In the two cases where information is available, the power-factors were :—

1.5×10^{-3} at 1,474 kc/s and 781 $\mu\mu$F, and
3.1×10^{-3} at 1,149 kc/s and 287 $\mu\mu$F.

These values and those shown in Fig. 5 are higher than many radio engineers would believe possible. Even supposing—an unlikely supposition—that no more than three-quarters of the total residue is in fact due to the condenser itself, it still appears that the best variable condensers available may easily have a power-factor comparable with that of the coil. When the leakage and dielectric losses of other circuit components are taken into account it becomes evident that any great effort to develop low-loss coils is almost wasted unless equal attention is paid to the dielectric and leakage losses outside the coil.

Acknowledgments

The experiments described were made in the Engineering Laboratory, Oxford, and the writer wishes to thank Dr. E. B. Moullin for his help and advice.

Correspondence

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

Velocity-Modulated Beams

To the Editor, The Wireless Engineer.

Sir,—Since the publication of my letter in the March issue of *The Wireless Engineer* I have found that I was wrong in stating that the formula for S' given therein holds good for any value of m.

The formula is correct when $m < 0.1$. For values of m greater than 0.1 S′ has to be multiplied by a correction factor c.

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

thus when $m = 0.4$, c becomes 0.83, while for $m = 1.0$, c approaches zero. For values of m which are likely to occur in practice c is very nearly 1.0.

RUDOLF KOMPFNER.

London, S.E.24.

To the Editor, The Wireless Engineer.

Sir,—In his article on velocity-modulated beams in the February issue of *The Wireless Engineer*, D. M. Tombs describes a graphical method of obtaining the instantaneous density distribution of electrons in such a beam. By plotting a number of these at various parts of the cycle, he deduces the optimum drift-tube length for a certain depth of modulation. Repeating this process for various depths of modulation, he obtains a graph of the optimum drift-tube length S' against depth of modulation, from which he derives some empirical relations connecting these and the phase retardation at this point.

In a letter in the March *Wireless Engineer*, R. Kompfner mentions that these results can be calculated analytically and gives his result without his calculations. I have also done this calculation, but I cannot agree with his result.

Let us take the same physical assumptions as Tombs—viz.:

(1) No electron interaction (space charge neglected).

(2) All electrons move along the axis of the drift tube.

(3) The time an electron is in the modulating field is small compared with the period of this field.

A sinusoidal modulating voltage is assumed, and the notation is the same as in Tombs' article.

Let m be the depth of voltage modulation.

u_0 be the velocity with no modulation.

ω be the angular frequency of modulating voltage.

u be the velocity of electron entering an equipotential drift tube at time t.

Then $u = u_0 (1 + m \sin \omega t)^{1/2}$

Let an electron entering at time t be a distance x along the tube at a later time T.

$$\text{Then } T = \frac{x}{u} + t$$

$$= \frac{x}{u_0}(1 + m \sin \omega t)^{-1/2} + t \quad \ldots \quad \ldots \quad (1)$$

Let ρ_0 be the number of electrons per second crossing a plane perpendicular to the unmodulated beam.

ρ be the number of electrons per second crossing a plane perpendicular to the beam at x.

If dn is the number of electrons entering the drift tube between t and $t + dt$, we have :

$$\rho_0 = \frac{dn}{dt}$$

Now these electrons will reach x between T and $T + dT$, hence

$$\rho = \frac{dn}{dT}$$
$$= \rho_0 \cdot \frac{dt}{dT}$$

From (1) we get :—

$$\frac{dT}{dt} = 1 - \frac{xm\omega}{2u_0} \cdot \frac{\cos \omega t}{(1 + m \sin \omega t)^{3/2}}$$

Hence : $$\frac{\rho}{\rho_0} = \frac{1}{1 - \dfrac{xm\omega}{2u_0} \cdot \dfrac{\cos \omega t}{(1 + m \sin \omega t)^{3/2}}}$$

This gives the instantaneous electron density at any point x at any time T.

From this we want to calculate the optimum length for the drift tube. The value of this depends on the detailed mechanism which we assume for the transference of energy between the beam and the resonator or other output circuit. If we assume a simple sinusoidal electric retarding field of the same frequency, the condition for optimum length is given by making the power delivered, which is given by

$$\int_0^{\frac{2\pi}{\omega}} V \cos (\omega t + \alpha)\, d\rho, \quad \text{a maximum.}$$

(V = amplitude of retarding field ; α = some phase angle).

Unfortunately this integral cannot be easily evaluated, and though a graphical solution could be obtained, the results aimed at by Tombs can be obtained analytically by finding the point at which the time maximum of ρ reaches a maximum with respect to x. To do this we first find the maximum of ρ with respect to time (T), which will give us the envelope inside which ρ must lie for all times, and then find the maximum of this with respect to distance (x).

The maximum with respect to T occurs when $\frac{d\rho}{dT} = 0$, but this gives the same condition as $\frac{d\rho}{dt} = 0$.

This differentiation is simple, but is omitted here as it is rather lengthy. The result is :—

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

which leads to :—

$$\frac{\rho}{\rho_0} = \frac{1}{1 - \dfrac{x\omega}{\sqrt{2}u_0} \cdot \dfrac{\{\sqrt{1 + 3m^2} - (1 + m^2)\}^{1/2}}{(2 - \sqrt{1 + 3m^2})^{3/2}}}$$

for the equation of the envelope.

The maximum of this with respect to x given by $x = S'$ where

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

$$\text{or } S' = \frac{\sqrt{2}u_0}{\omega} \frac{(2 - \sqrt{1 + 3m^2})^{3/2}}{\{\sqrt{1 + 3m^2} - (1 + m^2)\}^{1/2}} \quad .. \quad (2)$$

This holds for all values of $m < 1$, and can be expanded into the power series :—

$$S' = \frac{2u_0}{m} \left\{ 1 - \frac{9}{8} m^2 + \frac{243}{128} m^4 + \; . \; . \; . \; . \right\}$$

provided $3m^2 < 1$ (i.e. $m < 0.57$).

Comparing this with Tombs' and Kompfner's results, it can be seen that by neglecting m^2 and higher powers, Tombs' formula for small m $\left(S' = 0.45\left(\frac{2\pi}{\omega}\right)\frac{u_0}{m}\right)$ is obtained, but with a different constant $\left(\frac{1}{\pi} = 0.318 \text{ instead of } 0.45\right)$, while Kompfner gives the first term of the expansion only, which he states will hold for all values of m. [See Mr. Kompfner's letter on the opposite page. Ed.]

The formula (2) above gives the point at which the number of electrons crossing a given plane instantaneously reaches a maximum, and this point will be slightly nearer the modulating grid than the point of maximum transference of power to the sinusoidally oscillating resonator mentioned above. The difference between this result and Tombs' is due to his method of integration which consists in taking a finite, rather small, number of parts and summing. I have not seen Kompfner's calculations yet, but his different result may perhaps be explained by the choice of a different condition for the "optimum" length.

I am indebted to Standard Telephones and Cables, Ltd., for permission to publish this work, which was done in their laboratories, and to Dr. J. H. Fremlin for several helpful suggestions.

North Woolwich, C. STRACHEY.
London, E.16.

[A copy of the above letter was sent by the writer to Mr. Tombs, from whom we have received the following note for publication.—ED.]

"I agree about $\frac{1}{\pi}$ being the constant for the case where the density shall be a maximum at a *plane*. The case I considered was a different one—being the average density over a specified small length of drift-space.

Putting m = 0.8 in Mr. Strachey's equation No. 2 $S' = 0.14\, u_0 \cdot \frac{2\pi}{\omega}$ a point lying very near my curve derived graphically (and labelled as such), in my letter published in this issue.—D. M. T."

To the Editor, The Wireless Engineer

SIR,—I await Mr. Rudolf Kompfner's promised article with interest, but must immediately protest against the implication in his letter published in the March issue of *The Wireless Engineer*, that due to the insensitivity of the graphical method, given in my article "Velocity-Modulated Beams" in the February issue, my equations do not give a correct answer or at least do not agree with Mr. Kompfner's "exact" solution obtained mathematically. Strangely enough it is possible by my graphical method to indicate a false assumption of his mathematical methods as I hope to show in this letter.

Mr. Kompfner's equation $S' = \frac{1}{\pi}\left(\frac{2\pi}{\omega}\frac{u_0}{m}\right)$ compares with my curve *A*, Fig. 8, which can be described approximately by an exponential

$$S' = 0.45\frac{2\pi}{\omega}\;\frac{u_0}{\log_e \frac{1}{1-m}}$$

which reduces to $S' = 0.45\cdot\frac{2\pi}{\omega}\frac{u_0}{m}$ for small values of *m*. Mr. Kompfner claims that his equation is "exact" for all values of *m*.

Comparing the results we must consider first the constant (0.45 compared with $\frac{1}{\pi}$), secondly the form of the curve for large values of *m*.

Both of these matters I have considered in greater detail. In my article the average of density was taken over some 30 electrical degrees. This is the kind of grid spacing that is needed if the charges are to remain a reasonable portion of the cycle between the grids (see footnote, p. 55, *The Wireless Engineer*, February). For the smaller depths of modulation we could determine the position of this maximum to within a few per cent. ($m = 0.2$). There is no question of the difference between our results being due to the inaccuracy of my graphical method.

Mr. Kompfner's results clearly deal with a different condition from mine, viz. the position of the density maximum at a *plane* normal to the beam. This result is also readily available by the graphical method as is implied in the article on Fig. 2. The locus of intersections must be vertical for a region of increased density.

I have drawn curves every 15° for $m = 0.6$ a portion of which is reproduced herewith, Fig. A. It will immediately be seen that it is quite easy to locate the curve (Curve *P*, Fig. A) which gives a vertical non-reentrant line (at *X*). A reentrant line indicates that the density curve has developed two humps (for example Curve *Q* at *Y* and *Z*). The accuracy is fairly high—viz., 5° either side being noticeable on the original drawings.

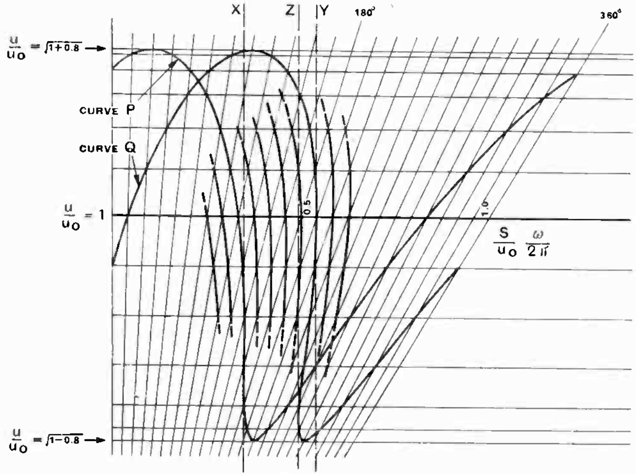

Fig. A.

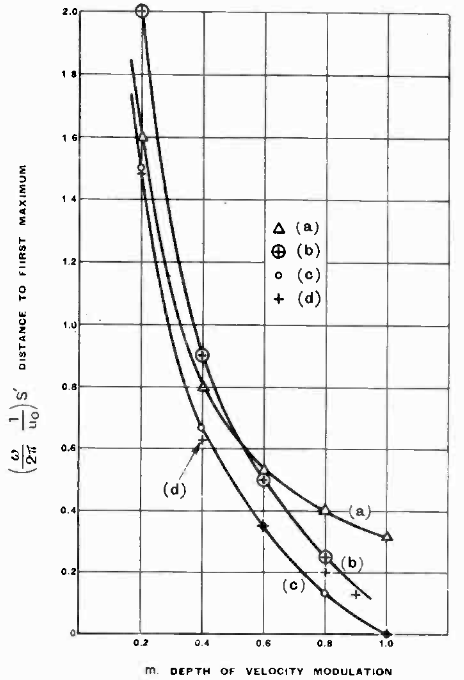

Fig. B.—*Points (a) Kompfner; (b) Tombs, 30° average (from Fig. 8, p. 60, February issue): (c) Tombs. first maximum at plane (X points Fig. A.); (d) Tombs, math. fit to X points,*

$$S' = \frac{1}{\pi}\left(\frac{2\pi}{\omega}\right)\frac{u_0}{\log_e \frac{1}{1-m}}.$$

I have taken the *X* points for different *m*'s from my graphs and plotted them on Fig. B herewith. The slope of the reciprocal *for small values of m* agrees with Mr. Kompfner's result of $\frac{1}{\pi}$. The points from my previously published curve (Curve *A*, Fig. 8) are also transferred to this diagram and it becomes clear that as the width over which the average is made, becomes less, the position of the maxima occur less far down the cylinder (not further down as stated in my article). I am indebted to Mr. Kompfner for drawing attention to this. The difference in constant then, is to be attributed to the width over which the density is averaged, both being correct for the different conditions. My hasty surmise that the constant approached 0.5 as *m* became small is wrong. It should be $\frac{1}{\pi}$.

It is now necessary to discuss the form of the equation.

Take the condition for $m = 1$. This means (as is pointed out in the article on p. 57) that there are particles entering the cylinder at "zero" velocity. This clearly indicates that at all events at $m = 1$ the first density maximum occurs at $S = 0$, a result not obtained from Mr. Kompfner's equation. If however we guess what Mr. Kompfner has assumed and take the position where the locus of intersections crosses the $\frac{u}{u_0} = 1$ line (line ABC, Fig. 2 of the article) vertically, this value of S when plotted against m gives Mr. Kompfner's results. It is, however, not the position of the first maximum as will be evident if consideration is given to Fig. A herewith. Curve P gives one maximum at X while Curve Q (Mr. Kompfner's) gives two maxima at Y and Z. The X maxima are plotted on Fig. B. Mr. Kompfner's results for large m gives S too large. Double humps have already appeared. Thus Mr. Kompfner's "exact" solution obtained by mathematical methods appears to be wrong.

It follows therefore that the curve given for my maxima which differs so widely from Mr. Kompfner's for large values of m may give a more correct representation of what occurs within the limitations set out in the paper within which I have assumed Mr. Kompfner is also working.

Whether either of us is anywhere near right in assuming such limitations is yet to be seen. Has Mr. Kompfner calculated the debunching effect of the other charges in the beam? And surely a plane of infinite density is physically impossible. However it appears from Webster's paper in the *Journal of Applied Physics*, July, 1939, Vol. 10, p. 504, that double humps do occur in practice showing that overtaking is possible. Comparing the results obtained graphically with those of Webster, and allowing for the fact that he is talking about velocity ratios and I of voltage ratios, and with the further limitation that m is small, his value for $S\omega \frac{m}{u_0}$ to give maximum *efficiency* is $2 \times 1.84 = 3.68$ compared with my value of 2.83 for the *density maximum*. Webster states that maximum efficiency occurs when there are 63 electrical degrees between the peaks. The corresponding distance can readily be estimated from my average curves and shows an increase in distance from the density maximum of approximately 30 per cent. ($m = 0.2$) bringing my figure close to Webster's.

Since the position for maximum efficiency is not critical and the position can readily be modified by the battery voltage the foregoing results are considered satisfactory.

Imperial College, D. MARTINEAU TOMBS.
London, S.W.7.

Wireless

By C. L. BOLTZ. Pp. 278, 123 Figs. John Gifford, Ltd., 111, Charing Cross Road, London, W.C.2. Price 10s. 6d.

The fundamental principles of wireless transmission and reception are explained in simple language in this recently published book which is written for the uninitiated. The 16 chapters cover the elementary facts about electricity, wireless waves, detection, the valve, L.F. and H.F. amplification, the straight set, the superhet and very briefly television.

Characteristics of the Ionosphere

WE understand that the National Physical Laboratory, Teddington, are continuing the issue of Monthly Tables of Ionospheric Data as described in *The Wireless Engineer* for January, 1939 (pp. 20-21). These tables give the measured characteristics—height and critical frequency—of the F_2 region of the ionosphere for each week-day at noon. In existing circumstances, the data sheets are issued usually two or three months in arrears, but, even so, the information should prove valuable to those experimenters who are investigating receiving conditions over appreciable periods and who wish to correlate their results with the conditions existing in the ionosphere at the time of observation.

Readers in this country who desire to obtain these tables should apply to the Director, National Physical Laboratory, Teddington, Middlesex, enclosing 2s. 6d. as subscription for the current year (January to December, 1940).

Quartz Oscillators and their Applications

By DR. P. VIGOUREUX. Pp. vi + 131, with 86 Figs. H.M. Stationery Office, Adastral House, Kingsway, London, W.C.2. Price 4s. 6d. net.

In 1928 the author prepared a monograph on the subject for the Department of Scientific and Industrial Research, which is now out of print. This has been completely rewritten and the new volume, although shorter, covers more ground, much of the historical matter having been omitted. Of the eleven chapters the first describes the geometry and notation of quartz crystals, the second the piezo-electric phenomena and the preparation of the quartz plates.

The third and fourth chapters describe the quartz resonator and its use in electric circuits. Luminous resonators and their development, especially by Giebe and Scheibe, are dealt with in Chapter V which contains some excellent photographs of the luminous effects. Chapter VI is devoted to the valve-maintained quartz oscillator and a discussion of the Pierce circuit and its modifications. Chapter VII deals with the important subject of the frequency and its variation with temperature. The next two chapters discuss the type of holder suitable for plates, rods, and rings, and the nature of the vibrations actually occurring in the quartz; these are illustrated by some beautiful stroboscopic interferometer photographs. Chapter X gives a number of practical applications to frequency standardisation, clocks, depth sounders, etc. A final chapter discusses the crystal structure of quartz. A bibliography gives all the more important publications on the subject.

All very well done and all for 4s. 6d.

In the typewritten summary issued to the Press by the Department of Scientific and Industrial Research only one scientist is mentioned by name and it is spelt "Langvin."

G.W.O.H.

Resistance Networks*

Complete Design Tables

By C. D. Colchester and M. W. Gough

(Marconi's W.T. Co., Ltd., Research and Development Dept.)

THESE notes are intended to be of use in the application of the more common resistance networks of telecommunication. No claim is made for originality, all the networks described having in fact been used commercially in the last few years. It was felt, however, that the publication of complete design tables would be appreciated.

So far as is known, similar tables have not previously been published in Great Britain, though tables somewhat similar to those given in Figs. 1 and 14 have appeared elsewhere.

It will be noticed that 600 ohms has been adopted as the characteristic impedance of networks where numerical values of element resistances have been inserted. It was considered whether the choice of 1 or 1,000 ohms instead might not simplify the general application of the tables, but since the calculations are in any case simple, and since 600 ohms is widely accepted as datum, this standard was preferred. Throughout the paper, all impedances introduced are assumed to be non-reactive. No apology need be made for the simplification thereby introduced.

Networks have been taken in the order of the number of elements they contain, and their uses considered. Design formulae or curves are then given for their application. If a network is to be balanced, or electrically symmetrical with respect to earth, it will generally be found that more elements are required than for the simplest unbalanced structure. The balanced forms of each network are considered with the unbalanced form in every case. Finally, tables of numerical element values for the four main types of attenuator are given in unbalanced and balanced form.

Single Element Networks

Single element networks may be series or shunt and require little comment. They may both be employed for adjustment of loss between generator and load at the expense of impedance disturbance, or for adjustment of impedance conditions at the expense of insertion-loss.

Their properties, together with those of other networks, are summarised in Fig. 1. Either type lends itself to the fine control of loss (of the order of one decibel, for example). Under these conditions impedance variations will probably not be important.

If the series type is to be used balanced (i.e. electrically symmetrical with respect to earth) two equal elements will be required. It is then sometimes employed in mixing the outputs from a number of microphones, and such an arrangement is shown in Fig. 2. This design is based on the match of any microphone which is fully faded up alone. Fader resistance values have been calculated on the assumption of 300-ohm microphones and load, and are graded to give fifteen steps of 2 decibels, followed by two steps of 4 decibels, followed by two steps of 6 decibels. The last position open circuits the microphone. The fading up of other microphones will, of course, impair the accuracy of the steps, but this is of little consequence. Of greater importance is the variable mismatch of microphone and load, which necessitates substantially resistive impedances over the working frequency range for the microphones and their amplifier. The system has, however, the advantage of simplicity and zero minimum loss through any channel.

Measurement of Resistance by Observation of Insertion-loss

The principles of series and shunt insertion may be used to compute the value of an unknown resistance. Fig. 3 gives data for these determinations.

The meter represents a measuring set indicating the audio frequency voltage across

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* MS. accepted by the Editor, November, 1939.

its input, and is calibrated to express this voltage as a decibel ratio of the power it would develop in 600 ohms, to the power developed by a datum voltage in 600 ohms.

To set up the instrument, a 600-ohm generator supplies power to a load of equal

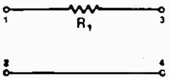
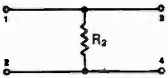
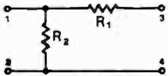
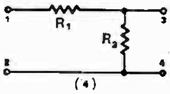
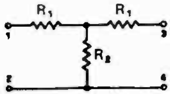
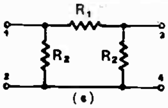
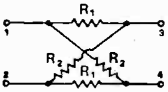
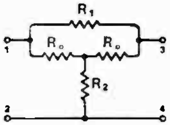
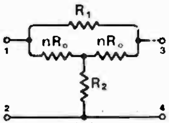
	R_1/R_0	R_2/R_0	R_0 across 3-4 R_{1-2}	R_0 across 1-2 R_{3-4}	R_0
 (1)	$2(\lambda - 1)$	—	$R_1 + R_0$	$R_1 + R_0$	—
 (2)	—	$\frac{1}{2(\lambda - 1)}$	$\frac{R_0 R_2}{R_0 + R_2}$	$\frac{R_0 R_2}{R_0 + R_2}$	—
 (3)	$\lambda - 1$	$\frac{\lambda}{\lambda - 1}$	R_0	$R_0[2\lambda(\lambda - 1) + 1]$	—
 (4)	$\frac{\lambda - 1}{\lambda}$	$\frac{1}{\lambda - 1}$	R_0	$R_0 / \left[\lambda - \frac{\lambda - 1}{2\lambda - 1}\right]$	—
 (5)	$\frac{(\lambda - 1)}{\lambda + 1}$	$\frac{2\lambda}{\lambda^2 - 1}$	R_0	R_0	$\sqrt{R_1 R_2 (2 + R_1/R_2)}$
 (6)	$\frac{\lambda^2 - 1}{2\lambda}$	$\frac{\lambda + 1}{\lambda - 1}$	R_0	R_0	$\sqrt{\frac{R_1 R_2}{2 + R_1/R_2}}$
 (7)	$\frac{\lambda - 1}{\lambda + 1}$	$\frac{\lambda + 1}{\lambda - 1}$	R_0	R_0	$\sqrt{R_1 R_2}$
 (8)	$\lambda - 1$	$\frac{1}{\lambda - 1}$	R_0	R_0	$\sqrt{R_1 R_2}$
 (9)	$\frac{2n(\lambda - 1)}{(n-1)\lambda + (n+1)}$	$\frac{1}{2} \cdot \left[\frac{\lambda + 1}{\lambda - 1} - n\right]$	R_0	R_0	—

Fig. 1.—*Attenuator Networks. The symbol* λ *is the ratio of the currents in a purely resistive load* R_0 *before and after the specified network is inserted between that load and a generator of purely resistive internal impedance* R_0. *Insertion loss of network* $= 20 \log_{10} \lambda$ *db.*

resistance bridged across the measuring set in order to provide the datum voltage. Measurements taken after insertion or removal of series or shunt elements are then indicated as a decibel loss or gain. In Fig. 3, diagram 1, the 600 ohms is removed after setting up, and replaced by the unknown resistance R. In diagrams 2 and 3 the 600 ohms is retained and the resistance R inserted either in series or parallel with the generator. The behaviour of the measuring set under the three conditions is given by the relevant curves in Fig. 3.

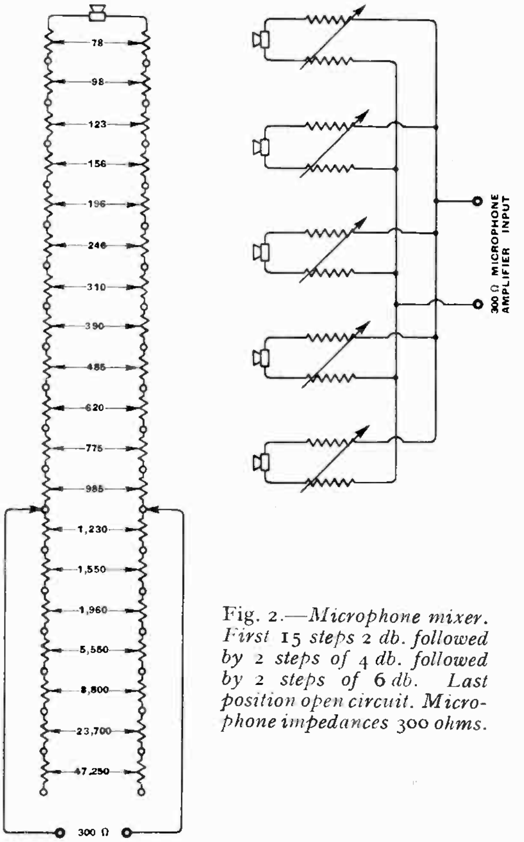


Fig. 2.—*Microphone mixer. First* 15 *steps* 2 *db. followed by* 2 *steps of* 4 *db. followed by* 2 *steps of* 6 *db. Last position open circuit. Microphone impedances* 300 *ohms.*

Two-element Networks

The use of two elements in a resistance network permits fulfilment of two independent properties. For example, in matching networks the resistances are chosen so that a generator and load are both faced by the desired impedances, though a certain loss is introduced, while in L attenuators a value is prescribed for the loss and for the impedance facing either the load or the generator. The second impedance will then have some other value, though it still remains possible to choose whether it shall be greater or less than the impedance already prescribed. The two types of network will be considered separately.

Matching Networks

These networks are employed where it is desired to link two circuits of differing impedance, and at the same time retaining the matching of both. The power lost in the two-element type allows of no choice, being determined solely by the ratio of the impedances. Design and performance data for these matching networks are given in Figs. 4, 5 and 6.

L Attenuators

L attenuators are but little used as fixed pads, but are frequently employed for variable attenuators since only two variables are involved, which may be electrically connected at one terminal. Design formulae are given in Fig. 1, networks 3 and 4.

The shunt input arrangement of network 3 is used when it is preferred that the output impedance presented at terminals 3, 4 be greater than R_0, and the series input arrangement of network 4, when it is preferred that the output impedance be less than R_0. The network at Fig. 3 is therefore sometimes used reversed after a triode amplifying stage, so

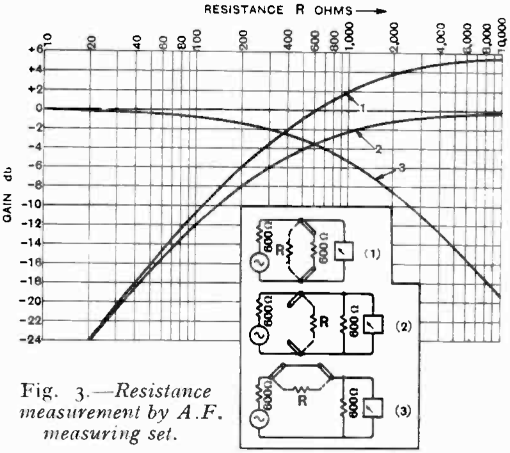
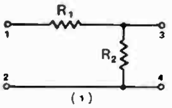


Fig. 3.—*Resistance measurement by A.F. measuring set.*

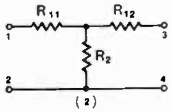
that the effective output impedance is R_0, but the valve is presented with an impedance greater than R_0, which makes for reduced harmonic distortion.

Three-element Networks

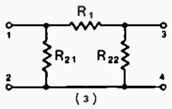
The use of three network elements permits the choice of three quantities, input impedance, output impedance and attenuation. The most useful case is that of symmetrical attenuators, in which the input and output impedances are equal. When these impedances are unequal and the network is used to provide matching, the attenuation range is limited and cannot be made less than that of the L network matching the same impedances. Design formulae for three-element attenuators are given in Fig. 1, networks 5 and 6, and for matching networks in Fig. 4.



$$R_1/R_0 = \sqrt{1 - 1/n^2}$$
$$R_2/R_0 = 1/\sqrt{n^2(n^2 - 1)}$$
$$\lambda = 1 + \sqrt{1 - 1/n^2}$$



$$R_{11}/R_0 = 1 - 2(\lambda - 1)/(n^2\lambda^2 - 1)$$
$$R_{12}/R_0 = (n^2\lambda^2 - 2n^2\lambda + 1)/n^2(n^2\lambda^2 - 1)$$
$$R_2/R_0 = 2\lambda/(n^2\lambda^2 - 1)$$



$$R_1/R_0 = (n^2\lambda^2 - 1)/2n^2\lambda$$
$$R_{21}/R_0 = (n^2\lambda^2 - 1)/(n^2\lambda^2 - 2n^2\lambda + 1)$$
$$R_{22}/R_0 = (n^2\lambda^2 - 1)/n^2(n^2\lambda^2 - 2\lambda + 1)$$

Fig. 4.—*Resistance matching networks. The networks are designed so that the apparent resistance across terminals* 1, 2 *is* R_0 *when a load of* R_0/n^2 *is across terminals* 3, 4 *and, conversely, the apparent resistance across terminals* 3, 4 *is* R_0/n^2 *when a load of* R_0 *is across terminals* 1, 2. *The symbol* λ *is the ratio of the current supplied by a generator* R_0 *at* 1, 2 *to the current taken by a load* R_0/n^2 *connected across* 3, 4. *The power loss between generator and load is equal to* 20 $\log_{10} n\lambda$ *db.*

Choice of τ or π networks for attenuators may be based on the following considerations :—

1. For balanced circuits the π network becomes a square of four resistances, while the τ network becomes an H network requiring five resistances.
2. For variable attenuators for unbalanced circuits controlled by keys switching individual pads, the switching of τ networks can be simpler than for π networks.
3. For variable attenuators with rotary controls (i.e. in which the resistance elements are varied) the construction may be somewhat simpler for the τ network than for the π network, but errors at high or low attenuations due to poor contact by the brushes are less serious with π networks.

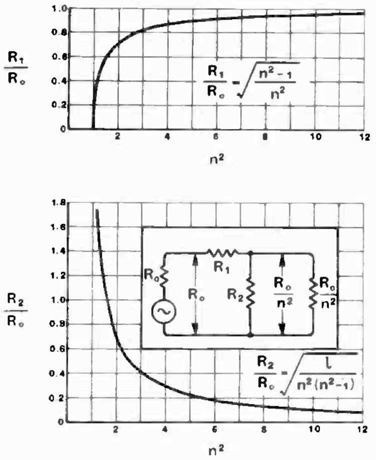


Fig. 5.—*Matching networks.*

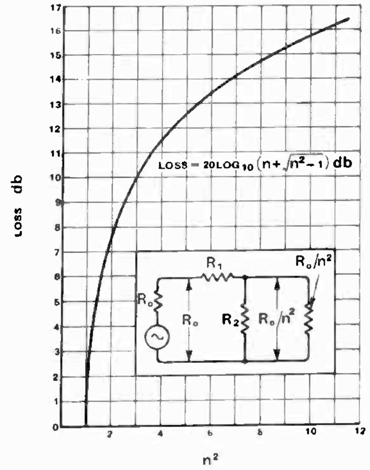


Fig. 6.—*Matching networks.*

Lattice Networks

Although composed of four resistance elements, lattice networks are almost invariably constructed with their resistances paired, so that in effect only two variables need be considered. In this form the network is balanced with respect to earth and is symmetrical, exhibiting equal input and output impedances.

It is often used where balanced attenuation is required, and is particularly suited to rotary attenuators owing to the possibility of using two pairs of commoned movers traversing a two-bank element assembly.

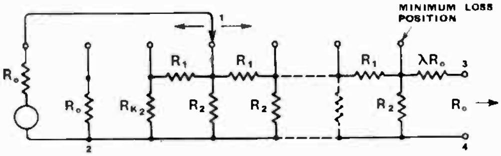


Fig. 7.—*Ladder type controls (two-element sections).* $R_{K1} = (\lambda + 1)R_0$; $R_{K2} = \frac{\lambda + 1}{\lambda} R_0$; $R_1 = \frac{\lambda^2 - 1}{\lambda} R_0$; $R_2 = \frac{\lambda + 1}{\lambda - 1} R_0$: *Min. loss current ratio* $(\lambda + 1)$; 3-4 *resistance, infinite loss* $\left[\frac{(\lambda + 1)^2}{\lambda} - 1\right] R_0$; 3-4 *resistance, min. loss* $\left[1 + \frac{2\lambda^2}{2\lambda + 1}\right] R_0$; *total loss current ratio* $\lambda^n \times \frac{\lambda + 1}{\sqrt{2}}$. *Design basis :—Series input iterative impedance of each ladder section is* R_{K1}. *Shunt input iterative impedance of each ladder section is* R_{K2}. *Insertion loss current ratio between* R_{K1} *terminations for each ladder section is* λ. *Generator* R_0 *matched throughout,* $1/R_0 = 1/R_{K1} + 1/R_{K2}$. *Load* R_0 *variably mismatched.*

The network has the disadvantage of liability to large errors in loss when the attenuation is high, unless high accuracy is maintained in element values. This disadvantage is not so serious as might at first appear, since large attenuations are in any case difficult to achieve accurately with balanced circuits, since slight unbalances with respect to earth in generator and load will cause coupling between them through the earth circuit. Design formulae are given in Fig. 1, network 7.

The form of lattice network in which the diagonal elements are unequal is of little importance when all elements are resistances, and need not be considered.

Bridged-τ Networks

Fig. 1, network 8, shows a form of bridged-τ network which is particularly useful for symmetrical unbalanced variable attenuators of the rotary type. This is because only two variable elements are required in order to maintain the constant resistance property at both input and output terminals, and give any desired value of attenuation. The balanced form requiring three variable resistances and four fixed resistances $R_0/2$, is also sometimes used. At high attenuations the variable resistances may have inconvenient values, in which case the arrangement of network 9 is sometimes used. It should, however, be noted that the maximum attenuation obtainable with this network is limited according to the relation

$$\frac{\lambda + 1}{\lambda - 1} > n > \frac{\lambda - 1}{\lambda + 1}$$

A more economical arrangement when attenuation is high, is to vary only one of the elements R_1, or R_2, the other element R_2 or R_1 being left short or open circuited. The network then behaves as a π or τ network with a small impedance error, amounting to less than one per cent. for losses greater than 40 decibels.

Ladder Type Controls

Of the various means for controlling the power in a load so far mentioned, all require at least two variable elements with the exception of the series and shunt inserted rheostat.

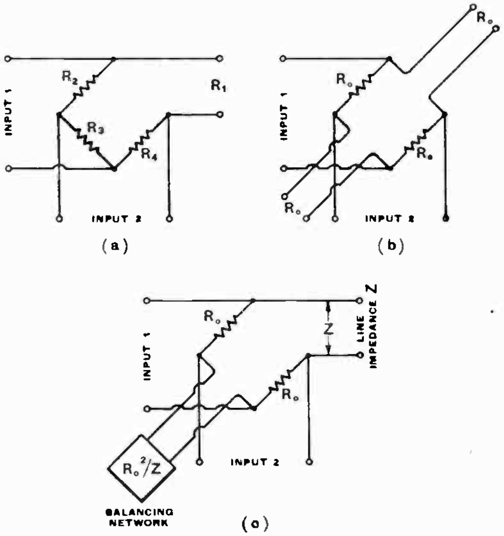
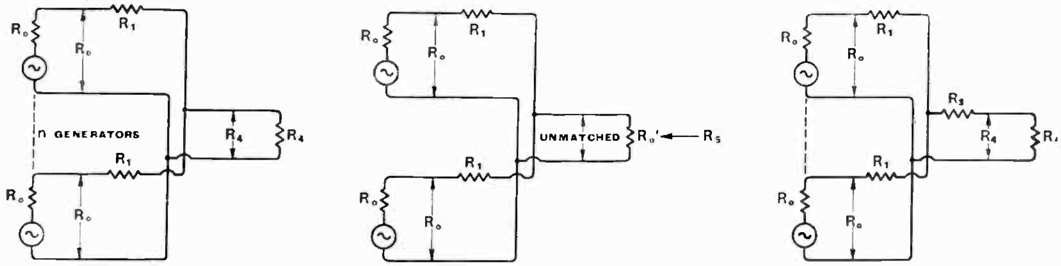


Fig. 8.—*Resistance hybrids.*

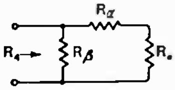
Either of these latter, however, causes large impedance changes for a large control range. To provide the economy of a single moving arm without large impedance fluctuation for a reasonable control range, various forms of "ladder" controls have been evolved. They all consist of series and shunt resistance elements permanently connected to the load, but having the generator switched between points in the series chain.



$$\frac{R_1}{R_0} = \frac{n-1}{n} \quad \frac{R_4}{R_0} = \frac{2n-1}{n^2}$$

Loss db $= 10 \log_{10}(2n - 1)$

NOTE :—If R_4 replaced by



where

$$R_\alpha = \frac{n-1}{n} R_0 \quad R_\beta = \frac{2n-1}{n\,.\,(n-1)} R_0$$

additional loss incurred is

$10 \log_{10}(2n - 1)$ db

$$\frac{R_1}{R_0} = \frac{-n + \sqrt{n^2 + 4(n-1)}}{2}$$

$$\frac{R_5}{R_0} = \tfrac{1}{2}\left(1 - \frac{R_1^2}{R_0^2}\right)$$

Loss db $= 20 \log_{10} \dfrac{R_0}{R_0 - R_1}$

NOTE :—

Loss computed as

Power in R'_0/Power Input

$R_0' = R_0$ in value.

$$\frac{R_1}{R_0} = \frac{1 + \dfrac{n(n-2)R_4}{R_0}}{\dfrac{n^2R_4}{R_0} - 1}$$

$$\frac{R_3}{R_4} = 1 - \frac{2(n-1)}{\dfrac{n^2R_4}{R_0} - 1}$$

Loss db $= 10 \log_{10} \dfrac{R_4}{R_0} n^2$

Fig. 9.—*Parallel mixers.*

The absence of rigid requirements permits a variety of design methods, but all have a finite minimum loss and show impedance changes at one termination.

Fig. 7 gives an example of this type, designed to match the generator at all control positions. The generator faces effectively two paralleled chains of two-element networks, and each pair of elements may be considered as a matching network between these two impedances, whose values are therefore determined by the loss between steps. For equal decibel intervals therefore, a uniform ladder network is obtained which is terminated in its iterative impedance at the end remote from the load.

Alternatively, design may be based on three-element networks, which may be symmetrical or unsymmetrical and afterwards combined to form the same general ladder shape. This method is mainly applicable where neither generator nor load is to face a constant impedance, but where impedance fluctuations are kept as small as possible.

The impedance variations facing the load are a disadvantage of ladder type controls, where smooth control of attenuation is required as in broadcast mixers. For example, in a typical control with 2 db steps the impedance varies from 1.9 to 3.1 times R_0.

Combining Circuits

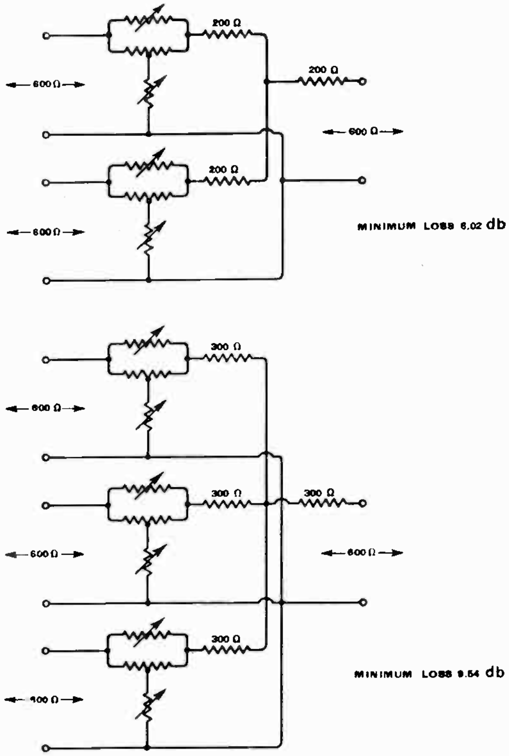
When a number of lines are to be combined, various simple circuits may be used to effect this while at the same time preserving prescribed conditions of impedance or attenuation.

The simplest type of combining circuit, known as the resistance hybrid, is used to combine two channels into one or two other channels, without interaction between them. The general arrangement is shown in Fig. 8*a*, in which it will be seen that by balancing the bridge network, disturbances on one channel can be prevented from reaching the other. Figs. 8*b* and 8*c* show applications to give two mutually independent outputs into constant resistance circuits, and to give an output into a line of varying impedance.

Mixers

When a number of programmes are to be combined in varying proportions, as at a broadcast studio control position, mixers are used. A number of types are possible to meet specific needs.

Simple series mixers have already been described under " Single Element Networks," wherein zero minimum loss is obtained when any one channel is used alone. Three other types of multi-channel mixer design are shown in Fig. 9, the basis of these designs being matching of generators and load. Practical forms of the circuit of Fig. 9 are shown in Fig. 10 with constant resistance attenuators added as controls. It will be noticed that the circuits have been combined in parallel, and thus all may be used balanced, or as is generally preferable, all circuits may be used with one side earthed. This advantage does not apply with the resistance hybrid arrangement, where at least one of the two circuits to be combined must be balanced.



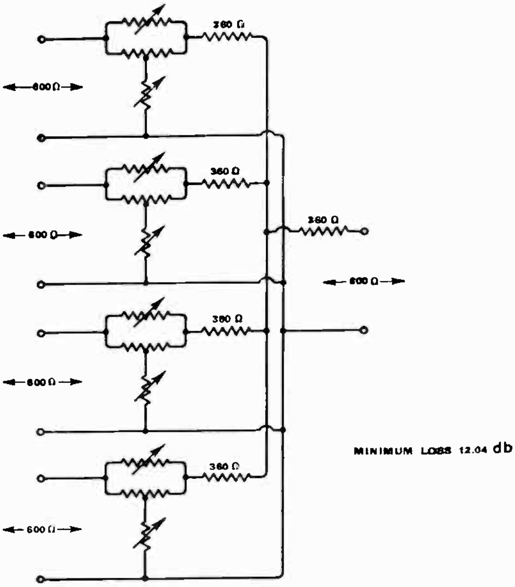
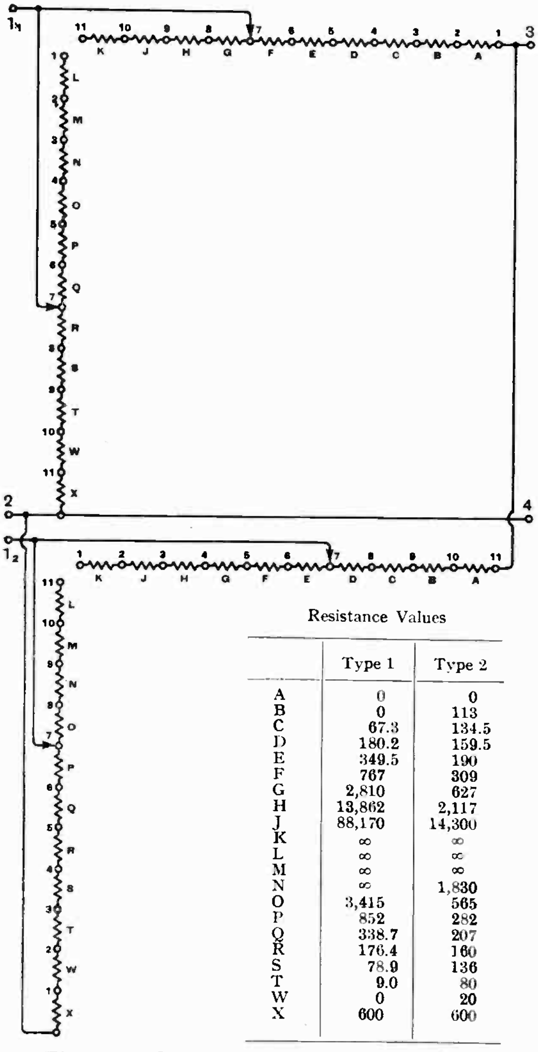


Fig. 10.—*Parallel mixers. Note :—attenuators 600 ohm characteristic impedance.*

Change-over Faders

When transition from one programme source to another by the rotation of a single control is required, a change-over fader must be used. This may take the form of a two-channel mixer as in Fig. 10, with the two attenuators ganged and suitably graded, but economy can be obtained by special designs. For example, L attenuators can be combined as in Fig. 11, in which each brush is designed to make contact with diametrically opposed contacts, thus necessitating only two rotors. One important advantage of this network is that it introduces no loss in either of the minimum loss positions.

The price paid for the simplicity of structure is the inter-relation between the channel losses and the impedance facing the load. This resistance can be made invariant, but the behaviour of the two losses is then undesirable. The basis of design chosen for the faders of Fig. 11 is that the load peak volts remain constant for any position of the control, presuming sources of equal random peak voltage and neglecting the bridging effect of one channel on the other. Type 2 fader has been modified to give a more pleasing transition from one programme to the other with the number of positions available. The measured loss behaviours of both types, and the calculated impedance behaviour of type 1, are shown in Figs. 12 and 13.



Resistance Values

	Type 1	Type 2
A	0	0
B	0	113
C	67.3	134.5
D	180.2	159.5
E	349.5	190
F	767	309
G	2,810	627
H	13,862	2,117
J	88,170	14,300
K	∞	∞
L	∞	∞
M	∞	∞
N	∞	1,830
O	3,415	565
P	852	282
Q	338.7	207
R	176.4	160
S	78.9	136
T	9.0	80
W	0	20
X	600	600

Fig. 11.—*Change-over fader for 600 ohm unbalanced circuits. As handle is turned clockwise brushes move from 1–11.*

Sender Circuits

Resistance networks are frequently introduced after a generator or before a load in order to provide protection against impedance fluctuations.

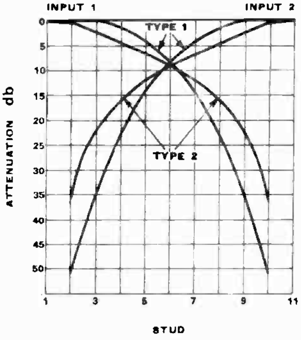


Fig. 12.—*Change-over fader for unbalanced circuits. Inputs from two equal generators of impedance R_0, load impedance R_0. For values for 600 ohm circuits see Fig. 11.*

It can be shown that the power ratio on the two sides of such a network is equal to the ratio by which small impedance fluctuations are reduced, e.g., if a generator R_1 is followed by a matching network giving a 10-decibel loss before a load R_2, as compared with the power which would be delivered from a matched generator, then small impedance fluctuations in R_1 or R_2 will appear as one-tenth of the proportional fluctuation on the other side of the network.

Special forms of such networks are used when it is desired to give a calibrated output from a generator, L networks being often

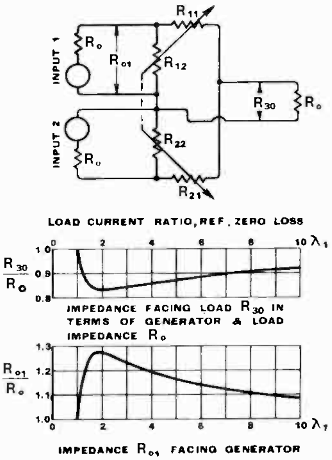


Fig. 13.—*Type 1 change-over fader.*

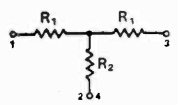
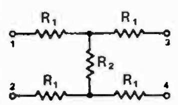
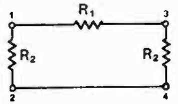
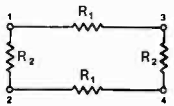
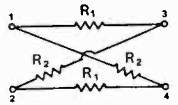
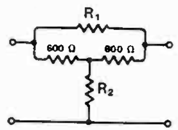
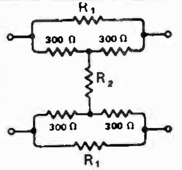
														
Impedance	600 Ohms		600 Ohms		600 Ohms		600 Ohms		600 Ohms		600 Ohms		600 Ohms	
Loss, dB	R_1 Ohms	R_2 Ohms	R_1 Ohms	R_2 Ohms	R_1 Ohms	R_2 Ohms	R_1 Ohms	R_2 Ohms	R_1 Ohms	R_2 Ohms	R_1 Ohms	R_2 Ohms	R_1 Ohms	R_2 Ohms
0	0	∞	0	∞	0	∞	0	∞	0	∞	0	∞	0	∞
0.1	3.58	50204	1.79	50204	7.20	100500	3.60	100500	3.58	100500	7.2	50000	3.6	50000
0.2	6.82	26280	3.41	26280	13.70	57380	6.85	57380	6.82	57380	13.8	26086	6.9	26086
0.3	10.32	17460	5.16	17460	20.55	34900	10.28	34900	10.32	34900	21.0	17143	10.5	17143
0.4	13.79	13068	6.90	13068	27.50	26100	13.80	26100	13.79	26100	28.2	12766	14.1	12766
0.5	17.20	10464	8.60	10464	34.40	20920	17.20	20920	17.20	20920	35.4	10169	17.7	10169
0.6	20.9	8640	10.45	8640	41.7	17230	20.85	17230	20.9	17230	43.2	8333	21.6	8333
0.7	24.2	7428	12.1	7428	48.5	14880	24.25	14880	24.2	14880	50.4	7143	25.2	7143
0.8	27.5	6540	13.75	6540	55.05	13100	27.53	13100	27.5	13100	57.6	6250	28.8	6250
0.9	31.02	5787	15.51	5787	62.3	11600	31.2	11600	31.02	11600	65.4	5504	32.7	5504
1.0	34.5	5208	17.25	5208	68.6	10440	34.3	10440	34.5	10440	73.2	4918	36.6	4918
1.5	51.8	3452	25.9	3452	104.3	6950	52.1	6950	51.8	6950	113.4	3174	56.7	3174
2.0	68.8	2582	34.4	2582	139.4	5232	69.7	5232	68.8	5232	155.4	2316	77.7	2316
2.5	85.9	2053	42.9	2053	175.4	4195	87.7	4195	85.9	4195	200.4	1796	100.2	1796
3.0	102.7	1703	51.3	1703	212.5	3505	106.2	3505	102.7	3505	247.8	1452	123.9	1452
3.5	119.2	1448	59.6	1448	258.0	3021	129.0	3021	119.2	3021	297.6	1209	148.8	1209
4.0	135.8	1249	67.9	1249	287.5	2651	143.8	2651	135.8	2651	351.0	1025	175.5	1025
4.5	152.2	1109	76.1	1109	324.6	2365	162.3	2365	152.2	2365	407.4	883.7	203.7	883.7
5.0	168.1	987.6	84.1	987.6	364.5	2141	182.3	2141	168.1	2141	466.8	771.2	233.4	771.2
5.5	184.0	886.8	92.0	886.8	405.9	1956	203.0	1956	184.0	1956	530.4	678.7	265.2	678.7
6.0	199.3	803.4	99.7	803.4	447.5	1807	223.8	1807	199.3	1807	597.0	603.0	298.5	603.0
6.5	214.6	730.8	107.3	730.8	492.6	1679	246.3	1679	214.6	1679	667.8	539.8	333.9	539.8
7.0	229.7	685.2	114.8	685.2	537.0	1569	268.5	1569	229.7	1569	743.4	484.3	371.7	484.3
7.5	244.2	615.6	122.1	615.6	584.7	1475	292.4	1475	244.2	1475	822.6	437.6	411.3	437.6
8.0	258.4	567.6	129.2	567.6	634.2	1393	317.1	1393	258.4	1393	907.2	396.8	453.6	396.8
8.5	272.3	525.0	136.1	525.0	685.5	1322	342.8	1322	272.3	1322	996.6	361.2	498.3	361.2
9.0	285.8	487.2	142.9	487.2	738.9	1260	369.4	1260	285.8	1260	1091	329.9	545.5	329.9
9.5	298.9	453.0	149.5	453.0	794.4	1204	397.2	1204	298.9	1204	1191	302.2	595.5	302.2
10.0	312.0	421.6	156.0	421.6	854.1	1154	427.0	1154	312.0	1154	1297	277.5	648.5	277.5
11.0	336.1	367.4	168.1	367.4	979.8	1071	489.9	1071	336.1	1071	1529	235.5	764.5	235.5
12.0	359.1	321.7	179.5	321.7	1119	1002	559.5	1002	359.1	1002	1788	201.3	894	201.3
13.0	380.5	282.8	190.3	282.8	1273	946.1	636.3	946.1	380.5	946.1	2080	173.1	1040	173.1
14.0	400.4	249.4	200.2	249.4	1443	899.1	721.5	899.1	400.4	899.1	2407	149.6	1204	149.6
15.0	418.8	220.4	209.4	220.4	1632	859.6	816.0	859.6	418.8	859.6	2773	129.8	1387	129.8
16.0	435.8	195.1	217.9	195.1	1847	826.0	923.2	826.0	435.8	826.0	3186	113.0	1598	113.0
17.0	451.5	172.9	225.7	172.9	2083	797.3	1042	797.3	451.5	797.3	3648	98.68	1824	98.68
18.0	465.8	152.5	232.9	152.5	2344	772.8	1172	772.8	465.8	772.8	4166	86.4	2083	86.4
19.0	479.0	136.4	239.5	136.4	2670	751.7	1335	751.7	479.0	751.7	4748	75.8	2374	75.8
20.0	490.4	121.2	245.2	121.2	2970	733.3	1485	733.3	490.4	733.3	5400	66.66	2700	66.66
22.0	511.7	95.9	255.9	95.9	3753	703.6	1877	703.6	511.7	703.6	6954	51.72	3477	51.72
24.0	528.8	76.0	264.4	76.0	4737	680.8	2369	680.8	528.8	680.8	8910	40.4	4455	40.4
26.0	542.7	60.3	271.4	60.3	5985	663.4	2992	663.4	542.7	663.4	11370	31.66	5685	31.66
28.0	554.1	47.8	277.0	47.8	7550	649.7	3775	649.7	554.1	649.7	14472	24.87	7236	24.87
30.0	563.0	37.99	281.6	37.99	9500	639.2	4750	639.2	563.2	639.2	18372	19.58	9186	19.58
32.0	570.6	30.16	285.3	30.16	11930	630.9	5967	630.9	570.6	630.9	23286	15.46	11643	15.46
34.0	576.5	23.95	288.3	23.95	15000	624.4	7500	624.4	576.5	624.4	29472	12.21	14736	12.21
36.0	581.1	18.98	290.6	18.98	18960	619.3	9480	619.3	581.1	619.3	37260	9.66	18630	9.66
38.0	585.1	15.11	292.5	15.11	23820	615.3	11910	615.3	585.1	615.3	47058	7.65	23529	7.65
40.0	588.1	12.00	294.1	12.00	30000	612.1	15000	612.1	588.1	612.1	59400	6.06	29700	6.06

Fig. 14.—*Attenuator networks.*

used in which one arm contains the measuring instrument.

Since the design of such networks is governed so much by the calibrating means available and the methods employed, they will not be discussed further.

Acknowledgment

The preparation of these tables has occupied the attention of various members of the Research Department of Marconi's Wireless Telegraph Company, Limited, at different times over the last few years.

It is hoped that errors are absent.

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2. W. L. Everitt, "Communication Engineering," Edition 2, Chapter II.
3. A. T. Starr, "Electric Circuits and Wave Filters," Edition 2, Chapter VI.
4. The Design of Pads, L. W. Barnett, *Communications*, February, 1935, p. 12.
5. Impedance Matching at Audio Frequencies, T. W. Kilmer, *Communications*, September 1935, p. 18.
6. Fundamentals in the Application of Matrices to Electrical Networks, J. R. Pernice, *Communications*, June 1936, p. 10, July 1936, p. 12, and August 1936, p. 12.
7. Design of Resistance Pads, C. F. Nordica, *Communications*, November 1936, p. 12.
8. Mixer Circuits, A. Preisman, *Communications*, June 1937, p. 9, and August 1937, p. 9.
9. A Ladder Network Theorem, John Riordan, *Bell S. Tech. Journ.*, July 1937, p. 303.
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11. Coupling Networks, W. L. Everitt, *Communications*, September 1938, p. 12, and October 1938, p. 12.
12. The Delta-Star Mixer, J. N. A. Hawkins, *Communications*, March 1938, p. 20.

Wireless Patents

A Summary of Recently Accepted Specifications

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

ACOUSTICS AND AUDIO-FREQUENCY CIRCUITS AND APPARATUS

516 745.—Means for reducing high-tension consumption in a low-frequency amplifier.

O. B. Sneath. Application date 6th July, 1938.

516 935.—Low-frequency push-pull amplifier with negative feed-back for preserving "balance" and preventing distortion.

Marconi's W.T. Co. (assignees of N. J. Oman). Convention date (U.S.A.) 14th July, 1937.

517 555.—Sound reproducer and amplifier designed for use with small portable wireless sets or deaf-aid appliances.

W. E. Harman. Application date 30th July, 1938.

AERIALS AND AERIAL SYSTEMS

517 306.—Short-wave aerial for radiating a wireless beam which will guide an aeroplane to ground.

G. L. Davies. Application date 20th February, 1939.

517 342.—Construction and arrangement of dipole aerials, particularly for transmitting and receiving television signals.

Marconi's W.T. Co. (assignees of P. S. Carter). Convention date (U.S.A.) 24th July, 1937.

517 772.—Short-wave aerial system mounted coaxially with the metal mast, say of a ship, and means for coupling it to a transmitter or receiver.

E. C. Cork and J. L. Pawsey. Application date 28th June, 1938.

DIRECTIONAL WIRELESS

517 580.—Directional receiver with manual, as distinct from automatic, sensitivity control, and an automatic warning device against the so-called 180° ambiguity.

Marconi's W.T. Co. and C. S. Cockerell. Application date 29th July, 1938.

517 667.—Blind-landing system designed to allow an aeroplane to maintain full aerodynamical stability up to the point of making contact with the ground.

W. H. A. Thiemann (communicated by Bendix Aviation Corp.). Application date 3rd June, 1938.

517 826.—Radio-navigational system which enables the position of a mobile craft carrying a wireless receiver to be continuously indicated on a map or chart.

Marconi's W.T. Co. (assignees of V. K. Zworykin). Convention date (U.S.A.) 24th September, 1937.

517 840.—Overlapping "array" of rhombic aerials designed to give highly-directional results.

Marconi's W.T. Co. and O. Böhm. Application date 8th August, 1938.

RECEIVING CIRCUITS AND APPARATUS

(*See also under Television*)

516 801.—Push-button tuning in which the wave-change switch adapts the set for manual control and also releases all operated buttons.

Kolster-Brandes and R. S. Lawrence. Application date 8th July, 1938.

516 830.—Circuit for receiving phase- or frequency-modulated signals.
Dubilier Condenser Co. (1925). *Convention date* (*Switzerland*) 11*th July*, 1937.

516 891.—Radio receiver adapted to be automatically tuned to one or other side-band of the transmitted carrier-wave to a degree that depends upon the strength of an interfering signal.
Kolster-Brandes and C. N. Smyth. Application date 12*th July*, 1938.

516 900.—Push-button receiver with sub-divided tuning-ranges.
W. J. Polydoroff. Application date 12*th July*, 1938.

516 901.—Television and sound receiver, also capable of receiving ordinary broadcast programmes, with a common frequency-changer.
The General Electric Co. and D. C. Espley. Application date 27*th July*, 1938.

517 201.—Wireless receiver in which only certain push-button selectors are effective on each setting of the wave-band switch.
Standard Telephones and Cables (*communicated by P. A. J. Visschers*). *Application date* 22*nd July*, 1938.

517 289.—Suppressing static interference in a wireless receiver by first compressing the signals and then expanding them.
K. H. Meier. Application date 18*th July*, 1938.

517 362.—Conjoint control of tuning and reaction in a short-wave receiver.
J. E. Rhys-Jones ; R. E. Bazin ; R. E. Howard ; and The Plessey Co. Application date 2*nd July*, 1938.

517 420.—Push-button tuning control with means for automatically setting the circuits to the appropriate wave-band for any selected station.
A. H. Cooper. Application date 17*th June*, 1938.

517 636.—Motor-controlled automatic tuning system, the motor being driven in one direction or the other according to whether the initial error in tuning is above or below the correct frequency.
Marconi's W.T. Co. (*assignees of W. R. Koch*). *Convention date* (*U.S.A.*) 31*st July*, 1937.

517 671.—Means for preventing the suppressor-grid of a pentode valve from rising above a small positive potential under working conditions.
Standard Telephones and Cables and F. D. Goodchild. Application date 3*rd August*, 1938.

TELEVISION CIRCUITS AND APPARATUS

(For Transmission and Reception)

516 743.—Construction and arrangement of the magnetic deflecting system for a cathode-ray tube, particularly for preventing "pincushion" distortion in television.
Telefunken Co. Convention date (*Germany*) 6*th July*, 1937.

516 749.—Modulating circuit for a television receiver employing a light cell of the supersonic pressure-wave type.
Scophony and S. H. M. Dodington. Application date 8*th July*, 1938.

516 782.—Mains rectifying unit for supplying the high voltages required by a cathode-ray television receiver.
The General Electric Co. ; W. H. Aldous ; and D. C. Espley. Application date 7*th July*, 1938.

516 786.—Cathode-ray tube in which the deflecting electrodes cause the scanning spot to make a circular trace on the fluorescent screen.
Siemens Apparate und Maschinen G.m.b.h. Convention date (*Germany*) 7*th July*, 1937.

516 946.—Television receiver with means for precisely controlling the initiation of the framing impulses when using interlaced scanning.
Ferranti and M. K. Taylor. Application date 3*rd August*, 1938.

517 170.—Preventing the effect of "static" interference, particularly on relayed television signals, by a method of completely suppressing the signals for short periods.
E. L. C. White and R. P. Chasmar. Application date 20*th July*, 1938.

517 181.—Separating the synchronising impulses from the picture signals in a television receiver.
D. von Oettingen. Convention date (*Germany*) 25*th February*, 1938.

517 392.—Mechanically-stabilised valve circuit for generating the synchronising impulses in a television receiver.
Cie des Compteurs. Convention date (*France*) 28*th July*, 1937.

517 427.—Fluorescent screen for a cathode-ray television receiver constructed and designed to prevent the accumulation of undesired electric charges.
Baird Television ; A. K. Denisoff ; and J. M. S. Spiers. Application date 27*th July*, 1938.

517 428.—Arrangement of a hinged translucent viewing-screen in a television receiver cabinet.
Baird Television and L. C. Bentley. Application date 27*th July*, 1938.

517 482.—Television transmitter tube with a sensitive "mosaic" screen which is flooded by a beam of electrons before being scanned by a second beam.
Baird Television and V. A. Jones. Application date 29*th July*, 1938.

517 483.—Reproducing television pictures on a screen which is rendered luminescent by ultra-violet rays, the luminescence being modified by the received picture signals.
Baird Television and V. A. Jones. Application date 29*th July*, 1938.

517 514.—Cathode-ray tube with a transparent photo-electric cathode at one end and a fluorescent screen which produces secondary emission at the other.
Baird Television and C. F. Chapter. Application date 14*th June*, 1938.

517 597.—Deflecting system for the electron beam of a cathode-ray tube designed to prevent the so-called "Keystone" distortion effect in television.
Baird Television and G. R. Tingley. Application dates 8*th August and* 20*th September*, 1938.

517 666.—Variable-gain amplifier, particularly suitable for fading-out one television scene in favour of another from a different studio.

Philco Radio and Television Corpn. (*assignees of P. J. Konkle. Convention date* (*U.S.A.*) *25th May,* 1937.

TRANSMITTING CIRCUITS AND APPARATUS

(*See also under Television*)

516 750.—Electron-discharge oscillator with a hollow resonator for generating wavelengths of the order of 10 centimetres.

Standard Telephones and Cables (*assignees of F. B. Llewellyn*). *Convention date* (*U.S.A.*) *31st July,* 1937.

516 989.—Arrangement for minimising "noise" in a signalling system over cables carrying high-frequency signals and telegraph or voice-frequency currents.

Standard Telephones and Cables and A. L. Long. Application date 15th July, 1938.

516 993.—Re-diffusion system for distributing broadcast programmes over an existing telephone network.

Automatic Telephone and Electric Co.; R. Taylor; and G. T. Baker. Application date 15th July, 1938.

517 180.—Negative feed-back circuit for effecting volume compression or expansion, particularly in short-wave telephone systems.

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

517 264.—Ultra-short-wave oscillator with a storage circuit having dimensions comparable with the wavelength.

A. H. Stevens (*communicated by The Leland Stanford Junior University*). *Application date 21st April,* 1938.

517 311.—Controlling the flow of electrons through a hollow tube and building-up a standing wave system, particularly for generating ultra-short waves.

A. H. Stevens (*communicated by The Leland Stanford Junior University*). *Application date 21st April,* 1938.

517 329.—Balanced modulator (or demodulator) circuit, including pentode valves in which the input and output impedances are balanced by negative feed-back.

Telephone Manufacturing Co.; L. H. Paddle; and B. Drake. Application date 22nd July, 1938.

517 330.—Carrier-wave transmission system with automatic control of the direction of the repeaters at intermediate stations.

Standard Telephones and Cables; F. C. Wright; and S. E. Aldrick. Application date 22nd July, 1938.

517 526.—Electron-discharge device for generating very short waves of the order of infra-red light.

Telefunken Co. Convention date (*Germany*) *23rd July,* 1937.

518 390.—Negative feed-back circuit for stabilising the operation of a screen-grid amplifier, particularly when handling high power or short waves.

B. N. Maclarty. Application date 23rd August, 1938.

CONSTRUCTION OF ELECTRONIC-DISCHARGE DEVICES

516 785.—Electron-multiplier in which the discharge current is modulated at an intermediate stage in the tube.

Baird Television (*communicated by Fernseh Akt.*). *Application date 7th July,* 1938.

517 577.—Thermionic valve which produces a definite beam or jet, as distinct from a stream of electrons, and is designed to handle very short waves.

Marconi's W.T. Co. and N. Levin. Application date 29th July, 1938.

517 579.—Cathode-ray tube fitted with auxiliary deflecting plates which impart a momentary radial movement to an electron stream which normally traces out a circular path.

Marconi's W.T. Co.; G. F. Brett; E. G. Herriott; and H. J. S. Gratze. Application date 29th July, 1938.

517 643.—Construction of the target or impact electrodes used to produce secondary emission in electron-discharge tubes.

Philips' Lamp Co. Convention date (*Netherlands*) *7th August,* 1937.

517 743.—Construction and composition of a valve electrode designed to produce a high degree of secondary emission.

Philips' Lamp Co. Convention date (*Netherlands*) *9th August,* 1937.

517 806.—Means for cooling the photo-electric cathode of an electron-multiplier so as to reduce background "noise."

Radio Akt. D. S. Loewe (*K. Schlesinger*). *Convention date* (*Germany*) *16th February,* 1937.

SUBSIDIARY APPARATUS AND MATERIALS

516 803.—Thermionic valve circuit for generating special wave-forms, such as are required for comparing frequency and phase characteristics.

Kolster-Brandes and P. K. Chatterjea. Application date 8th July, 1938.

516 924.—Compact tuning-unit consisting of an iron-cored coil with coaxial condenser.

Telefunken Co. Convention date (*Germany*) *13th July,* 1937.

517 179.—Method of operating and controlling the biasing potentials for a thermionic valve used as a direct-current amplifier.

British Sangamo Co. Convention date (*U.S.A.*) *10th August,* 1937.

517 200.—Negative feed-back circuit for reducing the static impedance, particularly of a pentode amplifier, to its dynamic value.

Standard Telephones and Cables and R. A. Meers. Application date 22nd July, 1938.

517 606.—Means for preventing the radiation of "static" disturbance from electric appliances such as vacuum cleaners.

The General Electric Co. and H. C. E. Jacoby. Application date 11th August, 1938.

518 317.—Arrangement of the objective "lens" and gate-space in an electron microscope.

"Fides" G.m.b.h. Convention date (*Germany*) *24th August,* 1937.

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

1743. CONVEX ENDOVIBRATORS.—M. S. Neiman. (*Izvestiya Elektroprom. Slab. Toka*, No. 10, 1939, pp. 21–27.)

The advantages of monocylindrical over spherical endovibrators (*see* 455 of February) are pointed out and a mathematical investigation is presented of electromagnetic oscillations within a right circular cylinder.

1744. TOROIDAL ENDOVIBRATORS.—M. S. Neiman. (*Izvestiya Elektroprom. Slab. Toka*, No. 11, 1939, pp. 24–34.)

The spherical and monocylindrical endovibrators examined in two previous papers (*see* 1743, above) possess a low decrement, but their size is determined by the lowest resonant frequency and this may become important when operating on longer waves (*i.e.* on metric and "short" waves). In the present paper the so-called toroidal endovibrators are considered, which have a somewhat higher decrement but are smaller in terms of the operating wavelength. Such an endovibrator in its simplest form consists of a hollow metal toroid with a slit along the inner circumference, on the sides of which rest two parallel metal discs, the whole forming a closed conducting surface (Fig. 1). Methods are indicated for calculating the natural wavelength, decrement, and equivalent impedance of the system. It is pointed out that this type of endovibrator can easily be adapted for continuous variation of the natural wavelength over a wide range, and several methods for doing this are suggested. A drawing (Fig. 5) and a photograph (Fig. 12) are shown of such a system, the operating wavelength of which can be varied between 3 and 8 m. The over-all dimensions of this are 100 cm × 82 cm.

1745. H-WAVES PASSING THROUGH CIRCULARLY CURVED WAVE GUIDES, *and* [EH]-WAVES PASSING THROUGH CIRCULARLY CURVED WAVE GUIDES.—S. Sonada, S. Morimoto, & M. Ito. (*Electrot. Journ.*, Tokyo, Feb. 1940, Vol. 4, No. 2, p. 47: pp. 47–48.) Further development of the work dealt with in 4275 of 1939. Buchholz's similar results, by a different method, are mentioned (2629 of 1939).

1746. RESEARCH ON WAVE GUIDES AND ELECTROMAGNETIC HORNS: REPORT I—ELECTROMAGNETIC WAVES RADIATED FROM THE OPEN END OF A WAVE GUIDE OF CIRCULAR SECTION, *and* REPORT II—FUNDAMENTAL THEORY OF WAVE GUIDES AND ELECTROMAGNETIC HORNS CONSTRUCTED BY POLAR COORDINATE SURFACES.—Sonada. (*See* 1886.)

1747. MEASUREMENTS WITH ULTRA-SHORT [and Micro-Wave] ELECTRIC WAVES ON WIRES.—Hartshorn. (*See* 1955.)

1748. ON THE ELECTROMAGNETIC RADIATION FROM POINT SOURCES.—Fradin. (*See* 1856.)

1749. WIRELESS PROPAGATION AND THE RECIPROCITY LAW.—T. L. Eckersley, S. Falloon, F. T. Farmer, & W. O. Agar. (*Nature*, 10th Feb. 1940, Vol. 145, p. 222.)

Tests on two-way transmission were made between Chelmsford and Bodmin, using pulses in each direction, with variable transmitter frequency; the echo pattern due to the distant transmitter was observed at each station on a cathode-ray tube and the oblique critical frequencies of F region were measured for the two opposite directions of propagation. "These frequencies were found to be identical for the two directions, both for the ordinary and extra-ordinary waves, showing that so far as electron limitation is concerned the conditions for propagation in one direction are the same as in the opposite direction. This special case of reversibility suggests that the law of reciprocity may be more generally valid in the ionosphere, since the critical rays examined are particularly sensitive to the properties of the refracting medium." *Cf.* Latmiral, 1308 of April.

1750. The Scattering of Waves in Radio Transmission [Analysis of Effect: Production by Momentary Irregularities and Small Clouds in E Region].—T. L. Eckersley: R. L. Smith-Rose. (*Nature*, 24th Feb. 1940, Vol. 145, p. 317: notes on recent I.E.E. paper.) *See* also 1304 of April.

1751. A Method for Calculating the Field Strength on Short Waves at the Shorter Distances.—T. I. Shchukina. (*Izvestiya Elektroprom. Slab. Toka*, No. 10, 1939, pp. 4–20.)

It is pointed out that the existing methods for calculating the field strength on short waves are only valid for distances from 1500–2000 km upwards, for which the angle of incidence of the incoming ray can be regarded as practically constant. On shorter distances, however, the angle of incidence can vary as much as from 5° to 85°, and it is therefore necessary in this case to take into account the vertical directivity of the transmitting aerial as well as the angle of incidence of the ray on the reflecting layer. For short distances and wavelengths within the range of 50–200 m, layers E and F_2 (and a sporadic layer E_s) are particularly important, and it is shown that widely different results are obtained according to the layer from which reflection takes place. The present investigation is therefore mainly concerned with methods for determining the optimum wavelengths for different periods of the day from a study of the ionisation charts of the layers. Formulae are quoted, both taking into account and neglecting the absorption of the waves, and a numerical example is given.

1752. Determination of Minimum Working Wavelengths from Measurements of the Ionosphere [Conflicting Requirements of Upper (Reflecting) & Lower (Absorbing) Layers: Four Main Advantages of Employment of Minimum Working Wavelength: Derivation of Equation $f = f_{cr}/\cos \gamma q$, and Its Representation by Graphs: Use of These at Moscow Wireless Centre].—K. M. Kossikov. (*Comptes Rendus (Doklady) de l'Ac. des Sci. de l'URSS*, No. 2, Vol. 24, 1939, pp. 140–142: in English.)

Here f_{cr} is the critical frequency for vertical incidence, and q (= $\cos \gamma_1/\cos \gamma$) is approximately 1.35 and 1.1 for F and E layers respectively.

1753. Non-Seasonal Behaviour of the F Region [Ionisation Measurements in Various Latitudes, with Harmonic Analysis of Intensity Curves].—S. L. Seaton & L. V. Berkner. (*Terres. Mag. & Atmos. Elec.*, No. 3, Vol. 44, 1939, pp. 313–319.) For previous work, on the F_2 ionisation, *see* 2192 of 1938.

1754. On the Ionisation in the Upper Atmosphere [No Serious Difference between Pannekoek's and Chapman's Theories: Wave-Mechanical Formula for Absorption Coefficient (replacing Kramer's Expression): Chapman's Formula for Electron Production as Function of Height obtained as Special Case: etc.].—M. N. Saha & R. N. Rai. (*Proc. Nat. Inst. Sci. India*, Vol. 4, 1938, pp. 319–336.)

1755. Solar Activity and Radio Reception in 1938 [Dutch P.T.T. Observations, & General List of 1938 Papers on the Subject].—J. H. C. Lisman. (*Tijdschrift van het Nederlandsch Radiogenootschap*, No. 3, Vol. 8, 1939, pp. 293–303: in Dutch.)

The writer deals first with the displacement of working wavelengths: the sunspot character figure for 1938 was 109.5 compared with 114.4 for 1937 (whereas in 1936 it was only about 80) and Kootwijk was thus able to keep its transmissions on the same wavelengths as for 1937; the trend towards shorter wavelengths seems to have come to an end with the passing of the sunspot maximum.

The rest of the paper is concerned with the Dellinger effect. Table I shows that in 1938 the Noordwijk station recorded 72 cases in all, of which 45 were severe (indicated by "3" and "2" in the third column); the corresponding figures for 1937 were 60 and 40. The table leaves out a large number of disturbances (notably in January, accompanied by auroral displays) which are considered not to be true Dellinger effects. The fourth column indicates the simultaneous occurrence, or absence, of solar eruptions. For all Dellinger effects, the coincidences amounted to 43%; for the severe effects, to 49%. The figure on p. 299 shows the magnetic records for 24th March, when there was a "2" Dellinger effect and a "2" solar eruption. Fig. 3 covers the years 1934/1938 and shows the correlation between severe ("3" and "2") Dellinger effects and the number of sunspots and of severe (>1) solar eruptions between 0400 & 2100 GMT, in 3-monthly totals. The relation between *s*, the sunspot figure, and *d*, the number of "3" and "2" Dellinger effects observed at Noordwijk in a year, was found to be given by the formula $d = 0.0034\ s^2 \pm 4$. Finally, the belief that directional changes also play a part in the Dellinger effect is mentioned, and in this connection reference is made to the London/New York tests with a broadside Musa aerial (Bown, 4622 of 1938): here, deviations of from 4 to 12 degrees in the horizontal plane were found in the incoming beam during magnetic disturbances and solar eruptions.

1756. The Coronaviser [with Some Photographs of Prominences].—A. M. Skellett. (*Bell Lab. Record*, Feb. 1940, Vol. 18, No. 6, pp. 162–166.) For previous papers *see* 1934 Abstracts, p. 610, and 30 of January.

1757. Ionospheric Effects associated with Magnetic Disturbances.—Berkner, Wells, & Seaton. (*Terres. Mag. & Atmos. Elec.*, No. 3, Vol. 44, 1939, pp. 283–311.)

1758. Final Relative Sunspot Numbers for 1938 and Monthly Means of Prominence Areas for 1931–1938, *and* Tables on Sunspot Frequency for 1749–1938.—W. Brunner. (*Terres. Mag. & Atmos. Elec.*, No. 3, Vol. 44, 1939, pp. 243–245 : pp. 247–256.)

1759. A Mechanical Analogy to the Motion of Electrons in Gases [Two-Dimensional Motion of Steel Sphere on Inclined Plane with Large Number of Projecting Nails gives Analogy to Steady Motion of Electron Stream through Gas under Uniform Electric Fields : Velocity Distribution Curves].—G. D. Yarnold. (*Phil. Mag.*, Jan. 1940, Series 7, Vol. 29, No. 192, pp. 47–51.)

1760. A 27.3-Day Period in the Aurora Borealis—F. E. Dixon. (*Terres. Mag. & Atmos. Elec.*, No. 3, Vol. 44, 1939, pp. 335–338.)

1761. Auroral Work in Southern Norway in the Year 1938 [Survey].—C. Störmer. (*Terres. Mag. & Atmos. Elec.*, No. 3, Vol. 44, 1939, pp. 233–242.)

1762. Height of Mother-of-Pearl Clouds observed in Southern Norway during 1926–34.—C. Störmer. (*Nature*, 10th Feb. 1940, Vol. 145, pp. 221–222.) For preliminary results *see* 1933 Abstracts, pp. 497–498 ; *cf.* 1320 of April.

1763. "Formeln und Tabellen zur Berechnung der nivellitischen Refraktion" [in Surveying : Refraction by the Air near the Ground, and Factors affecting It : Book Review].—T. J. Kukkamäki. (*Zeitschr. f. Instrumentenkunde*, Jan. 1940, Vol. 60, No. 1, p. 31.) From the Finnish Geodesic Institute.

1764. The Transparency of the Atmosphere : VI—The "White Haze" [Hypothetical Term in Atmospheric Absorption Coefficient, Independent of Wavelength : a Useless Artifice].—J. Duclaux. (*Journ. de Phys. et le Radium*, Feb. 1940, Series 8, Vol. 1, No. 2, pp. 41–43.)

1765. Measurements of Wave Propagation in Some Ostmark [Austrian] Mines [Wave Penetration takes place through Rock Itself, not along Tunnels, Shafts, etc : Reception of Different Frequencies].—V. Fritsch. (*E.N.T.*, Nov./Dec. 1939, Vol. 16, No. 11/12, p. 297 : short note only.) *Cf.* same writer, 1324 of April.

1766. Momentum of a Photon inside a Medium [and the Corpuscular Aspect of Light Propagation].—D. S. Kothara. (*Sci. & Culture*, Calcutta, Feb. 1940, Vol. 5, No. 8, pp. 456–457.)

1767. On Some Problems in the Diffraction of Heat [treated by Method of Laplace Transforms and Their Inversion by Operational Calculus : Thermal Equivalent of Problem of Diffraction of Electromagnetic Waves].—A. N. Lowan. (*Phil. Mag.*, Jan. 1940, Series 7, Vol. 29, No. 192, pp. 93–99.)

1768. Mathematical Theory of Irrotational Translation Waves [where Forces of Fluid Friction are Negligible compared with Inertia & Gravitational Forces].—Keulegan & Patterson. (*Journ. of Res. of Nat. Bur. of Stds.*, Jan. 1940, Vol. 24, No. 1, pp. 47–101.)

ATMOSPHERICS AND ATMOSPHERIC ELECTRICITY

1769. Cosmic Static [Tests at Wheaton, Illinois, on High-Resolving-Power Equipment receiving on 160 Mc/s : Intensity/Galactic-Longitude Curve follows approximately the Computed Curve].—G. Reber. (*Proc. Inst. Rad. Eng.*, Feb. 1940, Vol. 28, No. 2, pp. 68–70.) The r.f. "transit telescope" was dealt with in a previous article (1889 of 1939 and back reference).

1770. The Physics of Stellar Interiors and Stellar Evolution, *and* The Spectra of Supernovae.—H. A. Bethe & R. E. Marshak : A. Hunter. (*Reports on Prog. in Physics*, Physical Society, Vol. 6, pub. 1940, pp. 1–15 : pp. 137–144.)

1771. The Influence of a Cloud in Lightning Researches on Models [Electrolytic Trough Experiments on Field Distribution show that the Imitation of the Cloud is a Refinement of only Secondary Importance].—W. Weber. (*E.T.Z.*, 18th Jan. 1940, Vol. 61, No. 3, pp. 57–59.)

1772. Electromagnetic Force Effects of Large Currents in the Interior of Conductors, and Their Calculation.—P. Bachert : Foitzik. (*E.T.Z.*, 18th Jan. 1940, Vol. 61, No. 3, pp. 51–52.) Prompted by Foitzik's experimental results (1374 of 1939).

1773. The Use of Electrets in Electrical Instruments [Advantage for Radio Sondes : etc.].—Gemant. (*See* 1961.)

1774. A More Precise Determination of Humidity from the Records of Aerological Sounds.—V. G. Dybchenko. (*Comptes Rendus (Doklady) de l'Ac. des Sci. de l'URSS*, No. 2, Vol. 24, 1939, p. 143–144 : in English.)

1775. Temperature Measurement and Hygrometry in Radio-Meteorography.—R. W. Powell. (*Reports on Prog. in Physics*, Physical Society, Vol. 6, pub. 1940 : in a report on Progress in Heat, pp. 297–329.)

1776. Sensitive Aneroid Diaphragm Capsule with No Deflection above a Selected Pressure [Sevenfold Increase in Sensitivity in Radio Sondes above 46 000 Feet].—Brombacher & others. (*Journ. of Res. of Nat. Bur. of Stds.*, Jan. 1940, Vol. 24, No. 1, pp. 31–32 and Plate.)

1777. The Use of the Millibar in Weather Bureau Reports [Protest].—C. H. Sharp. (*Elec. Engineering*, March 1940, Vol. 59, No. 3, p. 124.)

PROPERTIES OF CIRCUITS

1778. Convex Endovibrators, *and* Toroidal Endovibrators.—Neiman. (*See* 1743 & 1744.)

1779. Contribution to the Study of the Potential Fluctuations at the Ends of a Conductor of Small Volume traversed by a Current [Bernamont Effect].—M. Surdin. (*Rev. Gén. de l'Élec.*, 3rd/10th Feb. 1940, Vol. 47, No. 5/6, pp. 97–101.)

Thermal fluctuations (Johnson effect) do not depend on the nature of the resistance but only on the temperature and the value of the resistance (at any rate when its capacity and inductance are negligible at the frequencies employed). When a current is passed through the resistance, the fluctuation e.m.f. increases, but its magnitude now depends on the nature of the resistance, on the current passing, and on the frequency. This phenomenon was first announced (in 1925) by Hull & Williams, who attributed it to imperfect contacts. Bernamont was the first to make a systematic study of it and to interpret it according to the theory of metals (*see*, for example, 1968 of 1936); Brillouin studied it from the quantum view-point.

The present writer has carried further Bernamont's experimental work, using a number of different films of various thicknesses, and widening the range of frequencies. He has also extended the frequency range of Christensen & Pearson's experiments on the spontaneous fluctuations of carbon microphones and other granular resistances (2674 of 1936). Thus curve 1 of Fig. 6 gives the distribution over different frequencies, up to nearly 1 Mc/s, of $\overline{e_\nu^2}$ for a constant value of current passing through the microphone capsule: the coordinates are logarithmic. From 100 c/s to 40 kc/s, this quantity can be represented by a curve of the form $(1/\nu)^{0.98}$; below 100 c/s it grows more quickly than this, while above 160 kc/s it varies inversely as ν^2. Curves 2–5 refer to sputtered platinum films. All the curves are limited, at the high-frequency end, by the Johnson effect; special shapes of film will have to be devised if the behaviour at higher frequencies is to be studied, so as to avoid this. Curves 4 & 5 are limited towards the low frequencies at 96 c/s owing to difficulties in measurement.

Fig. 7 shows the curves, given by the same resistances, of $\overline{e_\nu^2}$ as a function of current, for a fixed frequency of 1024 c/s. For the sputtered films, all the curves have the same shape, and curves for different frequencies are similar. For small current values $\overline{e_\nu^2}$ increases with the square of the current; for larger currents, less rapidly. In the case of the microphone the same thing occurs, but at high current values a cohering action sets in and the resistance decreases.

1780. On a Particular Case of Parametrically Coupled Systems [and the Possibility of Varying Continuously the Speed of an Inductive Parametrical Motor: Frequency Transformation in Practically Any Ratio].—N. D. Papalexi. (*Journ. of Phys.* [of USSR], No. 5/6, Vol. 1, 1939, pp. 373–379: in English.)

See, for example, 2595 & 2596 of 1935. An inductive "parametrical" alternator with 24 pole-pairs, running as a motor on a 600-cycle supply, should have shown a speed of 3000 r.p.m. but was found actually to vary between 500 & 800 r.p.m. Further investigation showed that the speed could be varied continuously by regulating the parameters of the supply circuit (*e.g.* by a variable condenser) while keeping the supply frequency constant. This result was traced to the reaction of the rotor on the electrical oscillating circuit parametrically coupled to it. The phenomenon is here analysed. "The above relation of frequencies and the possibility of a continuous variation of the speed of the motor gives us a new peculiar kind of frequency transformation in practically any frequency ratio."

1781. Experimental Investigation of a Quasi-Harmonic Vibrator [of Mathieu Type: for the Elucidation of Phenomena in Oscillatory Systems with Periodically Varying Parameters, in connection with Frequency Modulation, Relaxation Oscillations, Wave Diffraction, etc.].—H. Neusinger. (*Akust. Zeitschr.*, Jan. 1940, Vol. 5, No. 1, pp. 11–26.)

Using an experimental model of a pendulum with periodically varying restoring force. It is suggested that an elaborated design would solve Mathieu differential equations with perturbation functions, the theory of which is still incomplete.

1782. Non-Linear Circuits: Graphical Determination of Performance [Use of Equi-current-Line Families for Rectifiers with Choke-Input & Condenser-Input Filters as Load, Resistance Loads, Frequency-Doubler Circuit, etc.].—J. Frommer & A. Rédl. (*Wireless Engineer*, Jan. 1940, Vol. 17, No. 196, pp. 4–12.) From the Tungsram laboratories.

1783. Retarded Retroaction.—Gorélik. (*See* 1824.)

1784. Feedback improves Electromechanical Recording.—Vieth. (*See* 1902.)

1785. On the Theory of Multi-Stage Feedback [in Radio Transmitters].—Model & others. (*See* 1823.)

1786. The Application of Feedback to Wide-Band Output Amplifiers.—Everest & Johnston. (*See* 1940.)

1787. A Distortion-Free Amplifier [Fraction of Main-Amplifier Input Voltage, combined with Fraction of Distorted Output Voltage, is led to Auxiliary Amplifier to give Correcting Component for Combination with Total Output: Calculation of Resulting Characteristic and "Klirr Factor" Reduction].—P. O. Pedersen. (*Proc. Inst. Rad. Eng.*, Feb. 1940, Vol. 28, No. 2, pp. 59–66.)

1788. On the Theory of Radio-Frequency Amplification [Treatment by Introduction of "Control-Limit Line" in the I_a/V_a Characteristics].—A. Marino. (*Alta Frequenza*, Feb. 1940, Vol. 9, No. 2, pp. 67–102.)

Although the theory of r.f. amplification is one of the most lavishly studied problems in wireless technique, the writer thinks that the method of treatment presented here is valuable on account of the clear and complete view it gives of the problem and because it leads to the simple and rapid determination of the optimum working conditions for a given valve of any type (triode, pentode, etc.).

Author's summary:—"After a short discussion of the functioning of r.f. amplifiers, the concept of the 'utilisation-limiting straight line' of the characteristics in the plane of the anode currents I_a and anode voltages V_a is introduced, and it is shown how the drawing of this straight line is connected, in the triode, with the dissipation at the control grid, and in the pentode, with the dissipation at the screen grid.

"Two methods are described of studying r.f. amplifiers, both depending on the use of the static characteristics in the plane of I_a and V_a and on the tracing, in this plane, of the above-mentioned limit-line. The first method is based on the introduction of certain numerical coefficients characterising the r.f. amplification of a valve as regards supply power, power dissipated, useful power, maximum anode current, conversion efficiency, and utilisation coefficient; this method enables the solution to be obtained of all the most complex problems relating to r.f. amplification (amplifiers for non-modulated & modulated oscillations, and modulating amplifiers). The second method, based on the drawing of a special diagram [pp. 98, 99], also brings to light all the special characteristics of r.f. amplification. Both methods have a very general character . . . and can be employed whether the valve characteristics are considered as having a linear, semi-cubic, or quadratic form."

1789. Investigations on the Linearisation of Cascade Amplifiers [Compensation of Third Harmonic].—H. Holzwarth. (*E.N.T.*, Nov./Dec. 1939, Vol. 16, No. 11/12, pp. 279–285.)

The "klirr" factor compensation by pre-distortion given by R. Targon (German Patent No. 382 177) considers only the second harmonic; the aim of the present paper is to show how the third harmonic can also be compensated by pre-distortion. The end distortions arising from pre-distortion are first worked out (§ 1; cascade amplifier circuit with pre-distortion Fig. 1); Figs. 2a, b, c show calculated and measured values of the "klirr" factors of the cascade amplifiers, the input and the output valves respectively. It is found that "the desired compensation of the third harmonic is only possible when there are positive cubic distortions of the two single valves, which together are as great as the cubic distortion arising from the combination of the quadratic distortions of the two valves." The conditions for compensation of the third harmonic are worked out theoretically in § 2; eqn. 20 gives the condition for the second and third harmonics to vanish in the case of two equal valves connected one behind the other and working under exactly equal conditions. § 3 gives a practical discussion of this compensation for two equal valves, with curves of the connection between working point and matching ratio (Fig. 4) and of the compensation condition (Fig. 5). The power delivered is worked out in terms of various parameters; Fig. 6 shows the efficiency of the end valve of a compensated amplifier cascade, which, it is found, can only be profitably employed if the external resistance is as large as possible, *i.e.* in the case of high over-matching. A practical test of the theory is described. A high degree of equality in the valves is found to be required; the compensation is found to be relatively insensitive towards battery voltage variations, when grid and anode voltage are derived from the same source.

1790. On Choosing the Capacity of Tuned Circuits in designing Amplifiers.—Chistyakov. (*See* 1840.)

1791. Amplification of Power at Acoustic Frequencies [Theoretical Examination of Class A & Class B Amplification, with Special Attention to the Latter].—A. Pinciroli. (*Istituto Elettrot. Naz. Galileo Ferraris*, Reprint No. 64, 16 pp.)

1792. Bridge-Type Direct-Current Amplifier [with One Arm of Bridge replaced by a Triode: Derivation of Relation between Current in Diagonal and Applied Voltage, as Function of Valve Characteristics, and Deduction of Best Conditions for Sensitivity & Linearity: Experimental Confirmation].—L. Sponzilli. (*Alta Frequenza*, Jan. 1940, Vol. 9, No. 1, pp. 59–63.)

1793. A High-Efficiency R.F. Amplifier.—O'Brien & Kees. (*See* 1822.)

1794. Diode Operating Conditions [particularly the Positively Biased Régime].—Sturley: Court. (*See* 1877.)

1795. The Phase Convention of Currents and Voltages in Valve Circuits.—G.W.O.H. (*Wireless Engineer*, March 1940, Vol. 17, No. 198, pp. 95–96.)

1796. Constant-Potential Rectification [New Circuit where Load-Current or Supply-Voltage Fluctuations result in Phase-Swinging which controls D.C. Voltage within Fine Limits: Low Ripple].—S. A. Stevens & A. H. B. Walker. (*Wireless World*, April 1940, Vol. 46, No. 6, pp. 196–199.) "Noregg" & "Westat" systems: Brit. Pat. No. 493 362.

1797. Transformation Theory of General Static Polyphase Networks [illustrating the Power & Simplicity of Matrix Algebra in This Class of Problem].—L. A. Pipes. (*Elec. Engineering*, Feb. 1940, Vol. 59, No. 2, Transactions pp. 123–128.)

1798. Impedance Networks [including Filter Synthesis, Networks with Constant Input Impedance, and Distortion-Correcting Networks].—R. S. Rivlin. (*Reports on Prog. in Physics*, Physical Society, Vol. 6, pub. 1940, pp. 389–402.)

1799. Application of the Cauer Theory to Campbell-Zobel Ladder-Type Filters.—G. Madia. (*Alta Frequenza*, Jan. 1940, Vol. 9, No. 1, pp. 25–36.)

Author's summary :—" After recalling the principal points in the Cauer theory of symmetrical filters, the paper considers a ladder filter of the Campbell-Zobel type, composed of *n* similar cells in series; the impedance and attenuation characteristics of the equivalent lattice-type filter are derived. It is thus found that the poles and zeros of the characteristic attenuation function are distributed according to the cosines of the *n* angles obtained by the successive addition of the angles resulting from the division of a semicircle into *n* equal parts."

1800. A Brief Summary of Bridge Networks [with Selected Bibliography of 71 Items].—W. J. Seeley. (*Elec. Engineering*, March 1940, Vol. 59, No. 3, pp. 108–113.)

1801. Simple Treatment of Band-Pass Filters [avoiding Usual Employment of Complex Hyperbolic Functions].—J. Greig. (*Wireless Engineer*, March 1940, Vol. 17, No. 198, p. 110.)

1802. The Oscillation Frequency and Tuning in Externally Controlled Single-Circuit Transmitters.—Buschbeck. (*See* 1816.)

1803. The Presentation of Decaying Oscillations as Stationary Images on the Cathode-Ray Tube [for Visual Observation or Simple Photographic Recording : Utilisation of the Saw-Tooth Time-Base Impulses (with Their Numerous Harmonics) to Shock-Excite an Oscillatory Circuit].—J. Czech. (*Zeitschr. V.D.I.*, 3rd Feb. 1940, Vol. 84, No. 5, pp. 83–85.) *Cf.* Campe & Matschull, 760 of February ; the present arrangement, however, " is still simpler."

1804. A Note on Self-Induction [and the Misunderstandings concerning " Rate of Change of Flux " : Two Errors in the Usual " Cutting Rule " Formula : etc.].—A. O'Rahilly. (*Journ. I.E.E.*, Feb. 1940, Vol. 86, No. 518, pp. 179–187.) *See* also 801 & 3370 of 1939. " A clear exposition of the argument, illustrated by reference to a rectangular circuit, is here attempted."

TRANSMISSION

1805. Velocity-Modulated Beams : the Electron Density Distribution [Graphical Treatment for Sinusoidal Modulations, neglecting Redistribution of Electrons under Influence of Their Own Fields : Curves with Wide Range of Validity : Application to Non-Sinusoidal Modulation].—D. M. Tombs. (*Wireless Engineer*, Feb. 1940, Vol. 17, No. 197, pp. 54–60.)

1806. Velocity-Modulated Beams [Graphical Method Too Insensitive to give Correct Position of Maximum Density : Exact Solution found Mathematically].—R. Kompfner : Tombs. (*Wireless Engineer*, March 1940, Vol. 17, No. 198, pp. 110–111.) Prompted by Tombs's paper (1805, above).

1807. Induced Currents in Split Cylindrical Electrodes by Moving Charges [Calculation for Two-Split & Four-Split Electrodes : Incorrectness of Fritz's Field Equation for Four-Split Magnetron].—A. Okazaki. (*Electrot. Journ.*, Tokyo, Feb. 1940, Vol. 4, No. 2, pp. 46–47.) For Fritz's paper *see* 3379 of 1935 (*also* 1736 of 1936).

1808. An Experimental Investigation of Resonance and Electronic Oscillations in Magnetrons [Full-Anode, Two-Segment, & Four-Segment Types : Tendency towards Discrete Wavelengths : Empirical Formula $\lambda^2{}_i$ = const. for Resonance Oscillations : Main Effect of Tilt is Broadening of Magnetic-Field Range for Oscillation : Resonance & Electronic Oscillations essentially of Same Nature : etc.].—J. S. McPetrie & L. H. Ford. (*Journ. I.E.E.*, March 1940, Vol. 86, No. 519, pp. 283–292.)

1809. A Magnetron Oscillator with a Compound Field Winding.—Ford. (*See* 1868.)

1810. On the Magnetron Cut-Off Curve, *and* Influence of Magnetic Field upon Electron Motion in Axially Symmetrical Fields.—Spiwak & Zrebny. (*See* 1866 & 1867.)

1811. The Impedance of the Magnetron in Different Regions of the Frequency Spectrum [Series of Measurements to determine Special Properties in Dynatron, Resonance, & Electronic Régimes : Comparison with Existing Theory].—A. F. Harvey. (*Journ. I.E.E.*, March 1940, Vol. 86, No. 519, pp. 297–306.)

" It appears that a full explanation [of the mechanism of operation of the magnetron] is difficult unless existing theories of electron motion in the magnetron, especially under dynamic conditions, are much extended."

1812. Study of a Whole-Anode Magnetron, neglecting the Space Charge.—Bellustin. (*See* 1871.)

1813. A Practical 112 Mc/s Frequency-Modulated Transmitter [5–6 Watts Output].—B. Goodman. (*QST*, Feb. 1940, Vol. 24, No. 2, pp. 22–25 and 108..110.)

1814. Frequency Modulator [Analysis leading to Method of adjusting Phase of Reactance-Valve Grid Voltage so as to Eliminate the Tendency of This Valve to cause Amplitude Modulation : Increase of Modulation Range : Experimental Confirmation].—C. F. Sheaffer. (*Proc. Inst. Rad. Eng.*, Feb. 1940, Vol. 28, No. 2, pp. 66–67.)

1815. Barkhausen-Kurz Oscillations with Positive Ions [in Place of Electrons in Cylindrical Triode : Wavelength 500 m : Frequency determined by Operating Conditions of Triode : Weak Oscillations obey Scheibe Transit-Time Formula : Various Oscillation Types for Different Operating Conditions].—W. S. Elliott & J. A. Ratcliffe. (*Nature*, 17th Feb. 1940, Vol. 145, pp. 265–266.)

1816. The Oscillation Frequency and Tuning in Externally Controlled Single-Circuit Transmitters.—W. Buschbeck. (*E.T.Z.*, 11th Jan. 1940, Vol. 61, No. 2, pp. 25–28.)

From the Telefunken laboratories. "For the approximate determination of the oscillation frequency of a self-excited transmitter the general practice is to use the value $\omega_0 = 1/\sqrt{CL}$ obtained from the Thomson equation for the free oscillation of an undamped circuit. This value, which takes into account neither the valve constants nor the phase of retroaction, represents only an approximation. The object of the following paper is to give a simple procedure which without going back to the differential equation enables a determination to be made, on certain simplifying assumptions, of the oscillation frequency of a circuit which need not have a phase-pure retroaction." Among conclusions reached is that in separately controlled transmitters the most common method of tuning, to the minimum anode-current consumption (maximum impedance), may in certain conditions lead to serious errors if the tuning is done in that branch of the circuit from which the output power is taken (Fig. 3, contrasted with Fig. 4). Finally a symmetrically damped arrangement is considered, especially its behaviour to frequency changes.

1817. Oscillators with Current-Limited Multiple-Grid Valves [giving New Possibilities in Frequency Stabilisation, etc.].—R. Golicke. (*E.N.T.*, Nov./Dec. 1939, Vol. 16, No. 11/12, pp. 286–297.)

This paper describes "current-limited retroaction generators in which suitable characteristics are attained, not, as hitherto, by arrangements at the cathode, but by the use of current-distribution control (multiple-grid valves). This leads to new possibilities for the circuit, for amplitude regulation, frequency stabilisation, and supervision, to make these generators reliable and well suited to different uses." Properties of multiple-grid valves which are useful in current-limited oscillating circuits are first analysed on the basis of the current-distribution characteristics (Fig. 1, pentode ; Fig. 5, hexode) and working characteristics (Fig. 6, hexode). The control grid is found to have a characteristic with a point of inflexion for a negative bias point, where the characteristic is steepest. If the working point is set at this point of inflexion, stable oscillations can be produced ; the degree of retroaction determines the length of the characteristic over which the oscillations extend. The characteristic is very nearly linear in this region, so that the "klirr" factor of the oscillations is small, though the linearity makes the adjustment of the retroaction very critical. This difficulty can be overcome by automatic regulation of the degree of retroaction (circuits Figs. 7, 8). Fig. 9 shows a generator with low overtone content, Fig. 10 a generator for higher frequencies, above about 15 Mc/s.

Frequency-stabilised oscillators can be designed on the lines of the circuit of Fig. 4, which has low retroaction. Fig. 11 gives a general circuit for frequency stabilisation, which compensates for the effects of anode voltage on the frequency. Fig. 12 shows a frequency-stabilised generator, Fig. 13 its frequency variation with anode voltage. The effect of the cathode properties on the frequency is also discussed (Fig. 14, variation of frequency with filament voltage for circuit Fig. 12). Retroaction circuits are finally discussed (general circuit Fig. 15, fed by an electrode before the control grid). Fig. 16 shows a retroaction circuit with series resonance circuit or crystal, Fig. 17 a generator for sinusoidal oscillations with frequency tuning by resistances and condensers, Fig. 18 a circuit for distant frequency control. Various working characteristics ("klirr" factor, output voltage, etc.) of the circuit of Fig. 17 are shown in Figs. 19–21.

1818. Stabilisation of the Frequency of an Oscillation Generator with the Help of an Auxiliary Valve coupled to It [and the Good Results obtained by the Dutch Colonial Department on a Wavelength of about 16 m].—G. Schotel. (*Tijdschrift van het Nederlandsch Radiogenootschap*, No. 3, Vol. 8, 1939, pp. 271–292 : in Dutch.)

A 3-months' test showed a maximum deviation of ± 0.006%, on the shortest of the three optional waves of the transmitter : this is to be compared with the Cairo Convention rule of 0.01%. The theory of the method developed is given in full. Fig. 7 represents the practical circuit, and is in fact a combination of the oscillator with its coupled reactance-variation valve, as seen in Fig. 5 (*cf.* also Kusunose & Ishikawa, 1932 Abstracts, p. 342), with the "discriminating" circuit represented in Figs. 6 & 6a (*see* Foster & Seeley, 2543 of 1937). It therefore constitutes the application of an "automatic tuning correction" circuit, of broadcast-receiver technique, to the stabilisation of a transmitting station.

On the last page it is pointed out that the arrangement permits the small frequency variations such as occur in frequency modulation ; telegraphy signals can easily be modulated in frequency (for improved reception during fading), and preliminary tests on frequency modulation for telephony have already given promising results.

1819. Low-Temperature-Coefficient Quartz Crystal [Coupled-Frequency, Long-Bar, and AT, BT, CT, & DT Shear-Vibrating Crystals: Theory, & Comparison with Christofel Formula: a New Cut (GT Crystal) with Very Constant Frequency over Wide Temperature Range].—W. P. Mason. (*Bell S. Tech. Journ.*, Jan. 1940, Vol. 19, No. 1, pp. 74–93.)

1820. Lop-Sided Speech and Modulation: Voice-Wave Polarity and Its Effect on 'Phone Transmitter Operation [and a Practical Way of Utilisation].—G. Grammer. (*QST*, Feb. 1940, Vol. 24, No. 2, pp. 14–17 and 86..96.) *See* also Hathaway, 548 of February.

1821. The Various Representations of Modulation.—H. Mühlbacher: Ruprecht. (*E.N.T.*, Nov./Dec. 1939, Vol. 16, No. 11/12, pp. 299–300.) Criticism of paper on "Modulation" by Ruprecht (2303 of 1939); reply from Ruprecht.

1822. A High-Efficiency R.F. Amplifier [Higher Efficiency, & Greater Operating Simplicity, than Chireix, Doherty, and Dome Systems (80% Efficiency obtained): Disadvantages include Multiplicity of Voltages and More Valves].—E. J. O'Brien & H. Kees. (*Communications*, Feb. 1940, Vol. 20, No. 2, pp. 7–9 and 44.)

Valve 2 has twice the plate voltage of valve 1, and biases are arranged so that valve 1 supplies power when the exciting voltage does not exceed the carrier-level excitation voltage (giving high-efficiency Class C operation of valve 1), while valve 2 operates only when this is exceeded.

1823. On the Theory of Multi-Stage Feedback [in Radio Transmitters].—Z. I. Model, S. V. Person, A. I. Lebedev-Karmanov, & A. M. Pisarevski. (*Izvestiya Elektroprom. Slab. Toka*, No. 11, 1939, pp. 3–24.)

Continuing the work dealt with in 97 of 1939, the reduction in amplification of the main channel when the Black circuit is used, and the use of various circuits, such as that of Baggally (1934 Abstracts, p. 43), to obviate this, are briefly discussed; it is shown that these circuits do not present any considerable advantage over the original Black circuit. The greater part of the paper deals with methods for preventing singing due to phase distortion in the main channel. The use of gain limiters and phase compensators, especially in multi-stage circuits, is discussed in detail. It is shown that non-linear distortion in a radio transmitter using Class B anode modulation occurs mainly in the modulating circuits, and that the use of feedback amplifiers in these circuits is accompanied by certain peculiarities, which are examined in great detail. Various conclusions reached in this investigation have been verified experimentally.

1824. Retarded Retroaction [Theoretical Study of Auto-Oscillatory Systems where Retroactive Forces at Instant t are determined by State of System at Instant $t - \tau$].—G. Gorélik. (*Journ. of Phys.* [of USSR], No. 5/6, Vol. 1, 1939, pp. 465–470: in French.) The Russian paper was dealt with in 540 of February. *See* also Bovsheverov, 3329 of 1936.

1825. Another Approach to High Power: Push-Pull-Parallel Operation of Medium-Voltage Tubes.—J. A. McCullough. (*QST*, Feb. 1940, Vol. 24, No. 2, pp. 54–57.)

1826. Power Oscillators: Circuit for Surface Hardening of Steel [300 kW Oscillator with Thyratron Start-Stop and Power-Varying Control].—G. Babat & M. Losinsky. (*Wireless Engineer*, Jan. 1940, Vol. 17, No. 196, pp. 16–18.) *See* also 839 of 1939 and back reference; *also* 2120, below.

1827. "Wired Wireless" for Remote Control [of a Distant Transmitter].—J. E. Williams. (*QST*, Feb. 1940, Vol. 24, No. 2, pp. 34–37.)

RECEPTION

1828. Frequency Modulation [Vectorial Representation of Effect of Noise: Current-Limiting Device for Noise Reduction replaced by Local Oscillator, Frequency-Modulated by Feedback from Detector, giving Large Reduction of both Amplitude & Phase Effects of Noise].—J. G. Chaffee. (*Bell Lab. Record*, Feb. 1940, Vol. 18, No. 6, pp. 177–181.) *See* also 3120 of 1939.

1829. Motor-Car Interference and the Murphy Noise Limiting Circuit.—(*See* 1942.)

1830. Ignition Interference Suppression: How It Affects Motor-Car Performance.—C. Attwood & B. Cole. (*Wireless World*, April 1940, Vol. 46, No. 6, pp. 200–203: to be contd.) *Cf.* Scholz & Faust, 980 of March.

1831. A Regenerative Pre-Selector with Output-Metering Bridge [providing High Protection against Noise for Subsequent High-Selectivity Circuits].—H. O. Talen. (*QST*, Feb. 1940, Vol. 24, No. 2, pp. 32–33 and 118..122.) Using a modified "signal-metering valve" circuit (1440 of 1939).

1832. Instruments and Methods of Measuring Radio Noise [based on Recommendations of Joint Coordination Committee on Radio Reception of EEI, NEMA, & RMA].—Aggers, Foster, & Young. (*Elec. Engineering*, March 1940, Vol. 59, No. 3, Transactions pp. 178–192.) Including a long Discussion, among the items of which is one dealing with the desirable characteristics of the indicating instrument.

1833. The Suppression of Radio Interference from Trolleybuses.—Sinclair. (*Journ. I.E.E.*, March 1940, Vol. 86, No. 519, p. 231.) In a long paper on the Trolleybus.

1834. The Suppression of Broadcast Interference from Lifts [driven by D.C.].—M. Kreuzritter. (*E.T.Z.*, 18th Jan. 1940, Vol. 61, No. 3, pp. 49–51.)

The use of condensers alone to suppress this interference has frequently led to breakdown of these condensers after a time, with accompanying damage to the motor armature. The paper describes an investigation into this problem, leading to the development of methods of limiting the surges; the arrangement of Fig. 2, in which two protecting resistances (each around 1000 ohms) are used, was found to be particularly cheap and reliable, though it has the defect of consuming about 100 watts.

1835. Behaviour of High-Voltage Insulators in the Investigation of Broadcast Interference [Marked Effect of Momentary Overvoltage (attributed to Residual Surface Charges): Simultaneous Appearance of Interference & Corona, but Complete Independence of Intensities: etc.].—C. I. Miller, Jr. (*E.T.Z.*, 4th Jan. 1940, Vol. 61, No. 1, pp. 13–14.) Summary of an *Electrical World* paper.

1836. Testing of Distribution Arresters [including Radio Interference Tests].—H. Halpern. (*Elec. Engineering*, March 1940, Vol. 59, No. 3, Transactions pp. 142–149.)

1837. "Die Radiostorungen als Rechtproblem" [Radio Interference as a Legal Problem: Book Review].—H. Zurbrügg. (*Bull. Assoc. suisse des Élec.*, No. 5, Vol. 31, 1940, p. 129.)

1838. "Diversity" in South Africa: Receiving European Signals for Re-Broadcasting [Panorama Receiving Station].—(*Wireless World*, March 1940, Vol. 46, No. 5, pp. 188–189.)

1839. Ganging Superheterodyne Receivers [Definition of "Fault Factor" (Measure of Merit of a Padding Curve): Analysis leading to Approx. Formula giving the Three Adjusting Frequencies where Establishment of Correct Ganging will give Best Padding Curve, with Extreme Faults practically Equal].—M. Wald. (*Wireless Engineer*, March 1940, Vol. 17, No. 198, pp. 105–109.)

1840. On Choosing the Capacity of Tuned Circuits in designing [Superheterodyne] Amplifiers.—N. I. Chistyakov. (*Izvestiya Elektroprom. Slab. Toka*, No. 10, 1939, pp. 28–38.)

To raise the amplification factor of the i.f. amplifier in a superheterodyne receiver, tuned circuits of low capacity should be used. If, however, this capacity is made too low, the changing of valves may considerably detune the circuit and thus affect the frequency characteristic of the receiver. In this paper a mathematical investigation is presented of the effect of detuning the circuits on the band width within which the amplification of the amplifier does not vary by more than the permissible amount. Multi-stage amplifiers (Fig. 10 & 13) are considered, and the effect of changing the valves on the resultant capacity of the tuned circuits is discussed. On the basis of this investigation a formula (14) is derived from which the necessary minimum capacity of the circuits can be determined.

1841. Bandspread Short-Wave Converter [New System: Continuous Tuning from 13 to 72 Metres].—(*Wireless World*, March 1940, Vol. 46, No. 5, pp. 158–163.) Continued from 1008 of March.

1842. Input Capacitance of a Triode Oscillator [with Grid Condenser & Leak: Decrease with Increasing Anode Voltage (causing Trouble in Superheterodyne Receivers, particularly in Short-Wave Bands): Calculation of Variation, agreeing with Experimental Values].—J. van Slooten. (*Wireless Engineer*, Jan. 1940, Vol. 17, No. 196, pp. 13–15.) From the Philips laboratories.

1843. Compensating Tube-Input-Capacitance Variation [when Gain is Varied: Use of a Type 6L7 Valve with Control Voltages fed to Injection & Control Grids].—Farrington. (*QST*, Feb. 1940, Vol. 24, No. 2, pp. 42–43.) Based on a paper in the *RMA Engineer*.

1844. A Second-Detector Circuit using a 6H6 Diode in a Voltage-Doubling Connection.—A. Towle. (*QST*, Feb. 1940, Vol. 24, No. 2, p. 60.) *Cf.* 1423 of April.

1845. Three-Electrode Crystals with Barrier Layers [Short Survey].—F. A. Makovski. (*Izvestiya Elektroprom. Slab. Toka*, No. 10, 1939, pp. 57–59.) Among work quoted is that of Rögener & others, 3405 of 1937, and Hilsch & Pohl, 1683 (*see* also 4585) of 1939.

1846. Instrument enables Blind to do Radio Servicing [the "Videlyzer"].—Barany. (*Sci. News Letter*, 24th Feb. 1940, Vol. 37 No. 8, p. 121.)

1847. "Servicing by Signal Tracing," *and* "Radio Service Trade Kinks" [Book Reviews].—Rider: Simon. (*Wireless Engineer*, Feb. 1940, Vol. 17, No. 197, p. 64: p. 64.)

For a discussion of the first book and its method, including the very special requirements of the r.f. voltmeter ("Chanalyst") see *Wireless World*, April 1940, Vol. 46, No. 6, pp. 228–229.

1848. Simplified Push-Button Tuning [Buttons easily Re-Set for New Stations].—Crosley Radio. (*Scient. American*, Jan. 1940, Vol. 162, No. 1, p. 34.)

1849. Test Reports: Hallicrafters Sky-rider 23 [Communication Receiver, 10 Valves + Rectifier], *and* Cossor Model 71B.—(*Wireless World*, March 1940, Vol. 46, No. 5, pp. 174–176: April, No. 6, pp. 214–215.)

1850. Single-Valve Sets: New Light on Old Circuits [including Reflex Circuits].—(*Wireless World*, April 1940, Vol. 46, No. 6, pp. 207–208.)

1851. Compact Battery Receiver for Station or Portable Use [Regenerative Receiver with Semi-Tuned R.F. Stage, using the New "Peanut" Valves].—D. H. Mix. (*QST*, Feb. 1940, Vol. 24, No. 2, pp. 18–21 and 106.)

1852. Denco "Pocket-Two": an Economical Miniature Battery Receiver, *and* Miniature Portable—Compact Home-Built Receiver.—(*Wireless World*, April 1940, Vol. 46, No. 6, p. 220: p. 232.)

1853. H.M.V., Marconiphone, and G.E.C. "All-Dry" Portables.—(*Wireless World*, April 1940, Vol. 46, No. 6, pp. 223, 227, and 229.)

AERIALS AND AERIAL SYSTEMS

1854. Television Receiving Antennas and Transmission Lines [including Apparatus & Procedure for Surge-Impedance Measurement: Tests on Effect of Moisture-Absorption, for Various Kinds of Lines: etc.].—A. W. Barber. (*Communications*, Feb. 1940, Vol. 20, No. 2, pp. 15–16 and 48, 49.)

1855. Ultra-Short-Wave Aerial Systems: Their Characteristics and Designs.—F. R. W. Strafford. (*Wireless World*, April 1940, Vol. 46, No. 6, pp. 224–227.)

1856. On the Electromagnetic Radiation from Point Sources.—A. Z. Fradin. (*Journ. of Tech. Phys.* [in Russian], No. 13, Vol. 9, 1939, pp. 1161–1174.)

It has been shown by Howell (1702 of 1936) that considerable concentration of energy can be obtained at any finite distance when radiation takes place from a point source. So far this principle has found no practical application, and the present paper contains a theoretical discussion of whether it is possible to obtain a large concentration of energy when using a radiator of small but practicable dimensions. A spherical radiator is considered, and it is assumed that the field is symmetrical with regard to the axis and the equatorial plane (Fig. 1). The main conclusions reached are as follows:—(1) A point source, in the strict sense of the word, cannot radiate; it must be of finite dimensions; (2) to obtain high directivity, the radiator must be of the variable-phase type; (3) such a radiator is characterised by large wattless currents which reduce its practical utility.

1857. The Electromagnetic Field of a Spherical Oscillator excited by an Electromotive Force.—A. G. Arenberg. (*Comptes Rendus* (*Doklady*) *de l'Ac. des Sci. de l'URSS*, No. 9, Vol. 24, 1939, pp. 877–880: in French.)

Previous Notes (1014 & 1015 of March) have indicated the need for further research on the phenomena of electromagnetic emission: "in the present article we shall consider an electromagnetic field created by a spherical oscillator; we shall suppose that the vibrations of this oscillator take place under the influence of a 'superficial' external e.m.f. directed along its meridians." As a result of the treatment, "if one compares these expressions with the generally known formulae for the components of the electromagnetic field of an elementary dipole, it is easy to see that the electromagnetic field of the spherical oscillator in question corresponds to the field of an elementary dipole, placed at the centre of the sphere, whose electric moment is M_s" [p. 880].

The question of the tuning of such a spherical oscillator, excited by an external e.m.f. distributed over its surface in the manner indicated ("the first spherical harmonic"), is then considered, and it is found that the current $I(\theta)$ traversing the surface (by the spherical band of length $2\pi a \sin\theta$) reaches a maximum for a wavelength $0.855 \times 2\pi a$; this resonance wavelength does not coincide with the wavelength $1.158 \times 2\pi a$ found by J. J. Thomson for the free vibrations of a sphere.

1858. On the Distribution of the Energy of an Elementary [Hertz] Oscillator.—A. G. Arenberg. (*Comptes Rendus* (*Doklady*) *de l'Ac. des Sci. de l'URSS*, No. 9, Vol. 24, 1939, pp. 881–882: in French.)

"We have shown in the Note on the radiation resistance of a Hertz oscillator [1014 of March] that if this resistance is determined by an integration of the flux of a Poynting vector $\bar{S}$ across a sphere enveloping a dipole, it is sufficient to consider only the influence of the vector potential $\bar{A}$. At the same time, the determination of the value of the radiation resistance by the method of induced e.m.fs requires the taking into account, equally, of the scalar potential ϕ. But it can be shown that if the flux of the vector $\bar{S}$ were integrated not over a sphere but over a cylinder, it would be necessary, in order to determine the radiation resistance, to take into account the two potentials $\bar{A}$ and ϕ, which gives expressions entirely coinciding with the expressions (eqn. 15 of the previous paper) obtained by the method of induced e.m.fs." This is accomplished in the present Note, and eqns. 2 and 4 are derived giving, respectively, the power corresponding to the term of the Poynting vector depending only on $\bar{A}$ (power emitted by the dipole, "borrowed" from its magnetic field) and the power corresponding to the term depending only on ϕ (power "given up" to the electric field of the dipole). To each of these equations there is a corresponding expression (eqns. 5) for the components of the radiation resistance due to the potentials $\overline{A}$ and ϕ: the algebraic sum of these gives the usual formula for the radiation resistance. "Finally, it is easy to show that the Poynting vector has only a single component following the axis z [of the cylinder]," given by eqn. 6. Integration of the mean value of this component over an infinite plane perpendicular to the axis of the oscillator will give (for $|z| > 0$) a value equal to half the total emitted power.

1859. THE ELECTRIC AND MAGNETIC FIELDS OF A LINEAR RADIATOR CARRYING A PROGRESSIVE WAVE [and the Essential Differences between Such a Radiator and One carrying a Standing Wave].—F. M. Colebrook. (*Journ. I.E.E.*, Feb. 1940, Vol. 86, No. 518, pp. 169–178.)

Analysis of linear progressive-wave radiator by retarded-potentials method gives anomalous radial electric component: necessity for assumption of terminal charges (giving component cancelling this): asymmetry of field from progressive-wave radiators, and calculation of their radiation resistance: synthesis of a standing-wave radiator (applicable, *e.g.*, to series-phase arrays): etc.

1860. ANTENNA ARRAYS WITH CLOSELY SPACED ELEMENTS [" Flat-Top Beam " Aerials with Out-of-Phase Elements: Gain Equations: Effect of Spacing and Loss Resistance: etc.].—J. D. Kraus. (*Proc. Inst. Rad. Eng.*, Feb. 1940, Vol. 28, No. 2, pp. 76–84.) *See* also 1459 of 1939.

1861. ON FACTORS AFFECTING THE ANTI-FADING PROPERTIES OF AERIALS FOR RADIO BROADCASTING.—B. V. Braude. (*Izvestiya Elektroprom. Slab. Toka*, No. 11, 1939, pp. 34–45.)

The following two factors affecting the anti-fading properties of a tower aerial are discussed: (a) the travelling-wave component of the aerial current, and (b) the properties of the earth and the size of the earth system. A number of calculated vertical-directivity diagrams are shown, and the conclusion reached is that poor earth conductivity and the existence of a travelling-wave component both result in considerable distortion of the directivity diagram, and affect adversely the anti-fading properties of the system. The method proposed by Neiman for compensating these effects by using additional active or passive radiators is described.

1862. THE EXPONENTIAL TRANSMISSION LINE [for Matching Purposes, *e.g.* for Two Aerials in Parallel, with Common Feeder: Discrepancies between Calculated & Experimental Curves (Full-Scale Model), chiefly due to Stray Capacity of Mechanical Supports: Cure].—C. R. Burrows. (*Bell Lab. Record*, Feb. 1940, Vol. 18, No. 6, pp. 174–176.) For previous papers *see* 1453 of 1939.

1863. DANGEROUS CATCH PHRASES [applied to Screened Frame Aerials].—E. H. R. Green. (*Wireless World*, March 1940, Vol. 46, No. 5, p. 172.) " Helpful against types of interference in which the electrostatic field preponderates ": the writer protests against the use (" quite normal in our literature ") of phrases such as this.

1864. VIBRATION OF OVERHEAD LINE CONDUCTORS.—Double & Tuck. (*Journ. I.E.E.*, Feb. 1940, Vol. 86, No. 518, pp. 129–150: Discussion pp. 150–160.)

VALVES AND THERMIONICS

1865. VELOCITY-MODULATED BEAMS: THE ELECTRON DENSITY DISTRIBUTION.—Tombs: Kompfner. (*See* 1805 & 1806.)

1866. ON THE MAGNETRON CUT-OFF CURVE [and the Importance of the Energy of Random Motion].—G. V. Spiwak & P. E. Zrebny. (*Comptes Rendus* (*Doklady*) *de l'Ac. des Sci. de l'URSS*, No. 3, Vol. 24, 1939, pp. 237–241: in English.)

" With the exception of Linder [3165 of 1938] nobody appears to have made an attempt at expressing the equation for the cut-off curve of the magnetron by considering the random velocity as a function of magnetic field. Such an expression can be derived, however, if the temperature of the electronic gas is supposed to be high; yet as obtained by Linder it is incorrect, because there is a substantial error in his method of calculation " [the density of the electron swarm near the emitter, multiplied by the velocity of the electrons near the anode, does *not* give the current density]. *See* also 1867, below.

1867. INFLUENCE OF MAGNETIC FIELD UPON ELECTRON MOTION IN AXIALLY SYMMETRICAL FIELDS.—G. V. Spiwak & P. E. Zrebny. (*Comptes Rendus* (*Doklady*) *de l'Ac. des Sci. de l'URSS*, No. 3, Vol. 24, 1939, pp. 242–246: in English.)

" An important point to note here is that the currents between two coaxial cylinders are not indifferent to . . . whether it is the electrode with the greater or that with the smaller radius which emits electrons. The factor responsible for this variation of currents is the tangential component v which plays a different rôle in the two cases . . . ". " In the preceding paper [1866, above] we were discussing the case of electrons moving in a magnetron when the magnetic field exceeds its critical value. This was done on the assumption that $R_0 \gg r_0$ . . . The main object of the present paper is to obtain a more general solution which will embrace the case of an arbitrary relation between the radii of the cylinders."

1868. A MAGNETRON OSCILLATOR WITH A COMPOUND FIELD WINDING [Disadvantages of Connection where Anode Current increases Magnetic Field (except perhaps as Safety Device): Advantages of Differential Connection (Constancy of Output & Frequency: Protection against Overheating on Removal of Load, with Full Resumption on Restoration of Load): etc.].—L. H. Ford. (*Journ. I.E.E.*, March 1940, Vol. 86, pp. 293–296.)

1869. AN EXPERIMENTAL INVESTIGATION OF RESONANCE AND ELECTRONIC OSCILLATIONS IN MAGNETRONS.—McPetrie & Ford. (*See* 1808.)

1870. THE IMPEDANCE OF THE MAGNETRON IN DIFFERENT REGIONS OF THE FREQUENCY SPECTRUM.—Harvey. (*See* 1811.)

1871. STUDY OF A WHOLE-ANODE MAGNETRON NEGLECTING THE SPACE CHARGE.—S. V. Bellyustin [Bellustin]. (*Journ. of Tech. Phys.* [in Russian], No. 13, Vol. 9, 1939, pp. 1188–1198.)

A mathematical investigation of the operation of a magnetron employing two coaxial cylindrical electrodes. The investigation is confined to static conditions and the effect of space charge is neglected. Methods are indicated for determining the critical magnetic field, the trajectory of an electron, and the duration of its travel. A general formula (33) is also derived, in which the Maxwellian distribution of initial velocities is fully taken into account, for calculating the static characteristic of the magnetron. The discussion is illustrated by a number of numerical examples.

1872. PAPER ON INDUCED CURRENTS IN MAGNETRON ANODES.—Okazaki. (*See* 1807.)

1873. THE BEHAVIOUR OF SPACE CHARGES IN HIGH-FREQUENCY [and Ultra-High-Frequency] ELECTRIC FIELDS [Mathematical Treatment].—P. Güttinger. (*Bull. Assoc. suisse des Élec.*, No. 2, Vol. 31, 1940, pp. 29–34: in German.)

" In this paper an attempt will be made to derive general equations which will allow the behaviour of the electron clouds in an u.h.f. alternating field to be determined. It must be pointed out that the following theory represents only an approximation, in that magnetic effects will be neglected. This may be done without scruple, seeing that only the one-dimensional problem will be dealt with." The mathematical method is applied to the space charge between two plane electrodes acted on by an alternating voltage on which a d.c. voltage is superposed; the initial velocity of the electrons coming out of the cathode is assumed to be zero. In spite of these simplifications, " certain qualitative conclusions can no doubt be drawn from our formulae for the case also of triodes and multi-grid valves. It may be considered that in receiving valves of normal dimensions the practically important working region lies between $\omega T = 0$ and $= \pi/2$. Our result thus confirms the facts, experimentally found in the case of triodes, first that the absolute amount of slope is practically constant right down to very short wavelengths, and second, that the phase angle of the slope is to all intents and purposes directly proportional to the frequency, even in the u.s.w. region. Deviations from our theoretical results should only appear in the region of decimetric and centimetric waves."

As regards generating phenomena, " since we have shown that $I_e = -F \cdot I_k$ [I_e and I_k are the current in the external circuit and the current emerging from the cathode: F is the electrode surface: eqn. 49], it may be of special interest to examine more closely the angle of lead ϕ_k (compare also Fig. 2). If we follow numerically the course of this magnitude on a Riemann surface, we find that ϕ_k, first increasing regularly with ωT, reaches the value 90° (when $\omega T = 2\pi$), then slightly exceeds this value, and again returns to it. In its further course ϕ_k fluctuates periodically around 90°. The interesting point is that this phase angle ϕ_k passes through values *above* 90°, in which region the power factor cos ϕ_k assumes negative values. Thus in this region generating effects are to be expected, as soon as ωT is rather greater than 2π; that is, in the region of very short waves. This fact is the more interesting since it is of great practical importance."

1874. TELEVISION RECEPTION AND TELEVISION RECEIVING VALVES [Consideration of Special Requirements, and the Philips Types EE 50 (Secondary-Emission) and EF 50 (Pentode)].—(*Bull. Assoc. suisse des Élec.*, No. 1, Vol. 31, 1940, pp. 14–19 and 21: in German.)

1875. A 20 kW TETRODE FOR ULTRA-HIGH-FREQUENCY TRANSMITTERS [up to & over 80 Mc/s: Cylindrical Design].—Haeff & others. (*Elec. Engineering*, March 1940, Vol. 59, No. 3, p. 107.) *See* also 138 of January.

1876. THE TYPE 257 GAMMATRON [Beam Pentode of Unusual Design: All Electrodes of Tantalum, mounted Directly on Moulded Base, No Internal Insulators: Plate/Anode Capacity reduced to One-Third: etc.].—(*Communications*, Feb. 1940, Vol. 20, No. 2, p. 42.)

1877. DIODE OPERATING CONDITIONS [particularly the Positively Biased Régime: Reduction of Diode Efficiency leads to Higher Critical-Modulation Ratio: etc.].—K. R. Sturley: Court. (*Wireless Engineer*, Jan. 1940, Vol. 17, No. 196, pp. 19–20.) Prompted by Court's paper (154 of January) and referring to the writer's work dealt with in 1870 of 1939.

1878. PAPERS ON THE INPUT CAPACITANCE OF VALVES.—van Slooten: Farrington. (*See* 1842 & 1843.)

1879. THE ELECTROMETER TRIODE AND ITS APPLICATIONS [Philips Type 4060].—van Suchtelen. (*See* 1970.)

1880. THE ELECTROLYTIC METHOD OF STUDYING ELECTROSTATIC FIELDS.—V. S. Lukoshkov. (*Izvestiya Elektroprom. Slab. Toka*, No. 10, 1939, pp. 46–51.)

A general discussion of the electrolytic trough method used mainly for studying electrostatic fields within vacuum tubes. An enlarged model of the tube is used for this purpose and the distribution of potentials within the model is determined experimentally by means of a probe. The principle of similitude, necessary for obtaining conditions within the model similar to those within the original tube, is discussed and reduction formulae are derived. The method itself is then discussed in detail and a number of practical suggestions are made. It is stated in conclusion that the distribution of equipotential lines and of lines of forces can be determined by this method with an accuracy within about 0.1%, and that the method can also be used for a number of other measurements (static magnetic fields, distribution of temperatures due to a static flow of heat, etc.).

1881. ON THE SECONDARY-EMISSION FACTOR OF ELECTRON-IRRADIATED INSULATORS.—H. Salow. (*Zeitschr. f. tech. phys.*, No. 1, Vol. 21, 1940, pp. 8–15.)

The rather scanty researches on this subject are first surveyed. Owing to the difficulties in the way of measuring the secondary-emission factor (s.e. factor s) itself, owing to the charging-up of the insulator surface, previous workers have limited themselves to determining the surface potentials. Such measurements, however, only specify the s.e. regions in which s is greater than unity or less than unity, and the point where $s = 1$. Such knowledge is insufficient; for many purposes it is of interest to know the complete course of the s.e. of an insulator. The present paper therefore describes, and analyses fully, a method devised by the writer for the measurement of such curves. Results on mica, quartz, and various kinds of glass are given.

The measurement of the s.e. factor requires the reliable determination of both primary-electron and secondary-electron currents. The latter is the difficult one to measure: it is necessary to provide a constant p.d. between the bombarded surface and the collector electrode. The writer accomplishes this by irradiating the whole insulating surface with a stream of low-velocity electrons (i_2 in Fig. 2) for which the s.e. factor is always less than unity: as a result, the surface takes up a uniform potential, that of the cathode of the low-velocity beam system, and a constant collector-voltage V_2, equal to the volt-velocity of the slow electrons, is set up between the screen S (the insulator in the form of a 15 mm diam. plate, silvered on the back) and the collector A (an 80 mm diam. curved surface). Then if another electron beam i_1, small in current strength compared with the first but of higher velocity so that, for it, the s.e. factor is greater than unity, is directed onto a central portion only of the screen S, the secondary electrons excited by it leave the insulator and reach the collector A. In this case, however, A receives both primary and secondary electrons in a steady flow, so that their currents cannot be separated: but if the high-velocity beam i_1 is modulated with a.c. or chopped d.c. (a frequency of 50 kc/s was used, of steep-sided wave form) a displacement current i_3 flows through the insulator and provides a measure of the s.e. factor of the surface. For it can be determined, after suitable amplification, by the oscillograph O, while the chopped current i_1 can also be measured on the same oscillograph by connecting the collector A, instead of S, to the amplifier input. The quantitative relation between these currents i_1 and i_3 and the s.e. factor of the insulating layer is found by a subsidiary experiment in which the insulator S is replaced by a metallic screen and the direct coupling to the amplifier is broken by a condenser with specially high insulation.

The measurements on mica, quartz, and glass (results on aluminium-oxide layers have so far been unsatisfactory, probably owing to the inhomogeneity and porosity of the layer) showed that the s.e. characteristics of such homogeneous insulating surfaces strongly resembled those of metals; their s.e. factors, however, reach considerably higher maximum values than those of pure metals. Pre-treatment and cleaning of the surface have an important influence on the magnitude of the s.e. factor and on the shape of its characteristic.

1882. THE HALLWACHS PHOTOELECTRIC EFFECT IN METALS AT HIGH TEMPERATURES.—R. Deaglio. (*La Ricerca Scient.*, Jan./Feb. 1940, Year 11, No. 1/2, p. 89.) Prompted by della Corte's paper, 1429 of April.

1883. A NOTE ON THE SCHOTTKY EFFECT [Tests on Triodes discriminate between Formulae of Schottky and Gill in Favour of Schottky].—E. L. E. Wheatcroft. (*Phil. Mag.*, Jan. 1940, Series 7, Vol. 29, No. 192, pp. 16–17.) For Gill's formula *see* 532 of 1938.

1884. THE CONTACT DIFFERENCE OF POTENTIAL BETWEEN BARIUM AND ZINC. THE EXTERNAL WORK FUNCTION OF ZINC [Measurements].—P. A. Anderson. (*Phys. Review*, 15th Jan. 1940, Series 2, Vol. 57, No. 2, pp. 122–127.)

1885. AN INVESTIGATION INTO THE GETTERING POWERS OF VARIOUS METALS FOR THE GASES HYDROGEN, OXYGEN, NITROGEN, CARBON DIOXIDE, AND AIR.—L. F. Ehrke & C. M. Slack. (*Journ. of Applied Phys.*, Feb. 1940, Vol. 11, No. 2, pp. 129–137.)

DIRECTIONAL WIRELESS

1886. RESEARCH ON WAVE GUIDES AND ELECTROMAGNETIC HORNS: REPORT I—ELECTROMAGNETIC WAVES RADIATED FROM THE OPEN END OF A WAVE GUIDE OF CIRCULAR SECTION [and Comparison of Circular & Square Sections: Elliptical Section for "Pencil-Point" Beam: Blind-Landing Considerations: etc.]: *and* REPORT II—FUNDAMENTAL THEORY OF WAVE GUIDES AND ELECTROMAGNETIC HORNS CONSTRUCTED BY POLAR COORDINATE SURFACES.—S. Sonada. (*Electrot. Journ.*, Tokyo, Feb. 1940, Vol. 4, No. 2, pp. 35–41: pp. 41–45.)

1887. H-WAVES PASSING THROUGH CIRCULARLY CURVED WAVE GUIDES, *and* [EH]-WAVES PASSING THROUGH CIRCULARLY CURVED WAVE GUIDES.—Sonada, Morimoto, & Ito. (*See* 1745.)

1888. THE DEVELOPMENT OF THE KLYSTRON MICRO-WAVE GENERATOR, AND ITS USE FOR BLIND LANDING.—A. R. Boone. (*Scient. American*, Jan. 1940, Vol. 162, No. 1, pp. 20–21.)

1889. Indianapolis Landing System [CAA System] selected as the "Standard."—(*Sci. News Letter*, 3rd Feb. 1940, Vol. 37, No. 5, p. 69.) *See* 161 of January. The CAA (Civil Aeronautics Authority) system uses waves from 2.6 to 4 m: the Committee also urged that the micro-wave MIT system (with horn radiators) should be perfected.

1890. The Impetus which Aviation has given to the Application of Ultra-High Frequencies [particularly the Reduction of Multiple Courses, given by Low-Frequency Radio Ranges (especially in Mountainous Regions), by Use of Ultra-Short Waves: the Pittsburgh 63 Mc/s Tests].—W. E. Jackson. (*Proc. Inst. Rad. Eng.*, Feb. 1940, Vol. 28, No. 2, pp. 49–51.)

1891. On Direction Finder [Experiments on Ultra-Short Waves of about 5 m: Plotting (with Small Dipole-Aerial Measuring Apparatus) the Field Intensities & Directions around Various Forms of Conductors carrying Oscillating Currents: the Characteristics of These Radiators when used as Direction Finders].—D. Nukiyama, M. Irisawa, & T. Kobayasi. (*Report of Aeronaut. Res. Inst.*, Tokyo University, May 1939, No. 176, Vol. 14: in Japanese.)

1892. The Radio "Absolute Altimeter" [Direct-Reading: 60 Frequency Variations per Second from 420 to 445 Mc/s & back].—Western Electric. (*QST*, Feb. 1940, Vol. 24, No. 2, p. 42.) *Cf.* 560, 561, 1489, & 2374 of 1939.

1893. On One Application of Radio-Interference Distance Meters [Mandelstam-Papalexi Method adapted to measuring Distance between One Fixed and One Moving Point—Ship moving at Constant Speed: Graphical Method of Calculation, and Special Instrument].—E. J. Schegolev. (*Journ. of Phys.* [of USSR], No. 5/6, Vol. 1, 1939, pp. 389–392: in English.) *See* also 1894, below.

1894. A Radio-Interference Method for Fixing the Position of Ships [Importance of Mandelstam-Papalexi Method in Hydrographic Surveying, particularly in Arctic Regions: Account of Tests: Precision 150–300 m, Distances up to 100 km].—S. A. Mescheriakov & D. N. Preobrajenski. (*Journ. of Phys.* [of USSR], No. 5/6, Vol. 1, 1939, pp. 393–396: in English.)

See 3176 of 1939. The "master" station was on board the survey ship, and (since two distances should be measured to give the position) two "reflecting" stations (re-transmitting the signals received from the ship, after a 2/3 frequency transformation and amplification) at two known points on the shore, were used one after the other. Each measurement took about 35–40 minutes. For allied papers *see* 1405 of April, and 1893, above.

1895. Radioelectricity in Aeronautics [Part I—For Communication: Part II—For Navigation: Survey].—M. Laveran. (*Rév. Gén. de l'Élec.*, 2nd/9th March 1940, Vol. 47, No. 9/10, pp. 147–161.) Based partly on Hecht's paper (3973 of 1939). Part II is to follow.

1896. An Aerodrome Speaks and Hears [Short Account of Wireless Equipments at Budapest Aerodrome at Budaörs].—(*Radio e Televisione*, Sept. 1939, Vol. 4, No. 2, pp. 97–101: in German.)

ACOUSTICS AND AUDIO-FREQUENCIES

1897. Telephony in Noisy Surroundings [Strong Winds, Aeroplane Cabins, Tanks, etc.] and Tests on Laryngophones.—A. Ferrari-Toniolo. (*Alta Frequenza*, Jan. 1940, Vol. 9, No. 1, pp. 4–24.)

The difficulties exist both in transmission (distortions due to the necessity of speaking very loudly, to the deformation of the field around the speaker's head, etc.) and in reception (deafening effect). The paper deals with the former problem, and begins by a discussion of the results of Janovsky and of Hartmann & Janovsky (563 of 1938 and 1489 of 1936). It then describes the various methods which have been tried in order to reduce these difficulties, beginning with the use of directional microphones (p. 11). The writer's experiments on a compensation method (Fig. 6), though not yet tried out, seem to indicate that the principle is good but that it can hardly be applied in conditions where large variations in the frequency and intensity of the noise occur.

Thus the solution seems to lie in a radical change at the transmitter, by the use of osteophones or laryngophones instead of mouth-operated microphones. The preliminary work of Krüger & Willms (1490 of 1936) on the relation between oral and laryngeal spectra is discussed (Fig. 7). Italian tests, including the results of numerous articulation measurements made by a special team of operators, on laryngophones of the carbon type, of Italian manufacture, are discussed (Fig. 9). The rest of the paper deals with the objective calibration of these new types of mechanico-electrical transformers, by a method represented diagrammatically in Fig. 10. The vibrations applied to the laryngophone are generated by the vibrating blade, excited by a beat-frequency oscillator, of an electro-mechanical variable-frequency filter (Fubini-Ghiron, 1929 of 1938); their amplitude is kept constant at all frequencies by a capacitive system, varying in accordance with the point at which the laryngophone is applied to the vibrating blade (in place of the second magnet and secondary winding used when the device is employed as a filter). The amplitude of the vibrations can be varied from a few microns up to about 50, and the frequency from about 100 c/s to 10 kc/s. The detecting apparatus used may be called a micro-capacity-meter (resembling a type of ultra-micrometer) whose circuit is seen in Fig. 11; it is a r.f. generator with frequency modulation (controlled by the capacity variations provided by the vibrating blade) and detector, and is by several orders of magnitude more sensitive than the optical method (using a mirror on the free end of the blade) which is employed to give an absolute calibration, at one particular frequency, of the characteristic curve obtained by the sensitive method.

Two of these response curves, for carbon-type laryngophones, are seen in Fig. 13; Fig. 4 shows those of a quartz-type instrument, for two values of vibration amplitude. The carbon-type instruments show regularity to within ± 15 db (from 200–4000 c/s), the piezoelectric type to within ± 10 db (from 70–8000 c/s). The latter type gave a mechanical-electrical factor (measured by the optical method) of 1.6 millivolt/micron at 1000 c/s.

1898. A Method for the Generation of Extremely Strong Standing Sound Waves in Air [for Testing & Calibration of Special Microphones for High Sound Intensities, Investigation of Non-Linear Distortion, of Behaviour of Particles in Strong Sound Fields, of Edge Effects at Rayleigh Disc, etc.].—H. Oberst. (*Akust. Zeitschr.*, Jan. 1940, Vol. 5, No. 1, pp. 27–38.)

1899. Microphone Characteristics [Table of Data of American Crystal, M.C., & Velocity Types].—(*Communications*, Feb. 1940, Vol. 20, No. 2, p. 22 and 24.)

1900. Lop-Sided Speech and Modulation: Voice-Wave Polarity and Its Effect on 'Phone Transmitter Operation.—Grammer. (*See* 1820.)

1901. Amplification of Power at Acoustic Frequencies [Theoretical Examination of Class A & Class B Amplification, with Special Attention to the Latter].—A. Pinciroli. (*Istituto Elettrot. Naz. Galileo Ferraris*, Reprint No. 64, 16 pp.)

1902. Feedback improves Electromechanical Recording [Type 1A Recorder with Small Negative-Feedback Pick-Up Coil rigidly attached to Frame carrying Cutting Stylus].—L. Vieth. (*Bell Lab. Record*, Feb. 1940, Vol. 18, No. 6, pp. 171–173.)

1903. Gramophone Recorder Characteristics [American Types].—(*Communications*, Feb. 1940, Vol. 20, No. 2, p. 26.)

1904. Getting the Best from Records: Part II—The Pick-Up: Part III—More about Tone-Correction Circuits.—Voigt. (*Wireless World*, March 1940, Vol. 46, No. 5, pp. 177–180: April, No. 6, pp. 210–213.) For Part I *see* 1050 of March.

1905. Aids to Hearing: Some Problems of Design: Methods of Testing, *and* Tone Control in Hearing Aids: Response to suit Individual Cases.—T. S. Littler. (*Wireless World*, March 1940, Vol. 46, No. 5, pp. 167–170: April, No. 6, pp. 205–206.)

For Sell's solid-dielectric condenser microphone (with only 60–90 volts polarising voltage) here mentioned in passing, *see* 1385 of 1937. For a letter on alternative l.t. supplies see *ibid.*, April, No. 6, p. 219.

1906. Remark on "Inductive Systems for the Deaf" [Application to recording Both Sides of Telephone Conversation].—D. W. Aldous: Sowter. (*Wireless World*, March 1940, Vol. 46, No. 5, p. 172.) Prompted by Sowter's article (1056 of March).

1907. Perspectives in the Development of the Violin [leading to Violin with Piezoelectric Pick-Up transmitting to Several "Loudspeaker" Violins in Parallel, each with Moving-Iron Exciter on Bridge].—R. Vermeulen. (*Philips Tech. Review*, Feb. 1940, Vol. 5, No. 2, pp. 36–41.) The question of the difference between the results and the effect produced by several different players is discussed.

1908. Investigations on Recorders [Blockflöten].—A. von Lüpke. (*Akust. Zeitschr.*, Jan. 1940, Vol. 5, No. 1, pp. 39–46.)

1909. Electronic Music [Tabulation and Description of Electronic Musical Instruments].—L. E. C. Hughes. (*Nature*, 3rd Feb. 1940, Vol. 145, pp. 170–174.)

1910. 1940 Sound [Survey of Prospects, based on 1939 Developments (Completely Electrified Orchestras, Each Instrument having Its Amplifier & Loudspeaker: "Talk-Back" Speakers: Electronic Musical Instruments: Window Displays: Schools & Churches: Roller-Skating Rinks: etc.)].—S. G. Taylor. (*Communications*, Feb. 1940, Vol. 20, No. 2, pp. 17–20 and 23, 27..32.)

1911. A Tuning-Fork maintained by Photocell.—Cambridge Instrument Company. (*Journ. of Scient. Instr.*, March 1940, Vol. 17, No. 3, p. 72.)

1912. The Recording of Small Pitch Fluctuations [Modification of the Writers' Tone-Pitch Recorder to deal with Fluctuations of Order of 1%].—M. Grützmacher & W. Lottermoser. (*Akust. Zeitschr.*, Jan. 1940, Vol. 5, No. 1, pp. 1–6.) *See* 4005 of 1938 and back reference.

1913. Exploring-Note Analysis with Mechanical Band Filter and a High Carrier Frequency.—G. Buchmann. (*Akust. Zeitschr.*, Jan. 1940, Vol. 5, No. 1, pp. 7–10.)

When a high carrier-frequency (20–40 kc/s) is used with Grützmacher's "exploring-note" method of analysis, as is often desirable because of the shorter building-up times thus obtained, an electrical filter is unsatisfactory and recourse is usually made to a quartz filter, to give a steep-sided curve with a reasonably wide pass band. The automatic analyser now described dispenses with such a filter and returns to the principle of loosely coupled electrical circuits, transforming these, however, by the appropriate electro-mechanical analogy into a mechanical device of rolled-iron masses and silver-steel springs, with moving-coil (Figs. 3 & 4) or magnetic (Figs. 5 & 6) excitation. Examples are given of the records of the spectra of a violin and of vacuum-cleaner noise.

1914. Wave Analyser [for Complex Waves of Amplitudes 300 μV to 300 V, in Frequency Range 20 to 15 000 c/s].—Marconi-Ekco. (*Journ. of Scient. Instr.*, March 1940, Vol. 17, No. 3, pp. 70–71.)

1915. To Combat Noise [Osbon Portable Noise Analyser, Burgwin Mirror-on-Roller & Photo-cell Device for Measuring Magnetisation Length-Changes, etc.].—(*Scient. American*, Jan. 1940, Vol. 162, No. 1, pp. 10–11.)

1916. On the Equivalent Circuit of the Spherical Sound-Source.—L. Cremer: Weber. (*Akust. Zeitschr.*, Jan. 1940, Vol. 5, No. 1, pp. 46–50.) Prompted by Weber's paper on explosive sparks and Flobert pistols (1072 of March).

1917. Experimental Investigation of a Quasi-Harmonic Vibrator.—Neusinger. (*See* 1781.)

1918. Sound Radiometer of Resonance Type [about 24 Times as Sensitive as Static Rayleigh Disc, and Other Advantages].—T. Hayashi. (*Electrot. Journ.*, Tokyo, Feb. 1940, Vol. 4, No. 2, pp. 32–35.) For previous work *see* 4533 of 1939.

1919. The Acoustic Absorption of Audiences, and the Acoustics of Rooms [Measurements in a Reverberant Studio, with an Audience of Ten, and in an Auditorium, with Audience of about Ninety: Comparison with Results of Other Workers: Coefficients of Absorption (per Person) for Various Frequencies, for Design Purposes].—A. Gigli. (*Alta Frequenza*, Feb. 1940, Vol. 9, No. 2, pp. 103–107.)

The coefficients (which rise from 0.20 at 125 c/s to 0.45 at 1000 c/s and then fall to about 0.30 at 4000 c/s) apply to rooms about three-quarters full.

1920. Acoustic Condition Factors [Consideration of Question whether the Audibility in a Room, for Given Positions of Sound Source and Hearer, can be defined by a Factor of Merit].—M. Rettinger. (*Akust. Zeitschr.*, Jan. 1940, Vol. 5, No. 1, p. 56.) Short summary of a *Journ. Soc. Mot. Pic. Eng.* paper.

1921. Sound [Free Propagation, Supersonics: Vibrating Systems, Solids & Fluids: Impedance, Properties of Materials: Subjective Aspects: Technology: Electrical Musical Instruments].—E. G. Richardson. (*Reports on Prog. in Physics*, Physical Society, Vol. 6, pub. 1940, pp. 238–269.)

1922. "Standards on Electroacoustics 1938" [Terminology, Symbols, Loudspeaker Testing: Book Review].—I. R. E. (*Communications*, Feb. 1940, Vol. 20, No. 2, p. 12.) A previous review was referred to in 3623 of 1939.

1923. "Einführung in die Akustik" *and* "Leitfaden zur Berechnung von Schallvorgängen" [Book Reviews].—F. Trendelenburg: H. Stenzel. (*Akust. Zeitschr.*, Jan. 1940, Vol. 5, No. 1, p. 53: pp. 53–54.)

1924. "Lebendige Sprache" [Experimental Phonetic Investigations, with Analyses of Speech of Prominent Englishmen & English Dialects: Book Review].—W. Horn & K. Ketterer. (*Akust. Zeitschr.*, Jan. 1940, Vol. 5, No. 1, p. 54.)

1925. The Velocity of Sound in Air at Temperatures below 0° C.—A. E. Bate. (*Journ. of Scient. Instr.*, March 1940, Vol. 17, No. 3, pp. 68–69.)

1926. A New Application of Echo-Sounding [by Magnetostriction Recording Machine: Information regarding Kind of Bottom of Lake and Depth of Soft Deposits].—C. H. Mortimer & E. B. Worthington. (*Nature*, 10th Feb. 1940, Vol. 145, pp. 212–214.)

1927. Inertia of Régimes in Oscillating Fluids [including the Change of Acoustic Velocities by Obstacles].—Z. Carrière. (*Journ. de Phys. et le Radium*, Feb. 1940, Series 8, Vol. 1, No. 2, pp. 68–73.)

1928. The Absorption of Ultrasonic Waves in Air and in Monatomic Gases [Non-Uniformity of Field is Only Essential Factor causing Deviation from Theoretical Values], *and* The Absorption of Ultrasonic Waves by Electrolytes.—E. J. Pumper: P. A. Bazulin. (*Journ. of Phys.* [of USSR], No. 5/6, Vol. 1, 1939, pp. 411–430: pp. 431–437: both in English.)

1929. Remarks on the Calculation of Molecule Radius from Molecular Volumes and Velocity of Sound.—W. Schaaffs. (*Zeitschr. f. Physik*, No. 1/2, Vol. 115, pp. 69–76.)

1930. A Constant-Path Acoustic Interferometer [without Moving Parts] for Gases at Variable Pressure.—C. M. Herget. (*Review of Scient. Instr.*, Jan. 1940, Vol. 11, No. 1, pp. 37–39.)

1931. On the Distribution of the Intensity of Molecular Diffusion of Light in a Crystal Unequally Heated, *and* Diffusion of Light in a Crystal Unequally Heated [Yielding the Lower Limit of the Damping Coefficient of Supersonic Waves of Frequency around 2×10^{10} c/s].—M. Leontovitsch: Gr. Landsberg & A. Choubine. (*Journ. of Phys.* (of USSR), No. 5/6, Vol. 1, 1939, pp. 397–402: pp. 403–409: both in French.)

1932. Relations between Elastic Properties of Solids [Theory].—H. Ludloff. (*Phys. Review*, 1st Jan. 1940, Series 2, Vol. 57, No. 1, p. 66: abstract only.) For previous work *see* 2840 of 1939.

1933. "Grundlagen und Ergebnisse der Ultraschallforschung" [Supersonic-Wave Research: Book Review].—E. Hiedemann. (*Akust. Zeitschr.*, Jan. 1940, Vol. 5, No. 1, p. 52.)

PHOTOTELEGRAPHY AND TELEVISION

1934. Trapezium Distortion in Cathode-Ray Tubes [with Electrostatic Deflection: Not Due to Interaction between Fields of the Two Pairs of Plates (Experiment with One Pair only, combined with Magnetic Deflection): Lens Effect of Plates as True Cause: Elimination by Curvature of Plates, or by Shaping Plates and Use of Earthed Screen].—B. C. Fleming-Williams. (*Wireless Engineer*, Feb. 1940, Vol. 17, No. 197, pp. 61–64.)

1935. On Interlaced Scanning and the Frequency Band necessary for Television.—O. B. Lurje. (*Izvestiya Elektroprom. Slab. Toka*, No. 10, 1939, pp. 39–45.)

It is pointed out that there is no definite agreement in television practice as to the band width necessary for high quality transmission, and in fact two entirely different formulae are used, namely $f_{\max} = Nn/2$ and $f_{\max} = 0.64\, Nn/2$, where N is the number of frames per second and n the number of elements per frame. In the present paper it is suggested that the permissible blurring of the boundaries of the transmitted images in the direction perpendicular to the direction of scanning should be used as a criterion in determining the required highest frequency. Both progressive and alternate-line scanning are discussed from this point of view, and a comparison is made between the two methods. It is shown that the first formula applies only to progressive scanning and the second should be used for alternate-line scanning.

1936. A Projection Kaleidoscope [to give a "Visual Curtain" for Television Programmes].—W. C. Eddy. (*Communications*, Feb. 1940, Vol. 20, No. 2, p. 37.)

1937. The Coronaviser.—Skellett. (*See* 1756.)

1938. The Electron Micro-Oscillograph [Particularly Useful for Investigation of Television Transmission Systems, Transient Phenomena in H.F. Cables, etc.].—von Ardenne. (*See* 1976.)

1939. Scophony Pulse Generator [Type OA.134: for Synchronisation of Television Transmitters & Receivers: for Video Signal in Form of Lattice Pattern: for Sound Carrier modulated at 400 c/s].—(*Journ. Television Soc.*, No. 3, Vol. 3, 1940, pp. 80–81.)

1940. The Application of Feedback to Wide-Band Output Amplifiers [for Cathode-Ray Oscillographs, Television Transmitters, etc: Mathematical Analysis covering both Low- and High-Frequency Regions, applicable to Design Problems].—F. A. Everest & H. R. Johnston. (*Proc. Inst. Rad. Eng.*, Feb. 1940, Vol. 28, No. 2, pp. 71–67.)

1941. A Deflection and Video Chassis for Television Reception [Three-Inch Screen: Sweep Circuits use One Double-Triode each].—H. C. Lawrence, Jr. (*QST*, Feb. 1940, Vol. 24, No. 2, pp. 29–31.)

1942. Motor-Car Interference and the Murphy Noise Limiting Circuit [in 1940 Murphy Television Receivers: Noise-Suppression Diode (in Same Envelope as Second-Detector Diode), with Delay Network causing Signal to arrive at Cathode a Few Microseconds Later than at Anode].—(*Journ. Television Soc.*, No. 3, Vol. 3, 1940, pp. 74–76.)

1943. Television Receiver TV1 of the Firm Allocchio, Bacchini, & Company.—(*Alta Frequenza*, Feb. 1940, Vol. 9, No. 2, pp. 123–127.)

1944. An Introduction to Television Production [at W6XAO, Los Angeles].—H. R. Lubke. (*Radio e Televisione*, Sept. 1939, Vol. 4, No. 2, pp. 82–90: in English.)

1945. Television Economics: Part XIII—Conclusion [Theatre Television].—A. N. Goldsmith. (*Communications*, Feb. 1940, Vol. 20, No. 2, pp. 13–14 and 46 . . 48.) This series began in the issue for Feb. 1939 (Vol. 19, No. 2): an idea of its scope may be gathered from 2844 of 1939.

1946. Television Reception and Television Receiving Valves.—(*See* 1874.)

1947. Television Receiving Antennas and Transmission Lines.—Barber. (*See* 1854.)

1948. The Behaviour of Willemite under Electron Bombardment.—E. R. Piore & G. A. Morton. (*Journ. of Applied Phys.*, Feb. 1940, Vol. 11, No. 2, pp. 153–157.)

Authors' summary:—Under scanning conditions in a specially designed tube, it was found that a willemite screen not only deviates from the potential of the accelerating electrode, but also shows potential variations on the surface. These potential variations are functions of scanning frequency and current density and may become of the order of several thousand volts. Light measurements were also taken. The dependence of the light intensity on voltage can be represented by a power law.

1949. Optical Shutter formed by Heated Rouge in Suspension, oriented by Magnetic Field.—C. W. Heaps. (*Sci. News Letter*, 13th Jan. 1940, Vol. 37, No. 2, p. 28.)

1950. On the Nature of the Anomalous Physical [Light-Absorption] Properties of Thin Silver Films.—Ashtcheulov. (*Comptes Rendus* (*Doklady*) *de l'Ac. des Sci. de l'URSS*, No. 2, Vol. 24, 1939, pp. 122–125: in English.)

1951. The Optical Properties of Semitransparent Sputtered Films determined by Interference of Light.—J. B. Nathanson & C. L. Bartberger. (*Journ. Opt. Soc. Am.*, Feb. 1940, Vol. 30, No. 2, p. 92: summary only.)

1952. The Hallwachs Photoelectric Effect in Metals at High Temperatures.—R. Deaglio. (*La Ricerca Scient.*, Jan./Feb. 1940, Year 11, No. 1/2, p. 89.) Prompted by della Corte's paper, 1429 of April.

1953. Effect of the Quadrature Component in Single-Sideband Transmission [particularly in Picture Telegraphy].—Nyquist & Pfleger. (*See* 2069.)

1954. Facsimile Transmission [Notes on Recent American Developments].—G. Herrick. (*Nature*, 10th Feb. 1940, Vol. 145, p. 233: abstract of paper in *Electrical Review*, 19th Jan. 1940.)

MEASUREMENTS AND STANDARDS

1955. Measurements with Ultra-Short [and Micro-] Electric Waves on Wires [including Soil Measurements, Ferromagnetism, Absorption & Dispersion in Liquids, Impedance Measurements, Generators, and Detectors].—L. Hartshorn. (*Reports on Prog. in Physics*, Physical Society, Vol. 6, pub. 1940, pp. 378–388.)

1956. Radio-Frequency High-Voltage Phenomena.—Alford & Pickles. (*See* 2021.)

1957. Contribution to the Theory of Inductive Heating [*e.g.* in Induction Furnace].—M. Divilkovsky. (*Journ. of Tech. Phys.* [in Russian], No. 14, Vol. 9, 1939, pp. 1302–1314.) *See* 1958, below.

1958. The Problem of a Metallic Sphere in a Homogeneous Alternating Magnetic Field and Its Application to the Theory of Induction Furnaces [also to Extension of Induction-Balance Method to High Frequencies: etc.].—M. Divilkovsky. (*Journ. of Phys.* [of USSR), No. 5/6, Vol. 1, 1939, pp. 471–478: in French.) An abbreviated combination of the two Russian papers dealt with in 727 of February and 1957, above.

1959. Dielectric Losses in High-Frequency Fields, and Debye's Theory [Comparison of Debye's Old & New Theories: New Method of measuring Dielectric Constants & Conductivities of Liquid Dielectrics, using Ellipsoidal-Bulb Thermometer: etc.].—M. I. Filippov. (*Journ. of Phys.* [of USSR], No. 5/6, Vol. 1, 1939, pp. 479–506: in English.) By comparing simultaneous results with the ellipsoidal-bulb thermometer and one with a spherical bulb (*see* 1958, above, and back reference), ϵ' and ϵ'' can be measured without measuring the strength of the field.

1960. Absolute Method of Measurement of the Dielectric Constant and Losses in Liquids, for Decimetric Waves [by Use of Spherical-Bulb Thermometer only, Field Intensity of Stationary Wave being determined by Calibrated Mercury-Filled Thermometer: Necessary Corrections].—M. Divilkovsky. (*Comptes Rendus* (*Doklady*) *de l'Ac. des Sci. de l'URSS*, No. 5, Vol. 24, 1939, pp. 433–436: in French.) *See* also 1958 & 1959.

1961. The Use of Electrets in Electrical Instruments [Full Intensity of Electret lasts at least Four Years: Field Intensity near Surface: Application to Suspended-Disc, String, Pendulum, & Vibration Electrometers: Advantage for Radio Sondes: etc.].—A. Gemant. (*Review of Scient. Instr.*, Feb. 1940, Vol. 11, No. 2, pp. 65–71.) For the writer's previous work *see* 831 of 1936. For other work *see* 1287 of March.

1962. Instruments and Methods of Measuring Radio Noise.—Aggers, Foster, & Young. (*See* 1832.)

1963. A Tuning-Fork maintained by Photocell.—Cambridge Instrument Company. (*Journ. of Scient. Instr.*, March 1940, Vol. 17, No. 3, p. 72.)

1964. A New Time Standard [free from Some Objectionable Features of the Usual Very Accurate Arrangements: Hung Vertical Wire or Strip (tensioned by Weight) vibrating in Single Loop with Nodes at Both Ends: Valve Drive acting on Small Bar Magnet fixed to Middle Point].—H. E. Warren. (*Elec. Engineering*, March 1940, Vol. 59, No. 3, Transactions pp. 137–141.)

1965. Low Temperature-Coefficient Quartz Crystal.—Mason. (*See* 1819.)

1966. The Measurement of Capacitance.—N. F. Astbury. (*Reports on Prog. in Physics*, Physical Society, Vol. 6, pub. 1940, pp. 403–410.)

1967. A New Type of High-Frequency Bridge [for Measurement of Dielectric Losses: Variable Resistance (with Its Defects) eliminated: Some Results].—B. Itigo. (*Electrot. Journ.*, Tokyo, Feb. 1940, Vol. 4, No. 2, p. 48.) *See* 4618 of 1939 for this bridge.

1968. A Brief Summary of Bridge Networks [with Selected Bibliography of 71 Items].—W. J. Seeley. (*Elec. Engineering*, March 1940, Vol. 59, No. 3, pp. 108–113.)

1969. Influence of Temperature on the Errors of the Added Resistance in Wattmeters [Tests on Conductance & Characteristic Angle of Various Types of Resistance].—M. de Marco. (*L'Elettrotecnica*, 10th Dec. 1939, Vol. 26, No. 23, pp. 728–732.) Using Neri's "magnetic differentiation" method, specially suitable for the measurement of small characteristic angles, dealt with in 2697 (*see* also 4238) of 1937.

1970. The Electrometer Triode and Its Applications [Philips Type 4060: Grid Current around 10^{-15} Ampere (6000 Electrons per Second): Use for p_H Measurements, Photocurrents down to $10^{-13} - 10^{-14}$ A, etc.].—H. van Suchtelen. (*Philips Tech. Review*, Feb. 1940, Vol. 5, No. 2, pp. 54–59.) *See* also Thaes, 601 of February.

1971. Contribution to the Measurement of Currents with Distorted Wave Forms [Multi-Wave Currents] by means of Rectifier Meters [Influence of Distorting Components is Very Small, especially when Frequencies bear Fractional Ratio: the Usefulness of Rectifier Meters for Harmonic Analysis].—W. Grunert & E. Hueter. (*E.T.Z.*, 4th Jan. 1940, Vol. 61, No. 1, pp. 11–12.)

1972. Probe Valve Voltmeter: Suggested Correction.—J. Harris: Andrews & Lowe. (*Wireless World*, March 1940, Vol. 46, No. 5, p. 171.) *See* 1140 of March. For component values omitted see *ibid.*, April, No. 6, p. 219.

1973. Generating Voltmeter for Pressure-Insulated High-Voltage Sources.—Trump & others. (*Review of Scient. Instr.*, Feb. 1940, Vol. 11, No. 2, pp. 54–56.)

1974. On the Geometry of the Optical Indicator [involving the Optical Lever formed by Mirror & Reflected Ray].—de Juhasz. (*Zeitschr. f. Instrumentenkunde*, Jan. 1940, Vol. 60, No. 1, pp. 1–10.)

1975. An Equipment for Testing the Cases of Measuring Instruments against Dust and Rain.—Razumovski & others. (*Izvestiya Elektroprom. Slab. Toka*, No. 10, 1939, pp. 55–56.)

SUBSIDIARY APPARATUS AND MATERIALS

1976. The Electron Micro-Oscillograph.—M. von Ardenne. (*Hochf:tech. u. Elek:akus.*, Dec. 1939, Vol. 54, No. 6, pp. 181–188.)

It is claimed for this new oscillograph construction that "the resolving power attainable by moving-film time-deflection is increased by more than two orders of magnitude and, for the same oscillogram content, the amount of photographic material used can be decreased by two to four orders of magnitude." The principle (§ I) is that "oscillograms of microscopic dimensions are recorded on photographic material with high resolving power by means of an extremely fine recording spot, and subsequently analysed with the help of a measuring microscope and measuring bench." The diameter of the spot is made equal to the resolving power of photographic fine-grain films for electron beams. The extremely fine electron probes used have already been described (1667 of 1939 and 280 of January). Multiple recording can be used with the micro-oscillograph by applying a row of electron-optical reducing devices to a common electron source (Fig. 1). The theoretical foundations of the device are described in § II; Fig. 2 illustrates the path of the electron beam, the relation for spot deflection, and the equation for the current density in the recording spot, Fig. 3 the limits of the spot diameter imposed by the aperture error of the optical reducing device, Fig. 4 the true and the reduced recording velocity, which is found to have the same magnitude for all spot diameters. Different methods of recording are shown in Fig. 5.

The practical development is described in § III; Fig. 6 shows the section of a two-ray micro-oscillograph, Figs. 7–12 give photographs of various parts. Results and typical micro-oscillograms are given in § IV; Fig. 13 shows the magnified oscillogram of a modulated 10^6 c/s oscillation, Fig. 14 that of a very slowly decreasing 10^5 c/s oscillation, Fig. 15 the dimensions of the registration film with the original magnitudes of the illustrative sample records shown in the paper, Fig. 16 a micro-oscillogram of speech, Fig. 17 a small section from a double oscillogram. It is suggested that the new instrument may prove particularly useful in the investigation of h.f. phenomena occurring only once, and in particular for the investigation of television transmission systems, and problems such as the measurement of transient phenomena in h.f. cables.

1977. Micro-Wave Oscillography.—H. E. Hollmann. (*Hochf:tech. u. Elek:akus.*, Dec. 1939, Vol. 54, No. 6, pp. 188–190.)

The "transit-time effect of the second kind" in a cathode-ray tube shows in a phase displacement between the deflections in the two coordinate directions, if the two sets of deflecting plates are displaced from one another. This may be applied to micro-wave or transit-time oscillography with ultradynamic Lissajous' figures (544 of February) from which, by a simple graphical method, the time oscillogram of the imposed u.h.f. measuring voltage may be deduced. The micro-wave oscillograph here described (scheme Fig. 1, photographs Figs. 2, 3) combines the electron probe developed by von Ardenne and used in his micro-oscillograph (*see* 1976, above) with a system of deflecting electrodes of very small dimensions. Transit-time figures are obtained on a tiny oscillograph screen (about 1 mm^2); these are observed and photographed through a microscope. Some figures from the lower decimetric-wave band are shown (Fig. 4).

1978. A NEW DOUBLE CATHODE-RAY OSCILLOGRAPH [with Independent Electron Guns: Adoption of Square Cross-Section for Tube: Water-Cooled Anodes: Transportable Equipment].—Berger. (*Bull. Assoc. suisse des Élec.*, No. 5, Vol. 31, 1940, pp. 113–119: in German.)

1979. A HIGH-FREQUENCY ELECTRON COMMUTATOR FOR DOUBLE AND QUADRUPLE CATHODE-RAY-OSCILLOGRAPH OBSERVATION OF PERIODIC AND APERIODIC PROCESSES [applicable also to Remote Control].—Ladygin & Denisov. (*Izvestiya Elektroprom. Slab. Toka*, No. 11, 1939, pp. 46–52.)

Continuing the work dealt with in 3799 & 3845 of 1937, circuits have now been developed for the alternate connection of two or four channels to the deflecting system of a cathode-ray oscillograph. Thus two or four oscillograms can be observed simultaneously, and the circuits are suitable for studying periodic as well as aperiodic processes. The circuits are described and their operation is discussed. It is suggested that circuits of this type could be used for remote control by radio (of boats, aeroplanes, etc.), and suitable transmitting and receiving circuits (Fig. 13 and 14) are proposed.

1980. TRAPEZIUM DISTORTION IN CATHODE-RAY TUBES.—Fleming-Williams. (*See* 1934.)

1981. INFLUENCE OF MAGNETIC FIELD UPON ELECTRON MOTION IN AXIALLY SYMMETRICAL FIELDS.—Spiwak & Zrebny. (*See* 1867.)

1982. A MECHANICAL ANALOGY TO THE MOTION OF ELECTRONS IN GASES.—Yarnold. (*See* 1759.)

1983. GAUSSIAN DIOPTRICS OF THE ELECTRICAL-MAGNETIC CYLINDER LENS [Theory].—Gratsiatos. (*Zeitschr. f. Physik*, No. 1/2, Vol. 115, 1940, pp. 61–68.)

"A two-dimensional field distribution symmetrical with respect to a plane is assumed. The equations of electron beams in the neighbourhood of the symmetry plane of the field, slightly inclined to the axis of symmetry of the field, are derived, and the laws of the image produced by these beams deduced."

1984. "EINFÜHRUNG IN DIE THEORIE DER ELEKTRONENOPTIK" [Book Review].—Picht. (*Zeitschr. f. tech. Phys.*, No. 1, Vol. 21, 1940, p. 22.)

1985. MAGNETIC LENSES AND FIELDS [including the Telefunken Exploring-Coil Apparatus for Plotting the Fields].—(*Radio e Televisione*, Sept. 1939, Vol. 4, No. 2, pp. 91–96: in Italian.)

1986. THE ELECTROLYTIC METHOD OF STUDYING ELECTROSTATIC FIELDS.—Lukoshkov. (*See* 1880.)

1987. THE PRESENTATION OF DECAYING OSCILLATIONS AS STATIONARY IMAGES ON THE CATHODE-RAY TUBE [for Visual Observation or Simple Photographic Recording].—Czech. (*See* 1803.)

1988. IMPROVEMENTS IN THE TIME-SWEEP OF CATHODE-RAY TUBES BY MEANS OF CURRENT FROM THE SUPPLY MAINS.—Batlouni. (*Rev. Gén. de l'Élec.*, 17th/24th Feb. 1940, Vol. 47, No. 7/8, pp. 125–131.)

The ordinary way of obtaining the horizontal deflection for an oscilloscope from the mains, though often convenient, has the objections of lack of linearity, limited range of frequencies which can be examined conveniently, retracing of the oscillogram (thus diminishing its sharpness), and the impossibility of synchronisation with the wave under investigation. The writer examines each of these defects in succession, suggesting ways in which they can be overcome. Thus by increasing the sweep-voltage amplitude till the two ends of the oscillogram are driven well off the screen (the limit of this scale-spreading being set by the consequent diminution of the spot brightness) it is possible to deal satisfactorily with frequencies up to and over 10 kc/s with a sweep frequency of only 50 c/s.

A long section is devoted to the elimination of the retracing of the oscillogram. One method is to drive the spot off the screen, on its return journey, by a voltage of suitable form (Fig. 24) applied to one of the vertical-deflection plates (Figs. 23 & 25): by combining this plan with the scale-spreading mentioned above, the trace of the spot at its exit and re-entry is out of sight (Fig. 25 *bis*). More attention, however, is given to the method of cutting-off the spot on the return journey: Fig. 7 gives a simple way of doing this, by a cutting-off voltage, in quadrature to the sweep voltage, rendering the control electrode negative during a half-period. A sinusoidal form for this voltage leads to trouble (Fig. 10); it should have the form shown in Fig. 11, and a circuit to yield this is shown in Fig. 12.

It is undesirable to displace the phase of this non-sinusoidal cutting-off voltage, since the various harmonics would behave differently and the waveform would alter; it is therefore better to displace, by 90°, the phase of the sinusoidal sweep voltage itself, and two circuits based on this plan are shown in Figs. 13 & 16, of which the latter is the better. It does not, however, give a symmetrical sweep, and trapezium distortion therefore occurs: consequently the lower half of the diagram of Fig. 16 should be modified as in Fig. 20, which leads to a symmetrical sweep. Fig. 26 shows a complete diagram of such an equipment: the d.c. supply voltages for tube, time-base, and spot cut-off are all obtained from a single double-anode rectifier and a single h.t. winding.

Of the difficulties enumerated at the beginning of this abstract, the first (lack of linearity) comprises two defects—a crowding-up and an increased brightness of the oscillogram at its two ends.

These defects have been dealt with already by the devices for removing the other troubles, but the final difficulty (the impossibility of synchronising the sweep and the wave under examination) remains, and is discussed in the final section. No radical cure is suggested, but it is pointed out that for most investigations it is possible to select the frequency of the wave under examination so that it is a multiple of the sweep frequency. For example, in the investigation of the non-linear distortion of amplifiers a number of test frequencies in the audio-spectrum can be selected thus, and if they are produced by a beat-frequency oscillator it is quite easy to keep the oscillogram steady on the screen by manipulating the knob of this oscillator.

1989. METALLURGICAL INVESTIGATIONS WITH THE ELECTROSTATIC SUPER-MICROSCOPE.—Mahl. (*See* 2102.)

1990. A DEVICE FOR THE BORING OF EXTREMELY FINE HOLES IN METALLIC FOILS [by Steel Needle: Holes of 5–20μ Diameter (and probably Smaller) for Electron Microscopes, etc.].—von Ardenne & Reibedanz. (*Zeitschr. f. Instrumentenkunde*, Jan. 1940, Vol. 60, No. 1, pp. 22–26.) For the ionic-probe method *see* 1567 of April.

1991. ON THE SECONDARY-EMISSION FACTOR OF ELECTRON-IRRADIATED INSULATORS.—Salow. (*See* 1881.)

1992. THE BEHAVIOUR OF WILLEMITE UNDER ELECTRON BOMBARDMENT.—Piore & Morton. (*See* 1948.)

1993. ABSORPTION SPECTRUM OF SINGLE-CRYSTAL ZnS PHOSPHORS [Data].—Brasefield. (*Phys. Review*, 15th Jan. 1940, Series 2, Vol. 57, No. 2, p. 162.)

1994. INFRA-RED RADIATIONS, WITH SPECIAL REFERENCE TO THEIR QUENCHING EFFECTS UPON ZINC-SULPHIDE PHOSPHORS: I AND II [including Temperature Effects and Use of "Frozen-In" Phosphorographs in Investigation of Properties of Phosphors].—Blake. (*Journ. & Proc. of Roy. Soc. of New South Wales*, Parts 2 & 3, Vol. 73, 1939, pp. 112–124 and Plates & 190–205.)

1995. ON THE DECAY OF ALKALI-HALOID PHOSPHORS ACTIVATED BY THALLIUM.—Antonov-Romanovsky & Kochergin. (*Comptes Rendus (Doklady) de l'Ac. des Sci. de l'URSS*, No. 5, Vol. 24, 1939, pp. 430–432: in English.)

Experiments leading to the conclusion that when the decay curve is hyperbolic the process of "luminescence power exhaustion" takes place almost certainly according to a bimolecular reaction (contrary to recent ideas), and that even an exponential decay does not prove a monomolecular process.

1996. THE LUMINESCENCE OF SOLIDS.—Randall & Wilkins. (*Reports on Prog. in Physics*, Physical Society, Vol. 6, pub. 1940, pp. 174–185.)

1997. SPECTROPHOTOMETRIC RESEARCHES ON ELECTRO-PHOTOLUMINESCENCE [produced by Intense Electrical Fields].—Destriau & Loudette. (*Journ. de Phys. et le Radium*, Feb. 1940, Series 8, Vol. 1, No. 2, pp. 51–55.) For previous work *see* 2500 of 1939.

1998. AN INVESTIGATION INTO THE GETTERING POWERS OF VARIOUS METALS FOR THE GASES HYDROGEN, OXYGEN, NITROGEN, CARBON DIOXIDE, AND AIR.—Ehrke & Slack. (*Journ. of Applied Phys.*, Feb. 1940, Vol. 11, No. 2, pp. 129–137.)

1999. AN ION SOURCE OF THE LOW-VOLTAGE CAPILLARY-ARC TYPE.—Allison. (*Phys. Review*, 1st Jan. 1940, Series 2, Vol. 57, No. 1, p. 71: abstract only.)

2000. THE CYCLOTRON AND SOME OF ITS APPLICATIONS.—Mann. (*Reports on Prog. in Physics*, Physical Society, Vol. 6, pub. 1940, pp. 125–136: with 56 literature references.)

2001. "THE CYCLOTRON" [Book Review].—Mann. (*Wireless Engineer*, March 1940, Vol. 17, No. 198, p. 111.)

2002. HALL EFFECT IN PLASMA.—Rodin & Spiwak. (*Comptes Rendus (Doklady) de l'Ac. des Sci. de l'URSS*, No. 3, Vol. 24, 1939, pp. 247–249: in English.)

2003. EXPERIMENTAL RESEARCH ON RE-STRIKING PHENOMENA OF ARCS [and Conclusions regarding Breakdown by Ionisation by Collision and Thermal Ionisation: etc.].—Horikosi. (*Electrot. Journ.*, Tokyo, Dec. 1939, Vol. 3, No. 12, pp. 283–286.)

2004. THE TRANSITION FROM GLOW TO ARC DISCHARGE [Cathode-Ray Oscillograms of Initial Stages for Copper Electrodes in Air: Direct Evidence of Intermittent Voltage Collapse: Possible Transition Theories].—Wheatcroft & Barker. (*Phil. Mag.*, Jan. 1940, Series 7, Vol. 29, No. 192, pp. 1–15.)

2005. SOME EXPERIMENTS ON THE THEORY OF THE GLOW DISCHARGE.—Weizel & Olmesdahl. (*Zeitschr. f. Physik*, No. 11/12, Vol. 114, 1939, pp. 719–733.) For theory *see* 311 of January and back references.

2006. SUPER-TEMPERATURES IN THE GLOW DISCHARGE [Measurements for Plane and Hollow Cathodes in Various Gases at Various Pressures].—Fischer. (*Zeitschr. f. Physik*, No. 5/6, Vol. 113, 1939, pp. 360–366.)

2007. Electrical Discharge between a Stationary and a Rotating Electrode [in Dry Air: with Rotating Electrode as Cathode, Luminous Column is carried round Periphery of Rotor].—Beams & Snoddy. (*Phys. Review*, 1st March 1939, Series 2, Vol. 55, No. 5, p. 504.)

2008. The Effects of Irradiation, Humidity, and Sphere Material on the Sparkover Voltage of the Two-Centimetre Sphere Gap.—Lewis. (*Journ. of Applied Phys.*, Aug. 1939, Vol. 10, No. 8, pp. 573–577.)

2009. Spark Breakdowns of Hitherto Unobserved Form [Photographs: Comparison with Toepler's "Stielbuscheln"].—Neubert. (*Zeitschr. f. Physik*, No. 11/12, Vol. 114, 1939, pp. 705–708.)

2010. The Spark by Field Emission [Discharge Period may assume Constant Values around 10^{-8} Second: Kerr-Cell Methods of measuring Periods and Impulsive Potentials].—De Stefano & Ferretti. (*Boll. del Centro Volpi di Elett.*, English Edition, April/May/June 1939, Year 2, No. 2, Abstracts p. 223d.)

2011. Contribution to the Experimental Study of the "Power of Points" [Phenomena of Point Discharge, as function of Magnitude and Nature of Potential, Nature of Medium, Temperature & Humidity].—Yadoff. (*Rev. Gén. de l'Élec.*, 12th Aug. 1939, Vol. 46, No. 6, pp. 179–188.)

2012. Surface-Controlled Mercury-Pool Rectifier [New Type of Large-Current Rectifier for Voltages from 3 to 105 Kilovolts: Shielding Action greatly increases Voltage for Back-Fire and permits Use of Greater Vapour Pressure].—Libby. (*Proc. Inst. Rad. Eng.*, Feb. 1940, Vol. 28, No. 2, pp. 52–59.)

2013. Frequency-Changing with Mercury-Arc Mutators [Conversion from Three-Phase 50 c/s to Single-Phase 16⅔ c/s].—Feinberg. (*Journ. I.E.E.*, Oct. 1939, Vol. 85, No. 514, pp. 531–543.)

2014. Selenium Rectifiers of Soviet Manufacture.—Eristov. (*Izvestiya Elektroprom. Slab. Toka*, No. 10, 1939, pp. 59–63.)

2015. Three-Electrode Crystals with Barrier Layers [Short Survey].—Makovski. (*See* 1845.)

2016. The Irreversible Changes of the Electrical Resistance and Power of Light Reflection of Films of Antimony, Arsenic, Tellurium, Iron, and Silver, Condensed at Low Temperatures.—Suhrmann & Berndt. (*Zeitschr. f. Physik*, No. 1/2, Vol. 115, 1940, pp. 17–46.)

2017. The Preparation of Thin Films of Uranium and Thorium by Cathode Sputtering.—Van Voorhis. (*Review of Scient. Instr.*, Feb. 1940, Vol. 11, No. 2, pp. 77.)

2018. Constant-Potential Rectification [New Circuit].—Stevens & Walker. (*See* 1796.)

2019. The Direct-Acting Generator-Voltage Regulator.—Boice & others. (*Elec. Engineering*, March 1940, Vol. 59, No. 3, Transactions pp. 149–157.)

2020. On the Working of Voltaic Apparatus [Primary Cells & Accumulators: New Treatment, leading to Possibility of Pre-Calculation of Useful E.M.F. as Exactly as for Electro-Magnetic Generators: the Harmful Effects of Secondary Reactions].—Reiffer. (*Rev. Gén. de l'Élec.*, 3rd/10th Feb. 1940, Vol. 47, No. 5/6, pp. 101–105.)

2021. Radio-Frequency High-Voltage Phenomena.—Alford & Pickles. (*Elec. Engineering*, March 1940, Vol. 59, No. 3, Transactions pp. 129–137.)

With appendices and Discussion: *see* also 1130 of March. In their reply to the Discussion the writers mention a recent extension to still higher frequencies, up to 110 Mc/s. Here, "the best grades of glass and ceramics are no longer excellent insulators, in that there is a much greater tendency for the insulating material to heat. For this reason, metal fittings play a somewhat smaller part . . ."

2022. Dielectric Losses in High-Frequency Fields, and Debye's Old & New Theories. —Filippov. (*See* 1959.)

2023. The Molecular Nature of a Dielectric [Dielectric Constant & Its Molecular Interpretation: Polar Molecules & the Effect of Their Presence: Dielectric Loss in Polar Solids: etc.].—Moullin. (*Journ. I.E.E.*, Feb. 1940, Vol. 86, No. 518, pp. 113–128.) Chairman's address, Wireless Section.

2024. Dielectric Breakdown in Solids.—Fröhlich. (*Reports on Prog. in Physics*, Physical Society, Vol. 6, pub. 1940, pp. 411–430.)

2025. Edge Effect of Electrodes in the Breakdown of Solid Dielectrics [immersed in Insulating Liquids: Experiments on Prevention of Corona by Application of Suitable Varnish or Paste].—Toriyama & Sawa. (*Electrot. Journ.*, Tokyo, Feb. 1940, Vol. 4, No. 2, pp. 27–28.)

2026. Characteristic Data on Ceramic Materials at High Frequencies [Hescho and Stemag Products].—(*Alta Frequenza*, Jan. 1940, Vol. 9, No. 1, pp. 55–58.) Table taken from Albers-Schoenberg's book "Hochfrequenzkeramik." For a review of this book *see* 4701 of 1939.

2027. FLEXIBLE GLASS INSULATION [for Wireless Work].—Lee. (*Wireless Engineer*, Jan. 1940, Vol. 17, No. 196, p. 3.) Note on the paper referred to in 823 of February.

2028. AN EXPERIMENTAL INVESTIGATION OF AUSTRALIAN DIELECTRICS [Bakelised-Paper Bushings: Variation of Electrical Properties with Temperature & Frequency: etc.].—Martin. (*Journ. of Inst. of Eng. of Australia*, Dec. 1939, Vol. 11, No. 12, Transactions pp. 411–416.)

2029. ACTION OF OZONE ON RUBBER AND OTHER MATERIALS.—Norton. (*Gen. Elec. Review*, Feb. 1940, Vol. 43, No. 2, pp. 93–95.)

2030. COMPACT WIRE-WOUND RESISTANCES.—Vaganov. (*Izvestiya Elektroprom. Slab. Toka*, No. 11, 1939, pp. 55–61.)

A discussion on wire-wound resistances manufactured in Russia, having values of the order of several tens and hundreds of thousands of ohms. The design of these resistances, their properties (active life, heat-dissipation, etc.), the materials used, and the manufacturing processes, are included in the discussion.

2031. THE PRODUCTION OF ANNULAR MAGNETIC FIELDS OF GREAT UNIFORMITY.—Ference, Shaw, & Stephenson. (*Review of Scient. Instr.*, Feb. 1940, Vol. 11, No. 2, pp. 57–62.) A summary was referred to in 2105 of 1938.

2032. MAGNETIC SCREENING BY HOLLOW CIRCULAR CYLINDERS [Theoretical Study of Growth of Magnetic Field inside Hollow Conducting Cylinder for Some Aperiodic External Fields, Parallel and Perpendicular to Cylinder Generators: Method of Laplace Transformation].—Jaeger. (*Phil. Mag.*, Jan. 1940, Series 7, Vol. 29, No. 192, pp. 18–31.)

2033. THE EFFECTIVE PERMEABILITY OF A SUBSTANCE COMPOSED OF SPHERICAL METALLIC GRAINS WITHOUT ELECTRICAL CONTACT [by Lorentz Statistical Method].—Divilkovsky. (In paper dealt with in 1958, above.)

2034. ASSEMBLY MULTIPLIES MAGNET STRENGTH [Brass & Iron Mounting, making Flux pass through Many Air Gaps, enables Piece of Sintered Alnico to lift & hold 4 450 Times Its Own Weight (instead of Usual 500 Times)].—General Electric Laboratories. (*Elec. Engineering*, Feb. 1940, Vol. 59, No. 2, Advt. p. 10.)

2035. THE USE OF MODERN STEELS FOR PERMANENT MAGNETS [and the Necessity for Complete Re-Design when replacing (*e.g.*) Tungsten Steel by "Ticonal 2A": Calculation of Examples].—van Urk. (*Philips Tech. Review*, Feb. 1940, Vol. 5, No. 2, pp. 29–35.)

2036. THE INDUSTRIAL APPLICATIONS OF PERMANENT MAGNETS [and a Practical Method of Design Calculation].—Venco. (*L'Elettrotecnica*, 25th Oct. 1939, Vol. 26, No. 20, pp. 657–662.)

2037. ON THE MECHANISM OF COBALT MAGNETISATION.—Shirobokov. (*Comptes Rendus (Doklady) de l'Ac. des Sci. de l'URSS*, No. 5, Vol. 24, 1939, pp. 426–429: in English.)

2038. EFFECT OF A CURRENT THROUGH AN IRON BAR ON RESIDUAL MAGNETISM [Indication of Decrease of Magnetism for Small Residual Flux, Increase with Larger Values].—Perkins & Doolittle. (*Phys. Review*, 1st Jan. 1940, Series 2, Vol. 57, No. 1, p. 71: abstract only.)

2039. MAGNETISM AND THE STRUCTURE OF MATTER [Summary].—Lonsdale. (*Nature*, 13th Jan. 1940, Vol. 145, pp. 57–59.)

2040. ENERGY CHANGES ACCOMPANYING MAGNETISATION [Measurements of Thermal Changes in Step-by-Step Magnetisation Hysteresis Cycle of Nickel Rod in Unstretched and Stretched States: Proof of Warburg's Law: 90° Rotations of Weiss Domain Vectors are Not accompanied by Measurable Heat Changes].—Bates & Weston. (*Nature*, 3rd Feb. 1940, Vol. 145, pp. 188–189.)

2041. ELIMINATION OF TRANSFORMER NOISE [and the Need for Research on Reduction of Magnetostriction].—Norris. (*Electrician*, 23rd Feb. 1940, Vol. 124, p. 148.)

2042. A NOTE ON ANALYTICAL REPRESENTATION OF B-H CURVE.—Gatha. (*Electrotechnics*, Bangalore, Aug. 1939, No. 12, pp. 35–37.)

2043. THE INFLUENCE OF MECHANICAL TREATMENT, PRESSURE, AND TEMPERATURE ON THE CHARACTERISTICS OF FERROMAGNETIC MATERIALS.—Chiodi & Zerbini. (*L'Elettrotecnica*, 10th Feb. 1940, Vol. 27, No. 3, pp. 50–59.)

2044. THE ELECTRICAL RESISTANCE OF FERROMAGNETIC AMALGAMS [measured as Function of Temperature: Sharp Change in Resistivity near 340°C].—Bates & Fletcher. (*Proc. Phys. Soc.*, 1st Sept. 1939, Vol. 51, Part 5, No. 287, pp. 778–783.)

2045. FERROMAGNETISM IN AUSTENITE [shown in a Steel with Certain Proportions of Other Elements].—Tarasov & Parker. (*Phys. Review*, 15th Aug. 1939, Series 2, Vol. 56, No. 4, p. 379.)

2046. THE MAGNETIC PROPERTIES OF FERROMAGNETIC IMPURITIES IN NON-FERROUS ALLOYS.—Schröder. (*Ann. der Physik*, Series 5, No. 1, Vol. 36, 1939, pp. 71–96.)

2047. Studies on the Magnetic Moment in Ferromagnetic Alloys: II—The Gyromagnetic Phenomenon. Relation between Supplementary Moments and Curie Points.—Forrer. (*Journ. de Phys. et le Radium*, Feb. 1940, Series 8, Vol. 1, No. 2, pp. 74–80.)

2048. On the Theory of the Technical Magnetisation Curve in Ferromagnetic Monocrystals: II.—Vonsovskij. (*Journ. of Tech. Phys.* [in Russian], No. 13, Vol. 9, 1939, pp. 1151–1160.) For I *see* 2551 of 1939.

2049. A Magnetic Method of Investigating the Internal Elastic Stresses in Ferromagnetic Metals.—Akulov & Kirenskij. (*Journ. of Tech. Phys.* [in Russian], No. 13, Vol. 9, 1939, pp. 1145–1150.)

2050. The Physical Basis of Ferromagnetism [Survey].—Bozorth. (*Bell S. Tech. Journ.*, Jan. 1940, Vol. 19, No. 1, pp. 1–39.)

2051. "Ferromagnetismus" [Book Review].—Becker & Döring. (*Zeitschr. f. tech. Phys.*, No. 1, Vol. 21, 1940, p. 23.)

2052. Magnetic Susceptibilities in Weak Fields [Measurements of Susceptibilities of Organic Liquids relative to Water: No Large Discrepancy between Susceptibility of Water in High and Low Fields: Modified Form of Rankine Balance may yield Absolute Values of Magnetic Susceptibility].—Meeks & Jamison. (*Phys. Review*, 1st Jan. 1940, Series 2, Vol. 57, No. 1, p. 71: abstract only.) *Cf.* Hector & Peck, 2977 of 1939.

2053. Paramagnetic Hysteresis [Application of Ewing's Original Hysteresis Theory to Paramagnetic Salts], *and* Remark on the Theory of Paramagnetic Relaxation.—Temperley: Ornstein. (*Proc. Camb. Phil. Soc.*, Jan. 1940, Vol. 36, Part 1, pp. 79–83: *Physica*, March 1940, Vol. 7, No. 3, pp. 205–207: in English.)

2054. Order-Disorder Phenomena in Alloys.—Goodwin. (*Reports on Prog. in Physics*, Physical Society, Vol. 6, pub. 1940, pp. 369–377.)

2055. Metallic Materials in the Telephone System.—Schumacher & Ellis. (*Bell S. Tech. Journ.*, Jan. 1940, Vol. 19, No. 1, pp. 138–151.)

2056. Aluminium as a Material for Cable Sheaths.—Hanff & others. (*E.T.Z.*, 11th Jan. 1940, Vol. 61, No. 2, p. 41: summary only.)

2057. Thermostatic Bimetals.—Eskin & Fritze. (*Engineering*, 23rd Feb. 1940, Vol. 149, pp. 212–213: to be contd.)

2058. Cathode-Circuit Protection [Suggested Simpler Method, without Second Contact on Thermal Delay Switch].—Woods. (*Wireless World*, March 1940, Vol. 46, No. 5, p. 171.) *See* 1235 of March.

2059. A Selective Calling Device for Distant Control by Wireless.—Blasczyk. (*See* 2073.)

2060. Levers of Constant Ratio [for Fine Adjustments, etc.].—Clay. (*Journ. of Scient. Instr.*, March 1940, Vol. 17, No. 3, pp. 49–55.)

2061. Corrosion Effects on Electrical Machines.—Bätz. (*E.T.Z.*, 11th Jan. 1940, Vol. 61, No. 2, pp. 29–32.)

2062. Contact Phenomena in Telephone Switching Circuits [Investigation of Erosion as influenced by H.F. Transient Voltages & Currents, etc.].—Curtis. (*Bell S. Tech. Journ.*, Jan. 1940, Vol. 19, No. 1, pp. 40–62.)

2063. The Simultaneous Winding of Four Multi-Turn Coils by One Machine [manufactured by the Micafil Company].—Garskov. (*Izvestiya Elektroprom. Slab. Toka*, No. 11, 1939, pp. 53–55.)

2064. On the Single-Phase Magnet Motor [with Specially Shaped Iron Armature (without Winding)] and Its Power of running at Several Synchronous Speeds.—Buchhold. (*E.T.Z.*, 4th Jan. 1940, Vol. 61, No. 1, pp. 7–10.) *Cf.* 1780 (parametrical motor).

2065. Determination of the Spectral Sensitivity of a Photon Counter.—Roich. (*Comptes Rendus (Doklady) de l'Ac. des Sci. de l'URSS*, No. 7, Vol. 24, 1939, pp. 687–689: in English.)

STATIONS, DESIGN AND OPERATION

2066. Frequency Modulation.—Chaffee. (*See* 1828.)

2067. Frequency or Amplitude Modulation? Interesting Comparisons from America.—Weir. (*Wireless World*, March 1940, Vol. 46, No. 5, pp. 186–187.) Summary of a Radio Club paper: *see* also 3528 of 1939.

2068. Use of Frequency Modulation for Multiplex Service [*e.g.* Typewriter or Facsimile as well as Sound, or Stereoscopic Sound].—Armstrong. (*Sci. News Letter*, 27th Jan. 1940, Vol. 37, No. 4, p. 56.)

2069. Effect of the Quadrature Component in Single-Sideband Transmission [particularly Its Distorting Action in Picture Telegraphy: Superiority of Single- over Double-Sideband Transmission, for Given Band Width].—Nyquist & Pfleger. (*Bell S. Tech. Journ.*, Jan. 1940, Vol. 19, No. 1, pp. 63–73.) "It is not an inevitable conclusion that television images will be as little affected": *cf.* Goldman, 691 of February.

2070. TWO-WAY RADIO-TELEPHONY: A NEW "TWO-WIRE, FOUR-WIRE" CONTROL TERMINAL [Elimination of "Vodas" & Their Complexities by Simultaneous Use of Positive & Negative Feedback combined with Introduction of Negligible Amplitude Distortion: Analysis of New Terminal Circuit].—Marinesco. (*Wireless Engineer*, March 1940, Vol. 17, No. 198, pp. 97–104.) It is hoped to publish shortly experimental data on the performance.

2071. LONG-DISTANCE BROADCASTING [Review of General Development].—Ashbridge: Smith-Rose. (*Nature*, 3rd Feb. 1940, Vol. 145, p. 194: notes on recent Royal Institution Discourse.)

2072. RADIOELECTRICITY IN AERONAUTICS.—Laveran. (*See* 1895.)

2073. A SELECTIVE CALLING DEVICE FOR DISTANT CONTROL BY WIRELESS [*e.g.* from Aircraft, to switch-on Landing Lights: Avoidance of Too Long Waits and of Disturbance by Atmospherics, etc.].—Blasczyk. (*E.T.Z.*, 11th Jan. 1940, Vol. 61, No. 2, p. 36: summary only.)

2074. TRENDS IN THE APPLICATION OF ELECTRICITY IN BRITISH SHIPS [including Wireless Communication].—Watson. (*Journ. I.E.E.*, Feb. 1940, Vol. 86, No. 518, pp. 203–211.)

2075. AUTOMATIC WATER-STAGE TRANSMITTERS [Equipment for transmitting Signals representing Water Elevation in Remote Streams, at Predetermined Intervals: received on Automatic Tape Receiver: Battery-Powered Transmitter giving 4 Watts to Semi-Directional Aerial: Weight-Driven Clock Control: Servicing Once per Month].—Kennedy. (*Communications*, Feb. 1940, Vol. 20, No. 2, pp. 10–11.)

2076. SAFETY RULES FOR RADIO INSTALLATIONS: COMPRISING PART 5 OF FIFTH EDITION OF NATIONAL ELECTRICAL SAFETY CODE.—Nat. Bureau of Standards. (*Handbook* H35: 25 pp: for sale from Superintendent of Documents, Washington, D.C: price 10 cents.)

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2077. ON THE STATISTICAL BEHAVIOUR OF KNOWN AND UNKNOWN ELEMENTARY PARTICLES.—Pauli & Belinfante. (*Physica*, March 1940, Vol. 7, No. 3, pp. 177–192: in English.)

2078. ON A POSSIBLE MODIFICATION OF THE LORENTZ FORCES [of Interest in Determination of Mass of Particles of Cosmic Rays].—Caldirola. (*La Ricerca Scient.*, Jan./Feb. 1940, Year 11, No. 1/2, pp. 87–89.)

2079. THE ELECTRIC FIELD PRODUCED BY A POINT-CHARGE LOCATED OUTSIDE A DIELECTRIC WEDGE [Theoretical Expressions for Electrostatic Potential].—Rice. (*Phil. Mag.*, Jan. 1940, Series 7, Vol. 29, No. 192, pp. 36–46.)

2080. "THE ELECTRICAL DOUBLE LAYER" [Papers at Faraday Society's General Discussion: Book Notice].—(*Journ. of Scient. Instr.*, March 1940, Vol. 17, No. 3, p. 75.)

2081. ELECTRO-PHYSICS: A REVIEW OF PROGRESS.—Campbell. (*Journ. I.E.E.*, Feb. 1940, Vol. 86, No. 518, pp. 212–219.)

2082. THE NATURAL UNIT OF CAPACITY AND THE ABSOLUTE DEFINITION OF THE FARAD.—Laboccetta. (*La Ricerca Scient.*, Jan./Feb. 1940, Year 11, No. 1/2, pp. 83–85.)

2083. MAGNETISM AND ROTATIONS [and Liénard's Statement of Only One Characteristic Quantity, Magnetic Induction, instead of Field & Induction: Consideration of the Application of Larmor's Theorem to Electromagnetic Waves].—Brylinski. (*Rev. Gén. de l'Élec.*, 2nd/9th March 1940, Vol. 47, No. 9/10, pp. 165–172.)

2084. ELECTRICAL CONDUCTIVITY OF METALS [and Alloys: General Survey: Correlation of Problems on Basis of Bloch Theory].—Bardeen. (*Journ. of Applied Phys.*, Feb. 1940, Vol. 11, No. 2, pp. 88–111.)

2085. SUPERCONDUCTIVITY.—Jackson. (*Reports on Prog. in Physics*, Physical Society, Vol. 6, pub. 1940, pp. 335–344.)

MISCELLANEOUS

2086. ON THE ASYMPTOTIC LAWS OF THE DISTRIBUTION OF THE REAL ROOTS OF THE OSCILLATORY INTEGRALS OF A LINEAR DIFFERENTIAL EQUATION OF THE SECOND ORDER.—Sarymsakoff. (*Comptes Rendus* (*Doklady*) *de l'Ac. des Sci. de l'URSS*, No. 4, Vol. 24, 1939, pp. 322–324: in French.)

2087. AN ELECTRICAL METHOD FOR COMPOUNDING SINE FUNCTIONS [Device for evaluating the Series $\Sigma A_i \sin a_i x$].—Maxwell. (*Review of Scient. Instr.*, Feb. 1940, Vol. 11, No. 2, pp. 47–54.)

2088. RECENT MATHEMATICAL MACHINES [Survey, particularly of the M.I.T. Analysers].—Walther. (*E.T.Z.*, 11th Jan. 1940, Vol. 61, No. 2, pp. 33–36.)

2089. "TAFELN UND AUFGABEN ZUR HARMONISCHEN ANALYSE UND PERIODOGRAMMRECHNUNG" [Book Review].—Stumpff. (*Zeitschr. V.D.I.*, 3rd Feb. 1940, Vol. 84, No. 5, p. 88.)

2090. The Method of Symmetrical Components Applied to Harmonic Analysis [Determination of Fourier Series Coefficients from Graphically Known Wave: Use of Matrix Algebra].—Pipes. (*Phil. Mag.*, Jan. 1940, Series 7, Vol. 29, No. 192, pp. 66–74.)

2091. On a Hystero-Differential Equation arising in a Probability Problem.—Silberstein. (*Phil. Mag.*, Jan. 1940, Series 7, Vol. 29, No. 192, pp. 75–84.)

2092. Determination of the Curve fitting best to Experimental Points: Formula expressing an Experimental Law: Derivation of an Experimental Law.—Vernotte. (*Comptes Rendus*, 26th Feb. 1940, Vol. 210, No. 9, pp. 329–331.)

2093. Errors of Observation in Physical Measurements [Evidence of Particular Kind of Bias: the Use of Non-Uniform Scales: etc.].—Mahalanobis. (*Sci. & Culture*, Calcutta, Jan. 1940, Vol. 5, No. 7, pp. 443–445.)

2094. The Mathematical Societies of Great Britain.—Stigant. (*BEAMA Journ.*, Feb. 1940, Vol. 46, No. 32, pp. 51–53.)

2095. The Symbolic Representation of Impedance and Admittance [Desirability of Standardisation of Plus Sign Convention ($Z = R + jX$ and $Y = G + jB$)].—G.W.O.H. (*Wireless Engineer*, Jan. 1940, Vol. 17, No. 196, pp. 1–3.)

2096. The Phase Convention of Currents and Voltages in Valve Circuits.—G.W.O.H. (*Wireless Engineer*, March 1940, Vol. 17, No. 198, pp. 95–96.)

2097. Symbols for the Treatment of Electrical Communication: Suggestions of the National Electrotechnical Institute "Galileo Ferraris."—Ferrari-Toniolo. (*Alta Frequenza*, Feb. 1940, Vol. 9, No. 2, pp. 108–111.)

The use of the proposed system of symbols and suffixes is illustrated by Fig. 1, representing a voltage composed of a d.c. component V_0 on which is superposed an a.c. voltage v made up of first and third harmonics v_1 and v_3. The resultant is v_r $(= v + V_0)$; it is possible to distinguish the maximum values V_{1M} and V_{3M} of the first and third harmonics, of the a.c. voltage (V_M) and of the resultant voltage (V_{rM}). If the voltage were applied to the first grid of a valve, the maximum value of the voltage of the third harmonic would be indicated by V_{3g1M}. Interesting points in the system are the omission of the l on the grounds that it is easily confused with 1, the inclusion of D for "Durchgriff" (here called "intraeffetto") and F for fluorescent screen, etc.

2098. The Use of Electrets in Electrical Instruments.—Gemant. (*See* 1961.)

2099. The Problem of a Metallic Sphere in a Homogeneous Alternating Magnetic Field, and Its Application to the Theory of Induction Furnaces.—Divilkovsky. (*See* 1958.)

2100. Note on Earnshaw's Theorem [and Its Application to Attempts at Stable Suspension in Space by Magnetic Means].—Tonks. (*Elec. Engineering*, March 1940, Vol. 59, No. 3, pp. 118–119.) *See*, for example, 4268 of 1939 and back reference.

2101. A Magnetic Method of Investigating the Internal Elastic Stresses in Ferromagnetic Metals.—Akulov & Kirenskij. (*Journ. of Tech. Phys.* [in Russian], No. 13, Vol. 9, 1939, pp. 1145–1150.)

2102. Metallurgical Investigations with the Electrostatic Super-Microscope.—Mahl. (*Zeitschr. f. tech. Phys.*, No. 1, Vol. 21, 1940, pp. 17–18 and Plate.)

A fuller account will be published in the *Jahrbuch d. A.E.G.-Forschung* and the *Zeitschr. f. Metallkunde*. The apparatus is that dealt with in 1570 of April. The substances investigated were metallic-oxide fumes (such as occur in arc-welding and form a danger to health owing to their fineness, which has also prevented their investigation by the ordinary optical microscope); iron rust; and oxide surface-films, knowledge of whose structure is of importance in connection with corrosion, since it is on the nature of such films that the passivity of a metal depends. The magnifications used ranged from 10 000 : 1 to 14 000 : 1.

2103. A High-Frequency Commutator for Double and Quadruple C.R.O. Observation of Periodic and Aperiodic Processes [and Its Possible Use for the Remote Control of Aeroplanes, etc.].—Ladygin & Denisov. (*See* 1979.)

2104. Production of Electricity by Muscular Force ["Man-Power" Tests at Swiss National Exhibition: Bicycle-Drive, Hand-Winch, & Treadmill: Max. Daily Work is of Order of 0.6–0.7 kWh].—Hug. (*Bull. Assoc. suisse des Élec.*, No. 1, Vol. 31, 1940, pp. 9–12: in French.)

2105. Cardiophones of Various Types [Electro-Magnetic & Moving-Coil Types: suitable also for Recording on Cinema Film].—Giulietti. (*L'Elettrotecnica*, 10th Jan. 1940, Vol. 27, No. 1, pp. 14–15.)

2106. Emission and Absorption of Ultra-Short [40 cm–1.5 m] Waves by Atoms: Detectable Differences in Magnetic Properties: etc.—Rabi. (*Science*, 2nd Feb. 1940, Vol. 91, Supp. p. 40.)

2107. Radiation emitted by Uniformly Moving Electrons [Cerenkov Radiation].—Tamm. (*Journ. of Phys.* [of USSR], No. 5/6, Vol. 1, 1939, pp. 439–454: in English.) *See* also 375 & 3395 of 1939; and *cf.* Ginsburg ("Some Contribution to Quantum Electrodynamics"), *Comptes Rendus de l'Ac. des Sci. de l'URSS*, No. 2, Vol. 24, 1939, pp. 131–134.

2108. Action exercised by Ordinary Metals on the Photographic Plate [Russell's Hypothesis of Chemical Action must be amplified by Intervention of Absorbable Radiation].—Reboul. (*Journ. de Phys. et le Radium*, Feb. 1940, Series 8, Vol. 1, No. 2, pp. 56–62.)

2109. The Gurwitsch or Mitogenetic Rays [Discovery & Significance].—Puig. (*Biblioteca Cientifica del Observatorio de San Miguel*, Argentina, No. 12, 1939, 51 pp: in Spanish.) For other papers on this radiation *see* 376 & 1335 of 1936 and 745 & 746 of 1938.

2110. Experimental Results on the Problem of the Biological Action of Cosmic Rays.—Eugster & others. (*Radiologica*, Zürich, No. 3/4, Vol. 5, 1939, pp. 134–141.)

2111. On the Question of Point Heating in the High-Frequency Field [Negative Result of Tests with 3–12 m Waves to obtain Selective Heating of Suspended Particles above Temperature of Liquid].—Wenk. (*Strahlentherapie*, No. 4, Vol. 65, 1939, pp. 657–663.)

2112. The Effect of [Ultra-] Short Waves on Tissue Cells [Cells killed, by 3.5 m Waves, well below the Necessary Temperature].—Hasché. (*Strahlentherapie*, No. 4, Vol. 65, 1939, pp. 664–667.)

2113. The Electrical Properties of Blood under the Action of Decimetric Waves.—Malov. (*Comptes Rendus (Doklady) de l'Ac. des Sci. de l'URSS*, No. 5, Vol. 24, 1939, pp. 437–439: in German.)

2114. "Ergebnisse der Biophysikalischen Forschung" [Vol. I—Ultra-Short Waves and Their Medical-Biological Applications: Book Review].—Dänzer, Hollmann, & others. (*Bull. Assoc. suisse des Élec.*, No. 5, Vol. 31, 1940, pp. 129–130: in German.) The series is edited by Rajewsky.

2115. Effect of Electrization of Earth Layers by Elastic Waves passing through Them [Distinct from Seismo-Electric Effect].—Ivanov. (*Comptes Rendus (Doklady) de l'Ac. des Sci. de l'URSS*, No. 1, Vol. 24, 1939, pp. 42–45: in English.)

2116. Wandering Currents [Stray Currents in the Earth, due to Communication & Power Systems, Electric Trams, etc: Injurious Effects & Their Prevention: Useful Effects].—Puig. (*Biblioteca Cientifica del Observatorio de San Miguel*, Argentina, No. 14, 1939, 38 pp: in Spanish.)

2117. Practical Aspects of Earthing.—Fawssett & others. (*Nature*, 2nd March 1940, Vol. 145, pp. 357–358: notes on recent I.E.E. paper.)

2118. On Iso-Dielectric Lines [Lines of Maximum Water-Content] and Geologic Structure [Lines reveal Hydrologic and Petrographic Structure].—Löwy. (*Phil. Mag.*, Jan. 1940, Series 7, Vol. 29, No. 192, pp. 32–35.)

2119. Power Oscillators: Circuit for Surface Hardening of Steel.—Babat & Losinsky. (*See* 1826, above, and 2120, below.)

2120. Heat Treatment of Steel by High-Frequency Currents.—Babat & Losinsky. (*Journ. I.E.E.*, Feb. 1940, Vol. 86, No. 518, pp. 161–168 and Plates.). *See* also 2119, above.

2121. Two Small Portable Geiger-Müller Counters [particularly for Prospecting or in Hunts for Lost Radium].—Taft. (*Review of Scient. Instr.*, Feb. 1940, Vol. 11, No. 2, pp. 63–64.)

2122. [Photoelectric] Device for determining the Area of Leaves [for Photosynthetic & Other Studies].—Petrov & Gavrilov. (*Comptes Rendus (Doklady) de l'Ac. des Sci. de l'URSS*, No. 5, Vol. 24, 1939, pp. 499–501: in English.)

2123. Method of determining the Corrections necessary in Photometry with Selenium Barrier-Layer Cells owing to Deviations from the Cosine Law.—Buchmüller & König. (*Bull. Assoc. suisse des Élec.*, No. 5, Vol. 31, 1940, pp. 122–124: in German.)

2124. Infra-Red Radiations, with Special Reference to Their Quenching Effects upon Zinc-Sulphide Phosphors.—Blake. (*See* 1994.)

2125. The Spectral Energy Distribution of the Long-Wave Infra-Red Emission ($300\ \mu$) from Various High-Pressure Discharges [and the Electrodeless Ring Discharge].—Dahlke. (*Zeitschr. f. Physik*, No. 11/12, Vol. 114, 1939, pp. 672–681.)

2126. Watch-Testing and Water-Leak Detection (in Underground Mains) by Electronic Means.—Taylor. (In paper dealt with in 1910, above.)

2127. Automatic Water-Stage Transmitters.—Kennedy. (*See* 2075.)