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Editorial

Applying Transmission Line Theory to Aerials

THE properties of transmission lines have been reduced to a number of relatively simple formulae by means of which the relations between the voltage and current can be readily calculated for any given conditions. These formulae involve the constants of the line, and the definition of some of these constants is not entirely free from suspicion. These suspicions hardly arise in the ordinary transmission line problems in which the distance between the conductors is negligible compared not only with their length but also with the wave-length, but they become very strong when the same formulae are applied to cases in which these conditions no longer hold. In the simple case of two parallel overhead wires carrying alternating current, the P.D. between the two wires at any point is indefinite since the work done in moving a charge from one to the other depends on the path followed; similarly the reading on a voltmeter connected between the two points varies slightly with the path followed by the leads. In most practical cases the effect is small and merely of academic interest.

In the Year-book of Wireless Telegraphy and Telephony for 1917 (pp. 694–704) we published a paper on "The Inductance, Capacity, and Natural Frequency of Aerials" in which we applied transmission line formulae to ordinary aerials. In Fig. 1, which is reproduced from the paper, a vertical quarter-wave aerial is assumed to be conical, and at the moment of maximum voltage and charge the electric lines of force are assumed to follow the circular arcs shown dotted; this is reasonable because in the quarter cycle that has elapsed since the moment of zero voltage, the disturbance can only have travelled a quarter wavelength in any direction. On this assumption the capacitance (we called it "capacity" in those days) was shown to be a constant, the longer path as one goes farther up the aerial being exactly counterbalanced by the larger cross-section. The term capacitance per cm is used here in a very special sense; the calculation is based on the assumption that the electric field is integrated along the circular arcs.

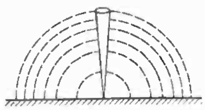


Fig. 1.

In more complex forms of aerials and in cases where the relation between dimensions and wavelength is not so simple, one can still employ the transmission line formulae, but the meaning to be attached to L and C per cm of length becomes much more difficult of definition, and the values will, in general, vary with the position.

These considerations are prompted by a paper recently published by Mr. F. M. Colebrook* of the N.P.L. entitled "The

* *Jour. I.E.E.*, Vol. 83, p. 403, Sept., 1938. On p. 404 the statement that "the principal object of the present paper *is* . . . A secondary object *was* . . . ," suggests that the latter did not materialise or had been abandoned, but an examination of the paper shows that this was not the case.

Application of Transmission-line Theory to Closed Aerials." The dimensions of the aerials are assumed to be comparable with the wavelength, so that the assumption that the current at any moment has the same value at all parts of the loop or rectangle is no longer tenable. Several papers, both theoretical and experimental, on the distribution of the current around the loop have been published by Professor L. S. Palmer and his associates, and the problem is recognised as one of considerable complexity. The method adopted by Mr. Colebrook is to regard the loop as a transmission line—a sort of ring main—in two parts of which electromotive forces are induced by the received wave, and every centimetre of which has a certain inductance and capacitance. It is probably wise to turn a deaf ear to anyone who asks how these values are determined. The actual aerial shown in Fig. 2 is regarded as functioning similarly to the transmission line shown in Fig. 3, to which, on the assumption of uniformly distributed inductance and capacitance, the ordinary transmission line formulae can be applied. The induced E.M.F. is, of course, uniformly distributed along the vertical sides, and not concentrated as we have shown in Fig. 3; if the width CD is small compared with λ the two E.M.F.s are almost

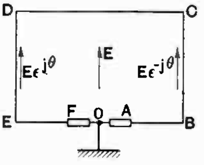


Fig. 2.

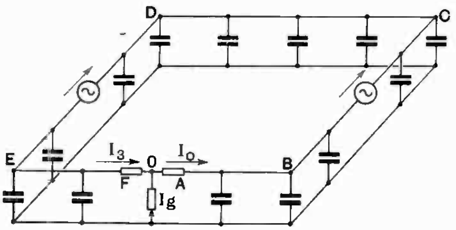


Fig. 3.

in opposition; if $CD = \lambda/2$ they are in phase. The problem is simplified if one assumes that the point O is earthed by a wire of zero impedance in which no E.M.F. is induced by the wave, so that the point O is at earth potential although current will, in general, flow in the earth wire, since the earthed loop will also act as a vertical aerial, unless the vertical sides are exactly half a wave-length apart.

The problem is further simplified by assuming that the tuning impedances OA and OF are similar, since the loop is then quite symmetrical. The problem then reduces to Fig. 4, from which one can calculate the currents due to the E.M.F. in one side; those due to the E.M.F. in the other side can then be written down, allowing for the difference of phase. In the paper the formulae do not assume the E.M.F. to be concentrated at the middle of the vertical side as shown in Fig. 4, but it is probable that the difference so introduced would be very small in most practical cases.

The system shown in Fig. 4 differs from the ordinary transmission line in that the generator is not connected between one end

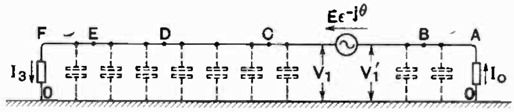


Fig. 4.

of the line and earth. The ordinary formulae would give the relation between the received current I_3 and the sending-end voltage V_1 of the line to the left of the generator and similarly the relation between the received current I_0 and the sending-end voltage V_1' of the line to the right of the generator. The currents I_0 and I_3 are determined from the two conditions that the sending-end current of each line must be the same, for it is simply the current through the generator, and that the generator voltage $E\epsilon^{-j\theta}$ must be the resultant of V_1 and V_1'. The application of transmission line formulae to Fig. 4 enables one to investigate the distribution of current and voltage around the loop for various values of the tuning impedances and for various shapes and sizes of loop. One must not forget, however, that the results can only be approximate because of the simplifying assumptions underlying this line of approach. In the paper referred to Mr. Colebrook carries the investigation much further than we have indicated here.

G. W. O. H.

Using Condensers for Eliminating Interference from Electrical Tramways*

By Siffer Lemoine

(Director of Bureau, Board of Swedish Telegraphs)

WHILE the technical methods for eliminating interference to broadcast reception caused by electrical machines and apparatus in general are now fairly well developed, there is still a certain hesitation as to the best manner in which to deal with interference produced by electrical tramways and railways. It is not the intention here to discuss the general advantages and drawbacks of different methods used for the suppression of such interference, but only to give an account of certain experiments carried out in Sweden with fixed interference protectors connected to the trolley wire of the tramway network.

Previous Tests with Condensers

It is several years since it was first stated in technical articles that condensers placed at appropriate intervals along the trolley wire of a tramway system afforded efficient protection against disturbances caused by the formation of sparks between the current collector and the trolley wire. It was natural to presume that this method was efficient. A condenser inserted between the trolley wire and earth, it was thought, would function like a direct short-circuit as regards the high-frequency currents produced at the point of contact between the wheel or bow and the wire and propagated along this wire. The insertion of condensers at regular intervals along the tram-line therefore seemed to afford an efficient means of preventing the propagation of high-frequency currents.

In order to test the appropriateness of the arrangement, experiments with condensers disposed along the tram-line of one particular street in Stockholm (Hantverkaregatan) were carried out in common by the Swedish Telegraph Administration and the Stockholm Tramways in 1934. The condensers had a capacitance of 8 μF. each and were placed at intervals of about 120 metres (400 feet). The results of the tests carried out with these condensers and additional devices may be briefly stated thus: It was possible to notice a certain reduction of the interference caused to radio reception, but this reduction was by no means sufficient.

The opinion was expressed that if the condensers were placed at shorter intervals and had a smaller capacitance, the result would be far more favourable. In consequence, new tests were made, though at the time it had become evident that the provision of a system of protective condensers in a tram-line network of the extension of that of Stockholm, would, for several reasons, hardly be practicable. The cost of installation would be considerable, and the maintenance (including inspection, exchange of disrupted condensers, safety fuses, etc.) of such an extensive system would be too onerous. The tests were nevertheless pursued owing chiefly to the desirability of ascertaining whether it would be possible, by the use of a small number of condensers mounted in a section producing particularly strong interference, such as a slope or the like, to obtain an essential reduction of the interference caused by that particular section.

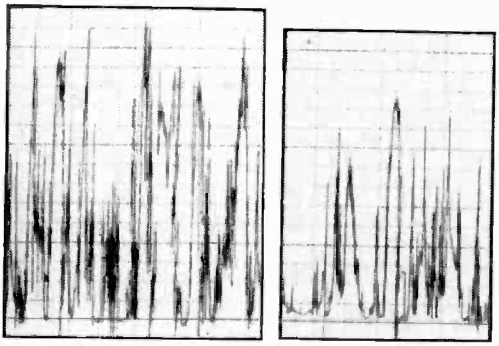
Tests with Condensers placed at Intervals of 60 and 30 metres (200 and 100 feet)

Still in collaboration with the Stockholm Tramways, new condensers of 1 μF. were therefore mounted at intervals of about 60 metres (200 feet; i.e., at every second pole) along the same street as mentioned before. These tests were finished in the early part of 1937.

In order to obtain the clearest possible idea of the effect of the condensers, the disturbances were in all these later tests measured by means of registering instruments. The measuring aerial was a 15-metre

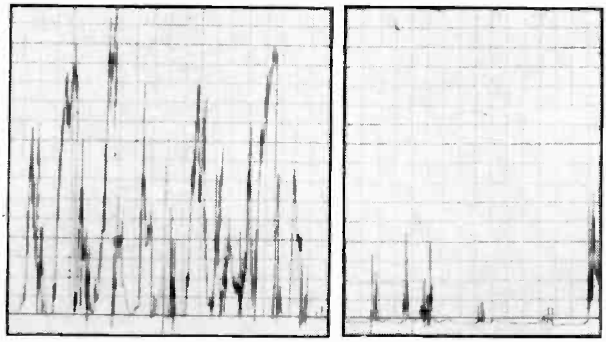
* MS. accepted by the Editor, July, 1938.

(50-feet) wire suspended parallel with the trolley wire and at a distance of 3 metres



(a) (b)

Fig. 1.—*Diagram of the interferences at 350 m. wavelength (a) without, (b) with 1 μF. condensers.*

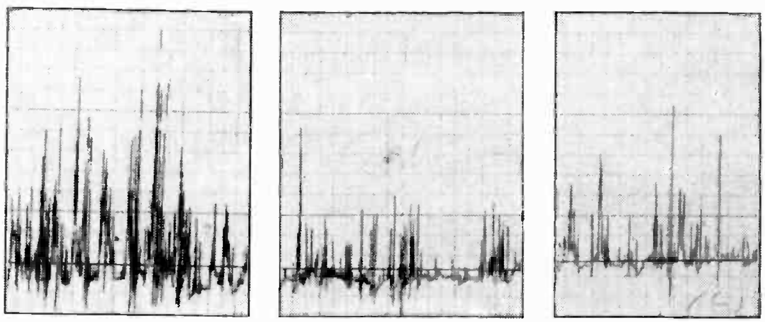


(a) (b)

Fig. 2.—*Diagram of the interferences at 1,350 m. wavelength. (a) without, (b) with 1 μF. condensers.*

(10 feet) from it. Fig. 1 (*a*) shows the disturbances from the line with *no* condensers fitted, and (*b*) after the insertion of condensers, the measurements having been carried out for a frequency of 850 kc/s. (wavelength of 350 m.). In Fig. 2 the same is shown for the frequency 220 kc/s. (wavelength 1,350 m.). It appears from the diagrams that the disturbances were stronger on the shorter wavelength, and that the reduction obtained was smaller on this wavelength than on the longer one. Further investigations in this respect have confirmed that the intensity of the interference is dependent on the frequency.

Simultaneously with the tests made in the above-mentioned street, which did not afford the most appropriate conditions for measurements, experiments were also carried out in another street section (passing by the Royal Palace). Here some thirty condensers of 1 μF. were mounted by the Stockholm Tramways at intervals of about 30 metres (100 feet) only (i.e., at each pole).



(a) (b) (c)

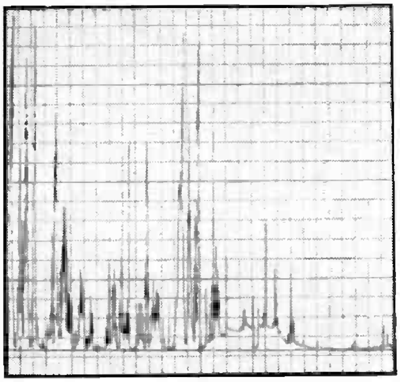
Fig. 3.—*Diagram of the interferences at 350 m. wavelength and condensers at each pole. (a) without, (b) condensers successively connected, (c) with 1μF. condensers.*

These tests in their first stage gave the same result as that mentioned above. The condensers prevented the propagation of disturbances from either direction outside the test section and provided considerable reduction of interference from passing trams, but the remaining interference was nevertheless strong enough to spoil the reception of foreign broadcast stations. A diagram of the measurements is shown in Fig. 3.

Conclusions

In general it was possible to conclude from the measurements that condensers afford a good reduction of interference under certain conditions but that they are by no means a universal remedy. The reason for this is as follows.

Assuming that the measurement is carried out at a frequency of 600 kc/s. (500 m.), the reactance of the condenser is about 0.25 ohm and has thus practically the same effect as a short-circuit. If, however, regard is also paid to the length of the lines connecting the condenser with the trolley wire, on the one hand, and with the earth, on the other, there comes into play an inductance of between 10 and 100 μH., producing a reactance, compared to which the equivalent resistance of the condenser can be entirely neglected. From this it is apparent that the reason for the condensers being more efficient at higher than at lower wavelengths



(a) (b)

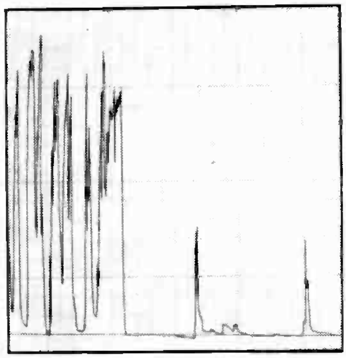
Fig. 4.—*Diagram for the interferences at 333 m. wavelength. (a) without, (b) with 0.002 μF. condensers.*

lies in the fact that, in the case concerned, the condenser with its leads forms a series-resonant circuit having a natural frequency situated far above the broadcast wavelengths.

Conversely, by reducing sufficiently the condenser capacitance, it ought to be possible to bring the optimum interference reduction within the broadcast bands of wavelengths. Tests to this effect were pursued on the latter of the sections referred to above (near the Royal Palace). A number of specially ordered condensers of 0.002 μF. were inserted in place of the previous ones of 1 μF., and then a series of measurements was made for different frequencies ranging from 600 to 1,050 kc/s (wavelengths from 500 to 285 m.). From the diagrams taken it can easily be inferred that this type of condenser affords a minimum of interference intensity at about 350 m. (850 kc/s.) and that the interference is less reduced on either side of this wavelength. Calculation shows that this corresponds to a line inductance of about 17 μH. and a resistance of about 100 ohms. The interference diagram obtained from the measurements is shown in Fig. 4.

The inference to be drawn from the experiments is, consequently, that *condensers used as interference protectors, in connection with a tram-line, function as wave-traps chiefly with regard to one fixed frequency determined by the condenser capacitance and the line inductance.* If the whole broadcast band (excepting short waves) is to be freed from interference, a number of condensers must be mounted on each pole. The corresponding curve of interference elimination then assumes a saw-toothed form, if drawn as a function of the number of condensers and the frequency. In extensive tramline networks the method of using condensers as interference protectors is altogether out of the question as being inappropriate in practice, or even impracticable.

The experiments showed, moreover, that close examination concerning the use of condensers as interference protectors in tram-



(a) (b)

Fig. 5.—*Diagram of the interferences at 333 m. wavelength. (a) without, (b) with 0.002 + 0.05 μF. condensers. The two peaks in (b) indicate passing trains.*

lines had previously not been made as to the conditions arising in case of such use. It is, of course, no good employing condensers of a capacitance of 1 μF., since the corresponding resonance wavelength will be about 8,000 m. If condensers are to be used, their capacitance ought to be of the order of 0.005 μF. to 0.01 μF. at the maximum.

Measurements made later with condensers of different capacitances on an electrical transport line have fully borne out the results obtained in Stockholm (cf. Fig. 5).[1]

[1] The measurements have been made by Mr. R. Berglund.

Small Temperature Coefficient of Frequency of Quartz Plates*

By Peter Modrak, M.Sc., B.E., A.M.I.E.E.

(State Telecommunication Institute, Warsaw, Poland)

IN 1922 Prof. Cady described the *X* or Curie cut quartz plate. In this plate the formula for the thickness vibration is: $f_1 = \frac{2870}{a}$ kc/s where *a* is in millimeters. The *X* cut plate may be excited also along the *Y* dimension. In this case the frequency may be calculated from the formula $f_2 = \frac{2700}{b}$ kc/s where *b* is the width in millimeters along the *Y* axis. Square plates exhibit also the coupling frequency which is determined from the formula $f_3 = \frac{3330}{b}$ kc/s where *b* is in millimeters. The *X* cut-circular disk with a thickness *a* mm and a diameter *d* mm exhibits three fundamental frequencies which may be determined from the following design formulae:

$$f_1 = \frac{2870}{a},\ f_2 = \frac{2715}{d},\ f_3 = \frac{3830}{d}\ \text{kc/s.}$$

The temperature coefficient of frequency of the *X* cut plates for the thickness vibrations is negative and varies between -20 and -35×10^{-6} per 1 deg. C.; for the *Y* vibration between -50 and -70×10^{-6} per 1 deg. C. and for the coupling frequency between -40 and -70×10^{-6} per 1 deg. C.

In 1927 the *Y* cut plates were described[1]. For the *Y* cut plates the thickness vibration is determined from the formula $f_1 = \frac{1960}{b}$ kc/s where *b* is the thickness of plate in mm. The *Y* cut plate exhibits vibrations in the direction of *X* axis whose frequency may be determined from the formula $f_2 = \frac{2860}{a}$ kc/s where $a =$ the dimension in mm. along the *X* axis.

The temperature coefficient of the thickness frequency of this cut is usually positive. It varies with the dimension along the *X* axis and depends upon the temperature of the plate. It varies between $+100$ and -20×10^{-6} per 1 deg. C.

The temperature coefficient along the *X* axis for this cut is negative and varies between -20 and -35×10^{-6} per 1 deg. C.

Thus it is seen that under certain conditions it may be possible to obtain the *Y* cut plate having zero temperature coefficient of frequency.

In 1929 F. R. Lack[2] pointed out that in the *Y* cut plates the frequency thickness constant and the temperature coefficient vary considerably with the width. The temperature coefficient is in addition a function of the temperature.

Also it was pointed out that there exists a certain amount of coupling between the fundamental vibration along the thickness of the plate and the overtone vibrations along the *X* axis.

It was observed that due to this coupling the frequency jumps at a certain temperature to a new frequency and that the temperature coefficient reverses its sign. Thus it is possible to obtain a plate of zero temperature coefficient within certain limits of temperature.

The same year W. A. Marrison[3] pointed out that by using ring shaped *Y* cut quartz it was possible to secure quartz having zero temperature coefficient by choosing suitable ratio between the inner and the outer diameter of the ring. The manu-

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

[1] R. C. Hitchcock: "Mounting Quartz Crystal Oscillators," *Proc. Inst. Rad. Eng.*, November, 1927.

[2] F. R. Lack: "Observations on Modes of Vibration and Temperature Coefficients of Quartz Crystal Plates," *Bell S. Tech. Journ.*, July, 1929.

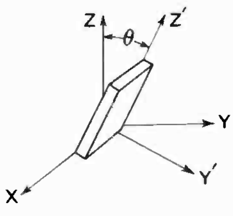
[3] W. A. Marrison: "A High Precision Standard of Frequency," *Bell S. Tech. Journ.*, July, 1929.

facture of the ring-shaped plates having small temperature coefficient is a very difficult matter because it is impossible to predict beforehand the proper ratio between the inner and the outer diameter. This ratio must be determined by trial.[1]

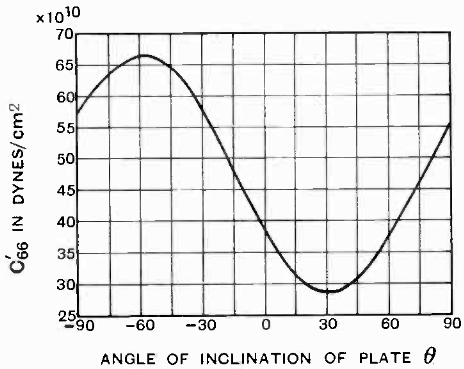
In 1934 W. P. Mason[2] pointed out that by suitable choice of the dimensions of the X cut crystal plates it is possible to attain a small temperature coefficient. Generally the crystal plates having small dimension along the optical axis exhibit small temperature coefficient. If the dimension along the X axis increases the temperature coefficient decreases.

About 1929 T. D. Parkin[3] produced plates having the temperature coefficient of the value $\pm 1 \times 10^{-6}$ per 1 deg. C. over the temperature range of 18 deg. C. to 80 deg. C. The crystal was the Y cut cube having the electrical and the optical axis equal in length and the Y axis = 5/6 the length of the electrical axis. In this case it is possible to predict the size of the crystal for a given frequency and generally two measurements are sufficient to determine how much should be removed to produce a plate of a given temperature coefficient and a given frequency.

The drawback of this type of crystal is that it is rather heavy and its wavelength is practically limited to the wave range from 700 to 4,000 metres. For shorter waves the cube becomes very small and for longer waves it is very bulky. For these reasons this type of crystal is not used for short-wave work.



(a)



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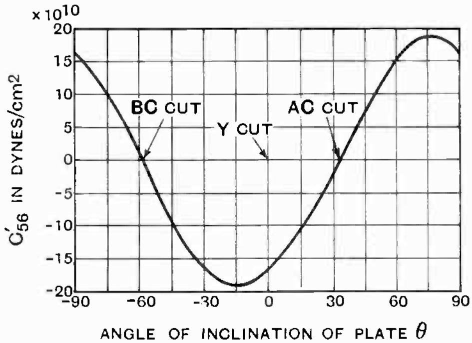
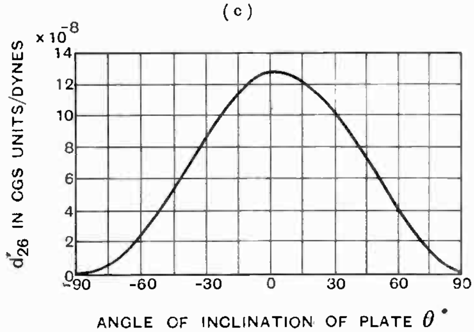


(c)



(d)

Fig. 1.

In November, 1934, Dr. R. Bechmann[4] in Germany produced quartz plates inclined at a certain angle to the optic axis of the crystal and parallel to the X axis.

The same year Prof. Issac Koga[5] in Japan described his R cut quartz plates.

[1] P. Modrak: "Quartz and Tourmaline," *The Wireless Engineer*, March and April, 1937.

[2] W. P. Mason: "Electrical Wave Filters," *Bell S. Tech. Journ.*, July, 1934.

[3] T. D. Parkin, Booth and Dixon: "Crystal Oscillators for Radio Transmitters," *Journ. I.E.E.*, August, 1935.

[4] R. Bechmann: "Über die Temperaturkoeffizienten der Eigenschwingungen piezoelektrischen Quartzplatten und Stäbe." *Hochf:tech. u. Elec:akus*, Band, 44, 1934.

[5] Issac Koga: "Thermal Characteristics of Piezo-electric Oscillating Quartz Plates," *Rep. of Rad. Res. in Japan*, 1934, Vol. IV. N.2.

Also F. R. Lack, G. W. Willard and J. E. Fair[1] carried out experiments in America and produced plates inclined to the optic axis Z of the mother crystal having zero temperature coefficient of frequency (Fig. 1a).

In general the elastic equations in the case of quartz are expressed by the following relations :—

$$\left.\begin{aligned}
-X'_x &= C'_{11}x'_x + C'_{12}y'_y + C'_{13}z'_z + C'_{14}y'_z + C'_{15}z'_x + C'_{16}x'_y \\
-Y'_y &= C'_{12}x'_x + C'_{22}y'_x + C'_{23}z'_z + C'_{24}y'_z + C'_{25}z'_x + C'_{26}x'_y \\
-Z'_z &= C'_{13}x'_x + C'_{23}y'_y + C'_{33}z'_z + C'_{34}y'_z + C'_{35}z'_x + C'_{36}x'_y \\
-Y'_z &= C'_{14}x'_x + C'_{24}y'_y + C'_{34}z'_z + C'_{44}y'_z + C'_{45}z'_x + C'_{46}x'_y \\
-Z'_x &= C'_{15}x'_x + C'_{25}y'_y + C'_{35}z'_z + C'_{45}y'_z + C'_{55}z'_x + C'_{56}x'_y \\
-X'_y &= C'_{16}x'_x + C'_{26}y'_y + C'_{36}z'_z + C'_{46}y'_z + C'_{56}z'_x + C'_{66}x'_y
\end{aligned}\right\} \quad (1)$$

where x'_x, y'_y, etc. represent stresses in the direction of any orthogonal set of axes, C represent moduli of elasticity and X, Y and Z represent strains in the respective directions.

If X', Y' and Z' coincide with the crystallographic axis of quartz crystal, i.e. with the X or the electric axis the Y or the mechanical axis and the Z or the optic axis of the crystal equations (1) reduce to the form :

$$\left.\begin{aligned}
-X_x &= C_{11}x_x + C_{12}y_y + C_{13}z_z + C_{14}y_z \\
-Y_y &= C_{12}x_x + C_{22}y_y + C_{23}z_z + C_{24}y_z \\
-Z_z &= C_{13}x_x + C_{23}y_y + C_{33}z_z \\
-Y_z &= C_{14}x_x + C_{24}y_y + C_{44}y_z \\
-Z_x &= \qquad + C_{55}z_x + C_{56}x_y \\
-X_y &= \qquad + C_{56}z_x + C_{66}x_y
\end{aligned}\right\} \quad (2)$$

From equations (2) it is seen that due to the constant C_{56} an X_y strain will set up a stress in the Z_x plane which will produce a Z_x strain.

Thus it follows that X_y and Z_x strain are coupled together mechanically and the constant C_{56} is responsible for that coupling. The values of the above elastic constants were determined by Voigt.[2] They are as follows :

$$\left.\begin{aligned}
C_{11} &= C_{22} = 85.1 \times 10^{10} \text{ dynes/cm}^2 \\
C_{33} &= 105.3 \times 10^{10} \text{ dynes/cm}^2. \\
C_{44} &= C_{55} = 57.1 \times 10^{10} \text{ dynes/cm}^2. \\
C_{66} &= (C_{11} - C_{12})/2 = 39.1 \times 10^{10} \text{ dynes/cm}^2 \\
C_{12} &= 6.95 \times 10^{10} \text{ dynes/cm}^2. \\
C_{13} &= C_{23} = 14.1 \times 10^{10} \text{ dynes/cm}^2 \\
C_{14} &= -C_{23} = C_{56} = 16.8 \times 10^{10} \text{ dynes/cm}^2.
\end{aligned}\right\} \quad (3)$$

Using these constants it is possible to calculate the value of any coefficient C'_{mn} for any orientation of quartz plate with respect to Z axis. The expressions giving C'_{16}, $C'_{26} \ldots C'_{66}$ (the constants relating to the X'_y strain) in terms of C'_{mn} for rotation about the X axis, are given below, θ being the angle between the Z' and Z axis.

$$\left.\begin{aligned}
C'_{16} &= C'_{26} = C'_{36} = C'_{46} = 0 \\
C'_{56} &= C_{14}(\cos^2\theta - \sin^2\theta) + (C_{66} - C_{44}) \sin\theta\cos\theta \\
C'_{66} &= C_{44}\sin^2\theta + C_{66}\cos^2\theta - 2C_{14}\sin\theta\cos\theta
\end{aligned}\right\} \quad (4)$$

The inverse piezo-electric relations for any orthogonal set of axes X', Y', Z', are expressed as follows :

$$\left.\begin{aligned}
X'_x &= d'_{11}E'_x + d'_{21}E'_y + d'_{31}E'_z \\
Y'_y &= d'_{12}E'_x + d'_{22}E'_y + d'_{32}E'_z \\
Z'_z &= d'_{13}E'_x + d'_{23}E'_y + d'_{33}E'_z \\
Y'_z &= d'_{14}E'_x + d'_{24}E'_y + d'_{34}E'_z \\
Z'_x &= d'_{15}E'_x + d'_{25}E'_y + d'_{35}E'_z \\
X'_y &= d'_{16}E'_x + d'_{26}E'_y + d'_{36}E'_z
\end{aligned}\right\} \ldots (5)$$

(where $E' \ldots$ = components of electric field in particular direction and $d' \ldots$ = piezo-electric constants of the quartz crystal).

When X', Y', Z' coincide with the crystallographic axes, equations (5) reduce to

$$\begin{aligned}
X_x &= d_{11}E_x \\
Y_y &= d_{12}E_x \\
Z_z &= 0 \\
Y_z &= d_{14}E_x \\
Z_y &= \qquad - d_{14}E_y \\
X_y &= \qquad - 2d_{11}E_y
\end{aligned}$$

[1] F. R. Lack, G. W. Willard and J. E. Fair : "Some Improvements in Quartz Crystal Circuit Elements." *Bell S. Tech. Journ.*, July, 1934.

[2] W. Voigt : "Lehrbuch der Kristallphysik," 1928, p. 754.

In these equations

$$d_{11} = -6.36 \times 10^{-8} \frac{\text{esu}}{\text{dyne}}$$

$$d_{14} = 1.69 \times 10^{-8} \frac{\text{esu}}{\text{dyne}}$$

For rotation of plate about the X axis

$$d'_{26} = (d_{14} \sin \theta - 2d_{11} \cos \theta) \cos \theta \quad .. \quad (6)$$

When the orientation of the crystal plate is changed with respect to the crystallographic axes then the elastic constants with respect to the axes of the plate will vary also.

The direct constants C'_{11}, C'_{22} representing the longitudinal and the shear moduli will vary in magnitude only, while the cross-constants C'_{mn} will vary both in magnitude and in sign. By proper choice of orientation it is possible to reduce C'_{56} to zero without at the same time introducing other couplings. The variation of C'_{66} and C'_{56} with regard to the angle of rotation about the X axis calculated from equation (4) is shown in Fig. 1(b).

Examination of this curve shows that at approximately $+31$ deg. and -60 deg. C'_{56} becomes zero.

Fig. 1(c) represents modulus of elasticity and Fig. 1(d) represents piezo-electric modulus determined from the equation (6). Examination of d'_{26} shows that the plate cut at 60 deg. has the value of $d'_{26} =$ 20 per cent. of the value for the Y cut; on the other hand, the value of d'_{26} for 31 deg. cut is practically equal to that for the Y cut. This shows that the activity of the plate cut at this angle is as good as that of the Y cut plate. The frequency of the plate cut at a certain angle to the Z axis may be calculated from the formula:

$$f = \frac{1}{2a}\sqrt{\frac{C}{\rho}} \quad .. \quad .. \quad .. \quad (7)$$

where

$C = C_{66} \cos^2\theta + C_{44} \sin^2\theta - C_{14} \sin 2\theta$

a = thickness of plate in mm.

ρ = density of quartz = 2.654 g/cm^3

θ = angle of inclination of plate

C_{66}, C_{44}, C_{14} = adiabatic elastic constants.

Differentiating (7) with respect to temperature T we get:

$$2\frac{1}{f}\frac{\partial f}{\partial T} = \frac{1}{C}\frac{\partial C}{\partial T} - \frac{1}{\rho}\frac{\partial \rho}{\partial T} - 2\frac{1}{a}\frac{\partial a}{\partial T}$$

where

$$-\frac{1}{\rho}\frac{\partial \rho}{\partial T} = \frac{1}{x}\frac{\partial x}{\partial T} + \frac{1}{y}\frac{dy}{\partial T} + \frac{1}{z}\frac{dz}{\partial T}$$

$$\frac{1}{a}\frac{\partial a}{\partial T} = 1^2\frac{1}{x}\frac{\partial x}{\partial T} + m^2\frac{1}{y}\frac{\partial y}{\partial T} + n^2\frac{1}{z}\frac{dz}{\partial T}$$

$$\frac{1}{x}\frac{\partial x}{\partial T} = \frac{1}{y}\frac{\partial y}{\partial T} = 13.7 \times 10^{-6}/1^\circ\text{C}.$$

$$\frac{1}{z}\frac{\partial z}{\partial T} = 7.5 \times 10^{-6}/1^\circ\text{C}.$$

It follows from the above that

$$2\frac{1}{f}\frac{\partial f}{\partial T} = \frac{1}{C}\frac{\partial C}{\partial T} + (7.5 + 12.4 \sin^2\theta)10^{-6} \quad .. \quad (8)$$

where

$$\frac{dC}{dT} = \frac{\partial C_{66}}{\partial T}\cos^2\theta + \frac{\partial C_{44}}{\partial T}\sin^2\theta - \frac{\partial C_{14}}{\partial T}\sin 2\theta$$

From a series of measurements Prof. Koga determined adiabatic elastic constants which are as follows:

$$\left.\begin{aligned}
\frac{\partial C_{44}}{\partial T} &= -113.5 \times 10^6 \\
\frac{\partial C_{14}}{\partial T} &= -18.5 \times 10^6 \\
\frac{\partial C_{66}}{\partial T} &= +77.8 \times 10^6 \\
\frac{1}{C_{44}}\frac{\partial C_{44}}{\partial T} &= -199 \times 10^{-6} \\
\frac{1}{C_{14}}\frac{\partial C_{14}}{\partial T} &= +110 \times 10^{-6}
\end{aligned}\right\} \quad .. \quad (9)$$

Substituting the values from (9) in (8) we have for the temperature coefficient of frequency:

$$\alpha = \frac{1}{f}\frac{\partial f}{\partial T} = \frac{1}{2}\left[\frac{(77.8\cos^2\theta - 113.5\sin^2\theta - 18.5\sin 2\theta)10^6}{(39.10\cos^2\theta + 57.09\sin^2\theta - 16.87\sin 2\theta)10^{10}} + (7.5 + 12.4\sin^2\theta)10^{-6}\right] \quad .. \quad (10)$$

Equation (10) represents theoretical relation between the temperature coefficient of frequency and the angle of inclination of the plate. This relation is shown by Fig. 2.

Investigations of Prof. Koga, Dr. Bechmann and F. R. Lack, G. W. Willard and J. E. Fair show close agreement between experimental and theoretical results.

It follows from the above that there are two angles $\theta = 35$ deg. and -49 deg. at which the temperature coefficient of frequency $= 0$. The 35 deg. cut is denoted as *AC* cut and the -49 deg. cut is denoted as *BC* cut.

It is possible to attain small temperature coefficient of frequency in plates, whose thickness is comparatively small in comparison with the remaining dimensions of plate, i.e. for frequencies above 3,000 kc/s.

In May, 1937, S. C. Hight and G. W. Willard[1] described plates of the *CT* and *DT*

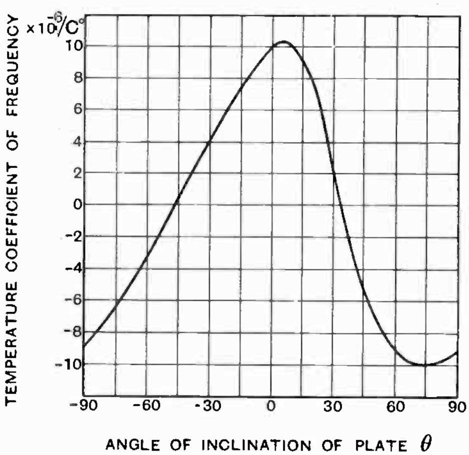


Fig. 2.

cuts exhibiting low temperature coefficients for frequencies below 500 kc/s. These plates are closely related to the plates of the *AT* and *BT* cut.

The same X'_y shear strain associated with X' and Y' axis, appears in all these cuts.

In *CT* plate the X'_y strain is produced by a shear mode of vibration as shown by the arrows Fig. 3(a) which represent instantaneous displacements. In this case the nodal plane is the mid plane of the plate. The frequency of vibration is determined from the dimension of Y'.

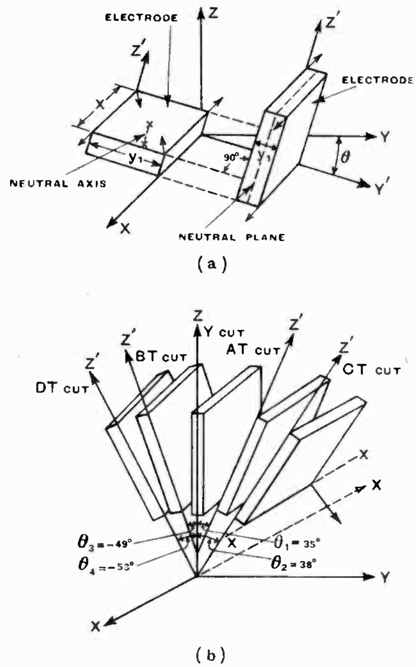


Fig. 3.

In the *DT* cut plate the elongation takes place along one diagonal and contraction along the other diagonal. The nodal line joins the centres of two opposite planes. The frequency of the *DT* and *CT* cuts depends upon dimensions along *X* and *Y*. The temperature coefficient of frequency of these plates may be made zero by proper choice of an angle of inclination of plate to the *Z* axis.

Actually the angle of the *DT* cut plate is not inclined exactly at 90 deg. to the *AT* cut plate. This is due to several factors, one being that the frequency determining dimension is not in the same direction in both cases.

However, the low frequency *DT* plate is practically analogous to the *AT* plate because the same elastic constant is responsible for the vibrations of these plates.

If we increase the dimension Y' of the *AT* plate a trouble is introduced from

[1] S. C. Hight and G. W. Willard: "A Simplified Circuit for Frequency Substandards Employing a New Type of Low-frequency Zero-temperature Coefficient Quartz Crystal," *Proc. Inst. Rad. Eng.*, May, 1937.

coupled modes of vibrations. In order to get rid of these vibrations one must keep the frequency-determining dimension Y' of the AT plates small in comparison with the other dimensions. With a small dimension of Y' undesirable frequencies are considerably below the fundamental frequency. With the DT cut plate the fundamental frequency is considerably below the undesirable frequency.

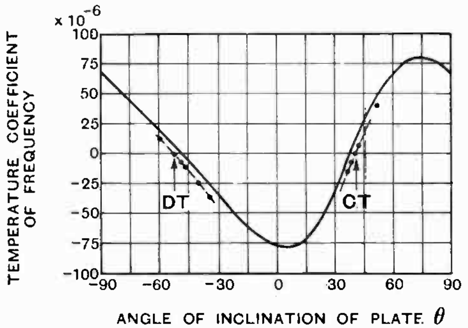


Fig. 4.

Under these conditions the undesired modes of vibrations have the least effect upon the desired frequency.

From S. C. Hight's and G. W. Willard's experiments it follows that for frequencies below 500 kc/s it is possible to use DT cut plates corresponding to AT cut and CT cut plates corresponding to BT cut. The orientations of these plates are shown in the Fig. 3(b).

The frequency of CT and DT cut plates depends upon the larger edge dimension of X and Z', the density ρ and elastic constant C'_{55} which is determined from the relation :

$$C'_{55} = C_{44} \cos^2\theta + C_{66} \sin^2\theta + 2C_{14} \sin 2\theta \quad (11)$$

where θ is an angle of inclination of plate to Z axis.

The frequency of vibrations of these plates may be calculated from the formula :

$$f = \frac{0.625}{d} \sqrt{\frac{C'_{55}}{\rho}} \quad \ldots \quad \ldots \quad (12)$$

where $d = X = Z'$ for square plate

and $d = \frac{X + Z'}{2}$ for approximately square plate.

It is found experimentally that the calculated value of frequency constant (dimension $\times$ frequency) agrees with the measured values within 2 per cent.

The temperature coefficient of frequency calculated from (11) and (12) and the respective temperature coefficients of their components and the values determined experimentally are represented in Fig. 4.

It follows that there are two orientations giving zero temperature coefficient of frequency CT at $+ 38$ deg. and DT at $- 53$ deg.

Fig. 5(a) and (b) show the relation between the frequency and the variation of temperature. It follows from these parabolic curves that zero temperature coefficient appears at a certain specified temperature for particular orientation of the plate with regard to Z axis. For that reason the orientation of plate should be chosen to suit the temperature at which it is desired to operate the quartz plate.

DT plates exhibit a flatter characteristic than the CT type. The activity of CT and DT plates varies with the orientation angle θ. The piezo-electric constant may be calculated from the equation :

$$d'_{25} = - d_{14} \cos^2\theta - d_{11} \sin\theta \cos\theta \quad (13)$$

It follows from the above formula that the CT cut plate is about 60 per cent. more

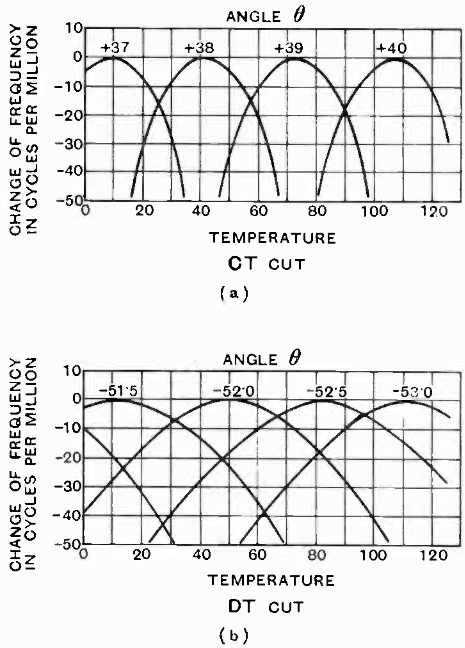


Fig. 5.

active than the *DT* cut plate. The disadvantage of these plates is that the zero temperature coefficient of frequency is secured only at certain specific temperature; when the temperature varies, the frequency varies also. For that reason in practice it is necessary to place these plates in thermostats.

From the above summary it is seen that it is possible to secure zero temperature coefficient plates by using *AT* and *BT* cuts for frequencies above 3,000 kc/s and *CT* and *DT* cut plates for frequencies below 500 kc/s.

Influence of Z′ upon Temperature Coefficient of Frequency

Numerous experiments carried out by the author on *AT* cut plates proved that by the proper choice of the length Z' it was possible to make plates of thermal coefficient of frequency equal to or approximating zero for frequencies between 300 and 1,000 kc/s. For that reason it was decided to carry out experiments on the dependence of the temperature coefficient of frequency upon the length Z' of plates.

Plates for these experiments were cut parallel to the X axis with an accuracy of 0.5′ and inclined at 35 deg. to the Z axis.

The above table shows the sizes and frequencies of plates used for experimental purposes.

The plates used for experiments were cut from different quartz crystals.

Plates 1, 2 and 3 were cut from one quartz piece, plates 4, 5 and 6 from another piece and plates 7, 8 and 9 from a third piece. In all cases the frequency along the X axis was determined as indicated in column 4 of the table. It should be noticed that the vibrations along the X axis were easily excited and were used for stabilisation of experimental generator for determination of temperature coefficient of frequency of plates 4, 5 and 6. These coefficients are tabulated in column 5 of the table. As it is seen, these coefficients are negative and vary between − 6.7 and − 29.5.

No. of plate.	Size in mm.			Frequency (kc/s) along Y′.	Frequency (kc/s) along X.	Temperature coefficient of frequency along X.
1	38.90	23.90	5.38	323.000	109.700	Not determined.
2	46.80	23.70	5.35	325.000	110.633	Not determined.
3	46.00	24.30	5.35	319.922	107.900	Not determined.
4 {	39.80	22.30	5.45	324.500	—	—
— {	37.97	21.70	4.22	—	147.500	-6.73×10^{-6}
5	43.89	22.40	5.43	325,362	136.000	-29.50×10^{-6}
6	43.86	22.36	5.42	324,000	134.500	-23.30×10^{-6}
7	40.00	25.80	1.50	1,117.765	99.000	Not determined.
8	46.52	26.20	2.00	862.178	96.000	Not determined.
9	40.15	26.00	1.00	1,571.475	122.000	Not determined.

After these preliminary measurements it was decided to determine the relation between the length Z' and the temperature coefficient of frequency along Y' and the influence of Z' upon the frequency in the direction of Y'.

In plates 1, 2, 3 and 4 the length Z' was reduced in steps of several tenths of millimeter and the measurements of the temperature coefficient of frequency proved that it was possible to prepare plates having small or approximately zero temperature coefficient of frequency at the following ratios of Z' to X (see Fig. 6).

(1) For plate 1 approximately as 3 : 2 and 4 : 3.

(2) For plate 2 approximately as 2 : 1 and 5 : 3.

(3) For plate 3 approximately as 2 : 1, 5 : 3 and 3 : 2.

(4) For plate 4 approximately as 2 : 1.

In view of that it was decided to carry out experiments on plates 5 and 6 in greater detail by reducing the length Z' in small steps of hundredths of a millimeter.

As is seen from the curve (Fig. 6) the change of the temperature coefficient of frequency with respect to the change of Z' for plates 5 and 6 is practically identical.

At the ratio of Z' to X slightly below 2 : 1 the temperature coefficient of frequency is equal to or approaches zero. With further change of Z' this coefficient increases and reaches the value of -30×10^{-6}, and then decreases rapidly to -3 or -4×10^{-6} per 1 deg. C. and remains practically constant until the length of 38 mm. is reached. Between 38 and 33 mm. the temperature coefficient of frequency varies considerably and irregularly.

out with plate 9 of frequency 1,571.475 kc/s. The author succeeded in securing zero temperature coefficient by the change of Z', but the frequency jumps caused great trouble at that frequency. When by the change of Z' the frequency jump was eliminated at low temperature it appeared at high temperature and vice-versa.

For that reason the above method of preparation of plates for frequency about 1,500 kc/s is not suitable. Then plate 7 of

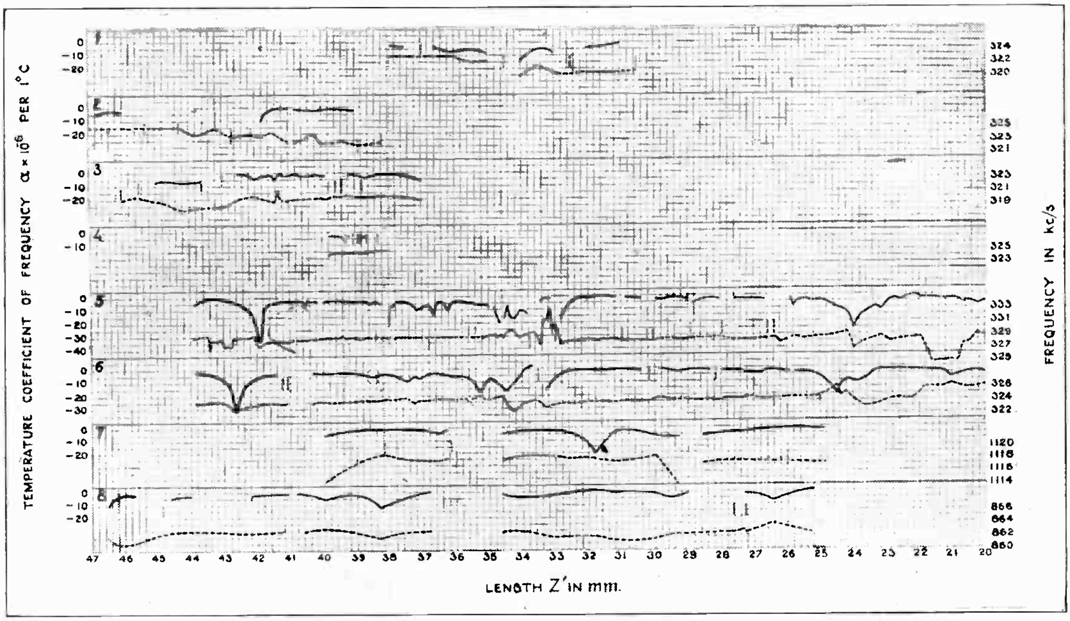


Fig. 6.—*Full line denotes temperature coefficient of frequency. Dotted line denotes frequency. Dotted vertical line denotes frequency jumps.*

When Z' reaches the value of about 33 mm. the coefficient again reaches the high value of about -18×10^{-6} per 1 deg. C. With still further reduction of Z' the value of this coefficient approaches zero. At 31 mm. it increases slightly. Between 26 and 23 mm. the coefficient changes irregularly. With further decrease of Z' the temperature coefficients are quite small. It follows from the above that when the ratio of Z' to $X = 2 : 1$, $9 : 5$, $3 : 2$ and $1 : 1$ the plates have small temperature coefficient of frequency. In order to determine the highest frequency of plates at which it is possible to attain small temperature coefficient by the above method experiments were carried

frequency 1,117.765 kc/s was tried. In this plate it was possible to attain zero temperature coefficient by the change of Z'. As is seen from Fig. 6 small temperature coefficient of frequency was obtained for $Z' =$ 39 — 38 mm., 34 — 33 mm., 31 — 30 mm. and 26 — 25 mm. In this case the ratio of Z' to X was 3 : 2, 5 : 4 and 1 : 1.

With plate 8 (frequency 862.178 kc/s) small temperature coefficient of frequency appears at $Z' = 46$ mm., 42.2 — 41 mm., 37 mm. 32 — 30 mm. and 25 mm., corresponding approximately to ratios of Z' to X of 7 : 4, 3 : 2, 5 : 4 and 1 : 1.

It follows from the above that it is possible to make plates of small temperature coefficient of frequency by the change of Z'. As the plates were cut from different blocks

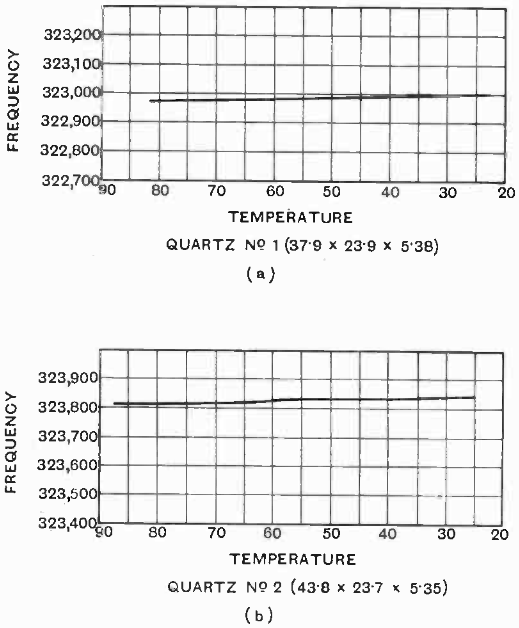


Fig. 7.

of quartz this conclusion appears to be general.

Frequency Jumps

As was mentioned above, the frequency jumps are very troublesome at frequencies above 1,500 kc/s and cause enormous practical difficulties in the preparation of plates for frequencies of this magnitude. On the other hand, it is possible to get rid of frequency jumps and parasitic frequencies by the change of Z' of plates for frequencies below 1,100 kc/s. The thicker the plate, the less troublesome are frequency jumps and the more readily can they be eliminated. As is seen from Fig. 6, the frequency jumps are not very troublesome in plates of 320 kc/s.

Very often a small change of Z' is sufficient to eliminate a frequency jump. It follows from the above that by the change of Z' it may be possible to prepare plates having small temperature coefficient for frequencies considerably below 300 kc/s.

Variation of Frequency caused by the Change of Z′

As is seen from Fig. 6, the change of Z' causes a change of frequency along Y'. The frequency appears to change more or less when the temperature coefficient of frequency changes considerably and irregularly. This change of frequency along Y' caused by the change of Z' should be taken into consideration when plates are to be ground for particular frequency.

Luminous Effect

In order to test the suitability of AT cut plates for making luminous quartzes, plate 2 was cut into small pieces. The particulars of those small plates are given in the table below:

No. of plate.	Size in mm.			Frequency (kc/s).	Coefficient $\alpha \times 10^{-6}$ per 1° C.
	Z'.	X	Y'.		
1	16.7	4.9	0.49	3,296.180	—8.170
2	15.0	5.8	0.49	3,299.000	—1.312
3	8.0	4.0	0.49	3,445.213	—0.317
4	10.0	4.0	0.49	3,441.710	—0.497

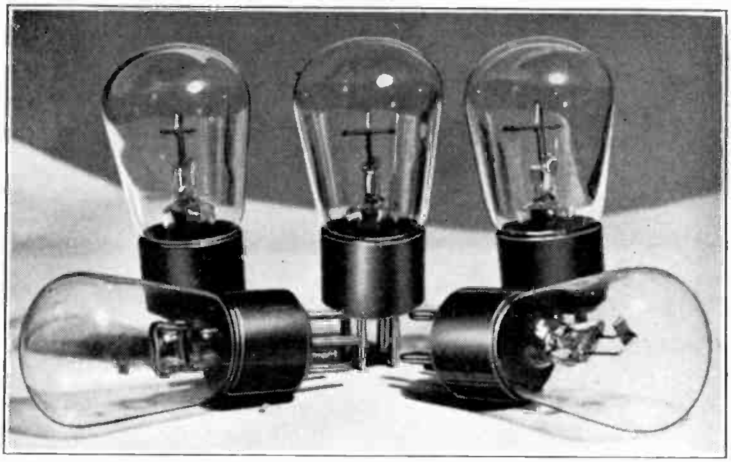


Fig. 8.

These plates were placed in a glass bulb (Fig. 8) filled with neon and the temperature coefficients of frequency were measured.

These measurements show that it is

possible to use AT cut plates for making luminous quartzes of small temperature coefficient of frequency.

Summary

The above experiments show:

(1) That it is possible to prepare plates for frequencies 1,100 — 300 kc/s, having zero or small temperature coefficient of frequency by suitable choice of ratio of Z' to X.

(2) That it is possible to eliminate jumps of frequency and spurious frequencies by the change of Z'; further, it is shown that the thicker the plate the less troublesome are frequency jumps.

(3) That the change of frequency of plates with respect to the variation of temperature is practically rectilinear and that the temperature coefficient of frequency for vibrations along Y' axis is generally negative.

(4) That the change of Z' has some influence upon the change of frequency along Y'.

(5) That it is possible to use AT cut plates for making luminous quartz plates of small temperature coefficient of frequency.

Correspondence

Noise of Frequency Changer Valves

To the Editor, The Wireless Engineer.

SIR,—The letter from the Tungsram Research Laboratories, published in the November *Wireless Engineer*, gives most important experimental information on this subject; but I think the theory behind it is far simpler, and more fundamental, than that proposed by the writers. I maintain, in fact, that the additional noise from heterodyning of the signal-frequency part of the noise spectrum by the local oscillator fails to appear simply because the signal-frequency spectrum does not exist at any point where it can be heterodyned by the local oscillator.

Perhaps this sweeping statement can best be explained with the aid of an acoustic analogy. If, for example, a stream of lead shot were poured on to a bell or other acoustic resonator tuned to 1,000 c/s, I should expect to hear the characteristic tone of the resonator being excited; and alternatively, if the stream were diverted to a 5,000 c/s resonator, I should expect to be able to generate a 1,000 c/s difference tone by turning on simultaneously a continuous tone source of say 4,000 c/s. But with the stream of shot turned back to the 1,000 c/s resonator only and the 4,000 c/s generator still running, I should not expect to hear, in addition to the direct 1,000 c/s tone, a further component at this frequency due to heterodyning of the independent 4,000 c/s tone with the 5,000 c/s component of the Fourier analysis of the irregular wave-form representing the impacts of the numerous independent shot on any receiver. In fact, I should expect the 1,000 c/s tone to be exactly the same with or without the independent 4,000 c/s tone, and to depend only upon the characteristics of the stream of shot and of the resonator on which it is impinging.

In the actual valve problem, it must be remembered that each single electron travelling through the valve is equivalent to a pulse of electric current whose duration is much shorter than a cycle of the working frequency of any of the circuits attached to the valve. While the electrons are in flight, therefore, and regarded as individuals, their "noise spectrum" consists mainly of frequencies of the order of say 10^9 or 10^{10} c/s upwards; but as soon as the electron stream impinges on an electrode, the aggregate result of large numbers of these extremely brief impulses, distributed in a random manner, generates fluctuations of potential at frequencies controlled by the characteristics of the circuit attached to the electrode. Hence in the frequency changer, the only noise due to the valve which appears in the anode circuit is that generated at the anode in exactly the same way as would occur in an amplifying valve receiving the same anode current. Obviously, however, this would no longer be true if grid-current were to flow at the signal control grid; for the flow of electrons to the control grid would set up signal-frequency fluctuations in its associated circuits, and these would be heterodyned by the local oscillator. At very high frequencies, it might be necessary to take account of the current to a negative grid arising from the charges induced on it by electrons in transit. There must of course be noise of oscillator frequency in the oscillator circuits, and this will appear in the I.F. output *if the conversion efficiency varies appreciably with oscillator amplitude*. But in normal working conditions, the very shallow modulation of the oscillator by noise will not have any effect on the amplitude of the difference frequency after rectification, and the oscillator noise therefore should not appear in the intermediate-frequency circuits. The conclusion is, therefore, that the noise output of a frequency changer will be the same as would be the noise output of an amplifying valve having an anode current of similar characteristics, *i.e.*, equal magnitude and shot noise "smoothing factor." D. A. BELL.

Chelmsford.

The Physical Society's Exhibition

THE Twenty-ninth Annual Exhibition of Scientific Instruments and Apparatus, arranged by the Physical Society, will be held at the Imperial College of Science and Technology, Imperial Institute Road, South Kensington, London, S.W.7, as follows:—

January 3rd, 2.30 to 9 p.m.; January 4th, 4 to 9 p.m.; January 5th, 2.30 to 9 p.m.

Admission to the exhibition is by ticket only. Members of Institutions and Scientific Societies may obtain tickets from their Secretaries; tickets may also be obtained from the Exhibition Secretary, 1, Lowther Gardens, Exhibition Road, S.W.7.

The February issue of *The Wireless Engineer* will contain a descriptive report of the exhibits of interest to wireless engineers.

The Stability of a Triode-Oscillator with Grid-Condenser and Leak*

By J. van Slooten

Natuurkundig Laboratorium der N.V. Philips' Gloeilampenfabricken, Eindhoven, Holland)

SUMMARY.—Thermionic oscillators, operating with grid-condenser and leak, under certain circumstances show the effect of "relaxation" or over-oscillating, being a periodic interruption of the oscillatory process.

This phenomenon is to be understood as instability of the only possible state of "normal" oscillation. The stability is analysed by the method of small oscillations, here oscillations of the amplitude in the neighbourhood of its stationary value, and a condition for stable operation is developed.

Introduction

It is a well-known fact that thermionic oscillators, operating with grid-condenser and leak, show a tendency to relaxation or "over-oscillating," which is a periodic interruption of the oscillatory process. This phenomenon occurs specially on short wavelengths and with strong retroaction.

It is also well known that small values of grid condenser and leak resistance are favourable for avoiding this undesirable effect, which in practice constitutes a limit to the design of triode-oscillators for shortwave superheterodyne receivers.

When the process of interruption starts, its period is determined by the relaxation-time RC of grid-condenser and leak. [1]

Further, it is known that when the process starts, this relaxation-time is of the same order of magnitude as the time constant $\frac{L}{r}$ of the oscillator circuit. But, as far as we know, there has not yet been given a theory, describing more precisely the conditions, under which the process begins. In this paper such a theory is given, which proves to be in satisfactory accordance with the facts.

In studying the subject it appeared to be of little use to analyse more in detail what happens, when the process of relaxation exists. It is the cause of the effect which really interests us, and this cause can be described by the following statement: The process of relaxation starts when the retroaction is so far increased that the only possible state of normal oscillation becomes unstable.

So we direct our attention to the state of normal oscillation, and in particular to its stability. The mentioned relaxation process can then be referred to as a "state of instability."

Now we find as the important cause for instability the fact that as soon as the working point, that is the D.C. position of the grid voltage, moves to the left of the cut-off point B (see Fig. 2), the average value of the mutual conductance of the tube increases with increasing oscillator voltage.

We shall call this the anti-stabilising effect, and it is evident that the oscillator could not be adjusted in such a way if there were not another effect to counteract this anti-stabilising effect.

In the case of an oscillator without grid-condenser and leak, it is the increased damping by grid currents which produces stability.

But in the case of a grid condenser and leak, grid currents are relatively small and cannot produce stability in this way.

Stability can now be produced by the fact that the D.C. position of the grid changes with the grid currents. More precisely: When the oscillator voltage increases, the mean grid current increases and this excess in grid current charges the grid condenser K (see Fig. 1).

As a result, the negative grid voltage increases, which means a decrease of the average mutual conductance. This we call the stabilising effect, and the stability of the oscillator depends on whether this effect can counterbalance the anti-stabilising effect or

* MS accepted by the Editor, July, 1938.

[1] In the following the value of the grid condenser is denoted by K.

not. We will consider this more in detail in the theoretical part.

So what we propose to do is to analyse the stability of the oscillator by what is known as the method of small oscillations, although this name is somewhat misleading in this case.

We will derive a differential equation, not for the instantaneous value of the oscillator voltage, but for its amplitude.

This differential equation describes the variation of the amplitude in the neighbourhood of its stationary value. In other words, we will consider a sinusoidal oscillator voltage with slowly varying amplitude.

Theoretical Part

In Fig. 1 a normal triode oscillator circuit is shown. Grid-condenser and leak resistance are called K and R, w means the amplitude of the oscillator voltage and v_g the D.C. value of the grid voltage. The symbols M, L, r and C need no further explanation.

The resistance r represents the total amount of all damping and will be regarded as a constant.

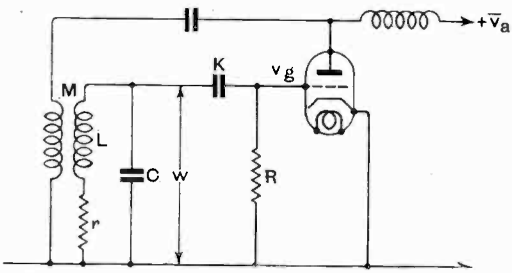


Fig. 1.—*A conventional oscillator-circuit. We see the circuit-coil L, the variable condenser C, the grid condenser K and leak R. The resistance r represents all damping. The amplitude of oscillation is denoted by w and v_g represents the D.C. voltage of K.*

As is well known, the condition for regeneration is

$$r - \frac{M\bar{S}_s}{C} = 0 \quad \ldots \quad \ldots \quad \ldots \quad (1)$$

where $\bar{S}$ means the average value of the mutual conductance of the triode. The index s here and in the following refers to the stationary state. Equation (1) expresses that the negative resistance, introduced in the circuit by the retroaction, equals the positive resistance.

In Fig. 2 is depicted the $i_a - v_g$ characteristic of the tube, which we suppose to be rectilinear.

If we now assume, as is shown in Fig. 2, that the working point A is to the left of the cut-off point B, the average mutual conductance $\bar{S}$ can be calculated by determining the first harmonic in the anode current. But it can be proved that we make only a small error if we suppose that $\bar{S}$ is given by $tg\,\beta$.

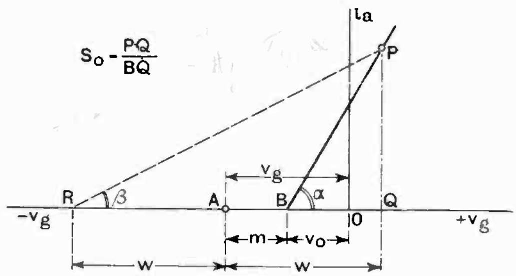


Fig. 2.—*The $i_a - v_g$ characteristic of the tube. B is the cut-off point, given by v_0, and A the working point, given by v_g. The amplitude of oscillation w reaches into the region of grid currents, supposed to begin at $v_g = 0$.*

Thus if we call $tg\alpha = S_0$ the slope of the rectilinear part of the characteristic, we have

$$\bar{S} = tg\beta = \frac{S_0}{2}\left(1 - \frac{m}{w}\right) \quad \ldots \quad \ldots \quad (2)$$

where m has the meaning, shown in Fig. 2 ($v_g = v_0 + m$).

Equations (1) and (2) do not determine exactly the working point A, as it is not yet known how far the amplitude w will reach into the region of grid currents.

In Fig. 3 is shown the relation between w and grid currents. For sake of simplicity we assume the grid current characteristic to be a straight line, which is permissible if the peak value of the grid current is at least 0.5 mA., which in most cases will be true. Now the grid current can be defined by the internal resistance R_i.

The calculation of the mean grid current is given in the appendix. It is shown there that, assuming the quotient v_g/w to differ only slightly from unity, the mean value of the grid current is:

$$\bar{i}_g = \frac{w}{R_i} \cdot \frac{2\sqrt{2}}{3\pi} \cdot \left(1 - \frac{v_g}{w}\right)^{3/2} \quad \ldots \quad \ldots \quad (3)$$

Here and in the following, the negative grid voltage is denoted by the positive quantity v_g. Further it will be evident that in the stationary state of oscillation we have the relation :

$$v_{gs} = \bar{i}_{gs} R \qquad \ldots \quad \ldots \quad \ldots \quad (4)$$

Now we can say that the stationary state of oscillation is fully determined by the relations (1) . . . (4), which will still be true if we consider the damping r to be dependent on $\bar{i}_{gs}$.

We still, however, suppose r to be constant.

Now we can turn to the calculation of the stability and we shall first consider the anti-stabilising effect, described in the introduction.

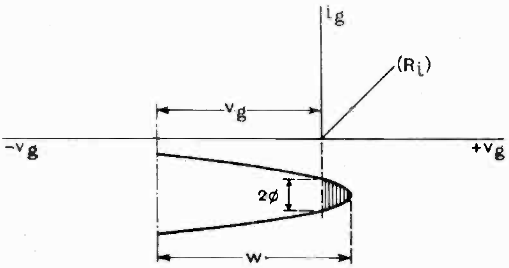


Fig. 3.—*Depicts the position of the amplitude w in connection to the rectilinear grid current characteristic. The shaded area represents the mean value of the grid current.*

We define simultaneously small changes of w and v_g from their values in the stationary state by :

$$\left.\begin{aligned} w &= w_s + \Delta w \\ v_g &= v_{gs} + \Delta v_g \end{aligned}\right\} \ldots \quad \ldots \quad \ldots \quad (5)$$

The resulting change of $\bar{S}$ can be calculated from (2) :

$$\frac{\partial \bar{S}}{\partial w} = \frac{S_0}{2} \frac{m}{w^2} \qquad \ldots \quad \ldots \quad \ldots \quad (6a)$$

$$\frac{\partial \bar{S}}{\partial v_g} = \frac{\partial \bar{S}}{\partial m} = -\frac{S_0}{2} \cdot \frac{1}{w} \qquad \ldots \quad \ldots \quad (6b)$$

Hence the total change of $\bar{S}$ will be :

$$\Delta \bar{S} = \frac{S_0}{2w_s}\left(\frac{m_s}{w_s}\Delta w - \Delta v_g\right) \qquad \ldots \quad (7)$$

The negative resistance introduced in the oscillator circuit now becomes (as a consequence of (1)) :

$$-\Delta r = \frac{M}{C}\Delta \bar{S} = \frac{MS_0}{2C} \cdot \frac{1}{w_s}\left(\frac{m_s}{w_s}\Delta w - \Delta v_g\right) \ldots (8)$$

As the total resistance in the circuit in the stationary state of oscillation is zero, (8) represents the total negative resistance when there is a deviation from this state.

Now we know that the free oscillations in a circuit, consisting of L, C and r, decrease by the exponential law: $w_t = w_0 e^{-\frac{r}{2L}t}$. Hence we have in our case :

$$\frac{dw}{dt} = \frac{d\Delta w}{dt} = -w\frac{\Delta r}{2L} = w_s \frac{M}{2LC}\Delta \bar{S}$$

Hence, using (7) :

$$\frac{d\Delta w}{dt} = \frac{MS_0}{4LC}\left\{\frac{m_s}{w_s}\Delta w - \Delta v_g\right\} \qquad \ldots \quad (9)$$

We will now consider the effect, called stabilising effect in the introduction, and produced by the change in the mean grid current.

By differentiating (3) and using equation (4) for the stationary state, we find (see appendix) :

$$\frac{\partial \bar{i}_g}{\partial w} = -\frac{\partial \bar{i}_g}{\partial v_g} = \frac{0.7}{\sqrt[3]{R_i^2 R}} \ldots \qquad \ldots \quad (10)$$

where R_i is the already mentioned internal resistance of the grid current characteristic. Hence :

$$\Delta \bar{i}_g = \frac{0.7}{\sqrt[3]{R_i^2 R}}(\Delta w - \Delta v_g) \qquad \ldots \quad (11)$$

The change in the current flowing through the leak resistance R is on the other hand :

$$\Delta \bar{i}_R = \frac{\Delta v_g}{R} \qquad \ldots \quad \ldots \quad \ldots \quad (12)$$

It will be clear that the difference between the currents, given by (11) and (12), is a current that charges the grid-condenser K and thus produces a further change of v_g. This can be expressed by the equation :

$$\frac{dv_g}{dt} = \frac{d\Delta v_g}{dt} = \frac{1}{K}(\Delta \bar{i}_g - \Delta \bar{i}_R) = \frac{1}{K}\left\{\frac{0.7}{\sqrt[3]{R_i^2 R}}\Delta w - \Delta v_g\left(\frac{0.7}{\sqrt[3]{R_i^2 R}} + \frac{1}{R}\right)\right\} \quad \ldots \quad (13)$$

The two equations (9) and (13) together describe the variations of Δw and Δv_g in the neighbourhood of the stationary state of oscillation.

We write them in the more simple form :

$$\left.\begin{aligned}\frac{d\Delta w}{dt} &= a\Delta w - b\Delta v_g\\ \frac{d\Delta v_g}{dt} &= c\Delta w - d\Delta v_g\end{aligned}\right\} \quad .. \quad .. \quad (14)$$

where a, b, c and d stand for :

$$a = \frac{MS_0}{4LC}\cdot\frac{m_s}{w_s},\quad b = \frac{MS_0}{4LC},\quad c = \frac{0.7}{K\sqrt[3]{R_i^2R}},$$

$$d = c + \frac{1}{KR} \quad .. \quad .. \quad .. \quad .. \quad (15)$$

We now can eliminate Δv_g from equations (14), which gives a second order differential equation for Δw.

$$\Delta w'' + \Delta w'(d - a) + \Delta w(bc - ad) = 0.$$

Now we put $\Delta w = e^{pt}$, which leads to

$$p^2 + p(d - a) + bc - ad = 0 \quad .. \quad (16)$$

When the real part of the roots of (16) is negative, there will be stability, as is well known.

Now we have from (16) :

$$p = \tfrac{1}{2}\{a - d \pm \sqrt{(a + d)^2 - 4\,bc}\}$$

Under practical circumstances we have $R_i \ll R$, hence d will approximately be equal to c.

As we have further $b > a$, we see that the expression under the root will be negative, thus the real part of p is $\frac{1}{2}(a - d)$ and we can draw the conclusion that the condition for stability will be :

$$d > a$$

Putting $c = d$, this becomes

$$\frac{0.7}{K\sqrt[3]{R_i^2R}} > \frac{MS_0}{4LC}\,\frac{m_s}{w_s}$$

This result can be put in a more simple form by making use of (2) and (1). So we find as the condition for stable operation in its most simple form :

$$K\sqrt[3]{R_i^2R} < 1{,}4\,\frac{L}{r}\left(\frac{w_s}{m_s} - 1\right) \quad .. \quad (17)$$

On the left side we see the product of the grid-condenser K and a resistance, lying in value between the grid leak R and the internal resistance of the grid current characteristic. On the right side we see the time constant $\frac{L}{r}$ and a factor, depending on the strength of oscillation.

When we put $m_s = 0$, which expresses that the working point falls on the cut-off point, there will be stability for every value of K.

We further see that it is advantageous to improve the quality of the oscillator circuit, if the retroaction is at the same time so far reduced that the strength of oscillation remains the same, a fact also known from practice.

APPENDIX

The mean grid current $\bar{i}_g$ is, as will be clear in connection with Fig. 3, determined by :

$$\bar{i}_g = \frac{\omega}{2\pi}\,\frac{1}{R_i}\int_{-\phi}^{+\phi}(w\cos\psi - v_g)\,\frac{d\psi}{\omega}$$

$$= \frac{\omega}{\pi R_i}\int_0^{\phi}\left(\cos\psi - \frac{v_g}{\omega}\right)d\psi$$

As ϕ is a small angle, we have in approximation :

$$\bar{i}_g = \frac{\omega}{\pi R_i}\int_0^{\phi}\left(1 - \tfrac{1}{2}\psi^2 - \frac{v_g}{\omega}\right)d\psi$$

$$= \frac{\omega}{\pi R_i}\left\{\phi\left(1 - \frac{v_g}{\omega}\right) - \frac{\phi^3}{6}\right\} \quad .. \quad (18)$$

We further have

$$\frac{v_g}{\omega} = \cos\phi = 1 - \tfrac{1}{2}\phi^2$$

Hence $\qquad \phi^2 = 2\left(1 - \frac{v_g}{\omega}\right)$

So we get :

$$\bar{i}_g = \frac{\omega}{\pi R_i}\cdot 1/3\,\phi^3 = \frac{\omega}{R_i}\cdot\frac{2\sqrt{2}}{3\pi}\left(1 - \frac{v_g}{\omega}\right)^{3/2} .. \quad (3)$$

We now find for the derivative :

$$\frac{\partial\bar{i}_g}{\partial\omega} = \frac{1}{R_i}\cdot\frac{2\sqrt{2}}{3\pi}\cdot\left(1 - \frac{v_g}{\omega}\right)^{3/2} + \frac{1}{R_i}\,\frac{2\sqrt{2}}{3\pi}\,w\,3/2\left(1 - \frac{v_g}{\omega}\right)^{1/2}\frac{v_g}{\omega^2}$$

As $\frac{v_g}{\omega}$ is approximately equal to unity, $\left(1 - \frac{v_g}{\omega}\right)$ can be regarded as a small quantity, and we have in approximation :

$$\frac{\partial\bar{i}_g}{\partial\omega} = \frac{1}{R_i}\,\frac{\sqrt{2}}{\pi}\left(1 - \frac{v_g}{\omega}\right)^{1/2} \quad .. \quad .. \quad (19)$$

Further we have :

$$\frac{\partial\bar{i}_g}{\partial v_g} = -\frac{1}{R_i}\cdot\frac{\sqrt{2}}{\pi}\cdot\left(1 - \frac{v_g}{\omega}\right)^{1/2} .. \quad .. \quad (20)$$

In the stationary state we have :

$$v_{gs} = \bar{i}_{gs}R = \frac{R}{R_i}\,w_s\cdot\frac{2\sqrt{2}}{3\pi}\cdot\left(1 - \frac{v_{gs}}{\omega_s}\right)^{3/2}$$

Hence

$$\left(1 - \frac{v_{gs}}{\omega_s}\right)^{3/2} = \frac{v_{gs}}{\omega_s}\cdot\frac{R_i}{R}\cdot\frac{3\pi}{2\sqrt{2}}$$

With the aid of this, (19) and (20) can be written as :

$$\frac{\partial\bar{i}_g}{\partial\omega} = -\frac{\partial\bar{i}_g}{\partial v_g} = \sqrt[3]{\frac{3}{\pi^2}\cdot\frac{1}{R_i^2R}} = \frac{0.7}{\sqrt[3]{R_i^2R}} \quad .. \quad (10)$$

when we put $\frac{v_{gs}}{\omega_s} = 1$.

Characteristics of the Ionosphere (F_2 Region)

Supply of Data from Radio Department, National Physical Laboratory

It is important to the radio engineer to know the highest frequency of radio waves which are returned from the ionosphere at any time or season, since this critical frequency represents the division between those frequencies which can be used for long-distance radio communication and those which are suitable for transmission only over quasi-optical ranges. The same knowledge is of importance also to the geophysicist, since it provides him with a reasonably accurate statement of the most intense ionisation existing at any level in the ionosphere.

For some years past the Radio Department of the National Physical Laboratory has conducted a comprehensive investigation into the propagation of waves as part of the programme of the Radio Research Board of the Department of Scientific and Industrial Research. Included in this work are daily measurements of the height and critical frequencies of the various regions of the ionosphere made at the field station of the Radio Department at Slough (lat. 51° 29′ 31″ N, Long. 0° 33′ 31″ W.). In view of the widespread use of long-distance radio communication and broadcasting on the short wave band between 10 and 100 metres (3 and 30 Mc/s) it is proposed that the ionospheric data relevant to this band should be made available as a special service to those interested in the subject.

When electric waves from a radio transmitter pass through the ionosphere, they are split into two components under the influence of the earth's magnetic field. These two components travel with different velocities and have opposite senses of circular polarisation. The region in the ionosphere which is capable of returning the higher radio frequencies to earth is known as the F_2 region, and the highest frequency which can just be returned by that region is known as the critical frequency and refers to the extraordinary component of the wave. It is, however, more convenient to measure the ordinary component, and in this hemisphere the plane of polarisation of this component has a left-handed direction of rotation when looking along the direction of propagation. The critical frequency for this component is generally about 0.7 Mc/s lower than that of the extraordinary component in the case of the results quoted. The daily measurements are carried out

Characteristics of the F_2 Region of the Ionosphere for November, 1938.

The following table contains the values of the critical penetration frequency for the F_2 region. The data refer to the ordinary ray and are obtained from vertical incidence measurements made at noon on weekdays at the Radio Research Station of the National Physical Laboratory (lat. 51° 29′ 31″ N, Long. 0° 33′ 31″ W.). The value of the critical frequency for the extraordinary ray is about 0.7 Mc/s higher than that given for the ordinary ray. Sufficient data are also given in the table to enable a curve to be drawn relating the frequency to the equivalent height of reflection, for the F_2 region. The following symbols are used in accordance with definitions agreed by the International Scientific Radio Union :—

f = frequency of exploring waves in megacycles per second.

$f^{\circ}_{F_2}$ = critical frequency for the F_2 region referred to the ordinary ray given in megacycles per second.

H′ = equivalent (or virtual) height in kilometres at which reflection takes place.

Date	f	H′	$f^{\circ}_{F_2}$	Date	f	H′	$f^{\circ}_{F_2}$	Date	f	H′	$f^{\circ}_{F_2}$	Date	f	H′	$f^{\circ}_{F_2}$
1	9.7 10.7 11.7 12.2	290 320 350 390	> 12.2	9	12.0 13.2 13.4	360 420 430	> 13.4	16	9.8 10.8 11.8 12.3	280 320 370 420	12.6	23	10.1 11.1 12.1 12.6	280 290 320 370	12.9
2	9.7 10.7 11.7 12.2	290 320 360 380	13.2	10	7.0 8.0 9.0 9.5	250 260 270 280	> 12.0	17	9.0 10.0 11.0 12.0	260 270 290 310	13.2	24	9.7 10.7 11.7 12.2	270 300 360 450	12.3
3	9.7 10.7 11.7 12.2	280 300 330 350	> 12.2	11	7.3 8.3 9.3 9.8	230 240 250 260	13.6	18	10.3 11.3 12.3 12.8	290 310 360 420	13.1	25	8.9 9.9 10.9 11.4	260 290 340 400	11.7
4	7.7 8.7 9.7 11.9	270 280 290 370	13	12	8.3 9.3 10.3 11.2	260 270 280 300	13.0	19	10.5 11.5 12.5 13.0	280 300 340 390	13.3	26	10.7 11.7 12.7 13.2	280 300 340 400	13.4
5	11.0 12.4 12.6 12.8	350 360 380 470	12.9	14	7.2 8.2 9.2 12.5	240 250 260 370	12.7	21	10.8 11.8 12.8 13.3	290 310 360 430	13.5	28	8.9 9.9 10.9 11.4	270 290 320 370	11.7
7	11.0 12.0 12.7 13.1	310 340 370 410	13.4	15	11.0 12.0 13.0 13.5	290 330 380 430	13.7	22	9.7 10.7 11.7 12.2	270 300 350 390	12.5	20	8.8 9.8 10.8 11.3	270 300 340 380	11.6
8	10.3 11.2 11.9 12.8	310 340 370 420	13.5									30	8.7 9.7 10.7 11.2	280 300 350 390	11.5

with waves returned from the ionosphere at vertical incidence, and the values of height and critical frequency of the regions studied refer to this condition. Physicists and engineers working on this subject are, however, familiar with the methods by which the corresponding values for oblique incidence may be derived, and from these, the conditions for long-distance communication can be deduced.

Included in this note is a table giving the results of the daily measurements made during the month of November 1938. This table gives a summary of the measurements made on week-days at noon, and sufficient values are usually given for any day to enable a simple curve to be plotted showing the relation between height and critical frequency of the region under consideration. Typescript copies of such monthly tables, beginning with January 1939, will be available for distribution to all those desiring to receive them on payment of a nominal subscription to cover the cost of preparation and postage. (2s. 6d. per annum for subscribers in this country or in the Empire overseas, and 5s. per annum for foreign subscribers. Applications for these tables, together with the appropriate remittance should be addressed to the Director, National Physical Laboratory, Teddington, Middlesex.) Arrangements have also been made by which those desiring to obtain early information on the state of the ionosphere as soon as the data are available may obtain them by telephoning the Radio Research Station (Slough 1560) between the hours of 10 a.m. and 4.30 p.m. Those wishing to avail themselves of this service should write to the Director of the National Physical Laboratory asking that their names may be registered, and at the same time enclosing a remittance of one guinea. For this sum fifty telephone enquiries will be answered during a period of twelve months. When fifty enquiries have been made, or at the end of twelve months, a payment of a further guinea will become due from those desiring to continue to receive information by telephone.

Book Reviews

Wireless Direction Finding

By R. Keen. Third and enlarged edition. Pp. 803 + xi with 549 illustrations. Iliffe & Sons Ltd., Dorset House, Stamford Street, London, S.E.1. Price 25s.

That small and comparatively select band of engineers and research workers who were engaged in the art of wireless direction finding nearly twenty years ago will remember the publication of Mr. Keen's work as the first text-book on the subject in the English language. This first edition was reviewed by the present writer in *The Wireless World* for December 23rd, 1922, and in general, the main criticism offered on an otherwise very satisfactory work, was that it was confined too much to one particular commercial system of direction finding. Five years later, a second edition was called for, and the author wisely enlarged the book to deal with other systems of direction finding, and even extended it to cover the use of directive aerial systems for general radio communication. To-day we are presented with the third edition which, with its scope reduced to the original objective, is still further enlarged in bulk and now forms a veritable cyclopaedia of the principles and practice of modern wireless direction finding.

The book now under review contains first a clear discussion, with a minimum of mathematics, of the principles of determination of direction or position by wireless means, using either special receivers or transmitters as the occasion demands. It includes detailed illustrated descriptions of most, if not all, the known commercial systems and apparatus for direction finding on land, sea or in the air, together with many practical details of direct use to those engaged in the installation or operation of direction finders or directive beacons. In addition, some account is given of many phases of research and investigations in the subject, particularly from the viewpoint of attempting to indicate the trend which future developments are likely to take.

In comparing this book with the preceding edition, it is interesting to note the progress that has been made in the intervening eleven years, and the extent to which this is dealt with by the author. The use of medium wave closed-loop direction finders for ship-to-shore working over ranges up to about 200 miles has resulted in steady improvements in design and construction with some accompanying increase in accuracy. In order to overcome the limitations in this field, due to the occurrence of night errors at the greater ranges, the Adcock aerial system has become a fully developed commercial proposition. While the reference to this system occupied less than two pages in the second edition, it comprises the subject matter of practically two whole chapters in the new book.

It is, however, the extension of direction finding as an effective aid to the navigation of aircraft that has given such a great stimulus to this subject during the past few years, and this accounts for much of the expansion of this latest work. The chapter on the shore direction finding station has been enlarged to cover the type of shore station now in operation for taking bearings of aircraft transmissions on medium wavelengths. Another chapter deals with the special equipment which is now available for carrying out the direction finding in the aircraft itself. Next, since the speed and ranges at which modern aircraft operate necessitate the use of direction finding bearings at distances of anything up to 2,000 miles, the technique has necessarily had to be worked out for short wavelengths. A separate chapter on this phase of the subject deals largely with the Adcock direction finder but also describes the extent to which the spaced-loop system is assisting in this field.

Succeeding chapters are also devoted to the use of fixed course transmitting beacons for long-range navigation, and to descriptions of the various systems, which have been suggested and tried out, particularly on ultra-short waves, for assisting aircraft to approach the aerodrome and land thereon in conditions of poor visibility. A chapter towards the end of the book surveys several systems of direction finding, including some ingenious schemes for obtaining a direct-reading instrument or a visual indication in place of the usual aural method. Included among these is the cathode ray direction finder which has proved such an ingenious and invaluable aid to various types of radio investigations for several years past.

In such a comprehensive work, it is difficult to criticise or draw attention to the few blemishes that exist without appearing to be pedantic. A general perusal of the whole book engenders a slight feeling that in places the descriptions are unnecessarily long and detailed, particularly where these refer to matters now largely of historical interest. As against this, however, it may be stated that it is often useful and suggestive for research workers to review some of the earlier work, particularly when effects which are negligible on one band of wave-lengths, may assume a major importance on another band which comes later into use. The writer considers also that the chapter on ultra-short wave landing beacons is not too satisfactory and may be found a little difficult to follow by those not already familiar with the subject. Chapter 2 is a good summary review of our knowledge of the propagation of waves and paves the way to an understanding of the principles of some of the direction finders described later in the book. But this chapter might not be found very easy to follow by a student new to the subject, and he might well be advised to pass over lightly or even omit this on a first reading of the book. In Chapter 10, the spaced-frame system is given priority over the Adcock system for short wave direction finding, whereas the former is at present used much more as a research tool than as a practical direction finder.

The author is to be congratulated on his bibliography of some 570 selected references, arranged in an original manner under the years of their publication. It would have been useful to have a footnote on p. 6, where the first reference number occurs, explaining the code employed and referring to the page on which the bibliography begins.

In a foreword to this edition, Mr. T. L. Eckersley explains how the subject of wireless direction finding provides an excellent example of the manner in which the technical and scientific aspects of the art have progressed hand in hand. It may well be stated that Mr. Keen has successfully achieved his object of providing a manual of instruction and reference in the subject appropriate to all classes of workers in direction finding, whether their interests are in design, construction, installation, operation, or investigation. R. L. S.-R.

Moderne Mehrgitter - Elektronenröhren (Modern Multigrid Valves).

By Dr. M. J. O. Strutt. Vol. 2. Electrophysical Foundations. Pp. 144 + v, with 98 Figs. Julius Springer, Linkstrasse 22-24, Berlin, W. 9. Price R.M. 13.50.

A review of Vol. 1 on the Construction, Operation and Characteristics of such valves was published in our issue of February 1938. The present volume is devoted to the physical theory involved in the operation of the valves. Dr. Strutt's work in the Philips Research Laboratories at Eindhoven is well known by reason of his many publications in technical journals. In Vol. 1 the static characteristics were taken as the starting point; in the present volume they are developed from the laws of electron dynamics, and the complicated electron movements in multigrid valves are calculated from fundamental principles. A section is devoted to the heating problems in such valves. In the preface the author states that there are more than a hundred million multigrid valves in use to-day in the whole world—an indication of their importance. The author devotes a special preface to the subject of the symbols and units employed. He refers very rightly to the annoyance of coming across a symbol that one remembers having seen earlier but without remembering what it stood for or exactly where it was. He uses practical units throughout, but we must confess that the statement on p. 7 that "The charge e is 1.6×10^{-19} coulomb and $e/m = 17.6 \times 10^{14}$ cm^2 sec^{-2} Volt^{-1}" came as a surprise when we were expecting coulombs per gramme. The figure given is the acceleration imparted to the electron by an electric field of 1 volt per cm. Unless we missed it, the actual value of m is not given in the book.

The material is handled in the clear straightforward manner which we associate with Dr. Strutt. That the calculations are sometimes rather complex and lead to equations occupying nine lines is the fault of the multigrid valve and not of the author.

Measurements on hexodes and octodes at short-wave frequencies are described and discussed, as is also the construction of valves to give as low a noise level as possible.

It is a book that one can confidently recommend.

G. W. O. H.

Ultrasonics, and Their Scientific and Technical Applications

By Dr. Ludwig Bergmann. Translated by Dr. H. Stafford Hatfield. Pp. 264, 148 figures. G. Bell and Sons, Ltd., 6, Portugal Street, London, W.C.2. Price 16s.

"Ultrasonics" concerns waves which are like sound waves but have frequencies which are comparable with radio frequencies. Like acoustics and radio, ultrasonics has made striking advances in the last quarter of a century, as numerous original papers testify. Until recently, however, those interested in the subject had no option but to consult the scattered papers, no complete summary being available before 1937, when Dr. Ludwig Bergmann's book in German gave a welcome general account of the subject. The present volume is an English translation with an additional section dealing with the application of ultrasonics to television, and an arranged list of references to those papers on ultrasonics which have been published in the few months which have elapsed since the German edition appeared.

The book naturally deals in turn with the generation, detection and measurement of ultrasonic waves. Quite a long interesting section is occupied by an illustrated account of methods of making sound waves visible, and of the diffraction of light

—like diffraction by an optical ruled grating—which arises in liquids subjected to ultrasonic waves. With stationary waves the intensity of the spectra is intermittent with double the frequency of the wave, and the phenomenon may be used to produce a high frequency modulation of light. Accounts are given of the use of the principle to afford high-frequency stroboscopic illumination, and of its application in a system of television where the cathode ray tube is not used.

The measurement of the velocity and absorption of ultrasonics in gases, liquids and solids has an important place in the book. Interferometers for accurately measuring the wavelengths of ultrasonics in gases are well described, and several tables give the velocity in vapours and organic liquids. Velocity measurements in liquids have a number of interesting contacts with the modern theory of electrolytes; and velocity measurements in solids—which may exhibit both longitudinal and torsional oscillations—make it possible for all the elastic constants of transparent (and even opaque) bodies to be determined from one sample.

Ultrasonics evolve considerable heat, break up highly polymerised molecules (e.g. convert starch into dextrine) and clear smokes by coagulating and depositing the particles. They have been used for determining the depth of the sea and for detecting the presence of icebergs, submarines, and even shoals of fish. Intense waves transform immiscibles, such as oil and water or even metals and water, into stable emulsions or colloidal solutions. They improve the homogeneity and stability of photographic emulsions, and in metallurgy promote finely grained alloys and cast metals. All these and other applications are surveyed in the book, and a brief outline of various biological effects is given.

The volume is well written, freely illustrated, and attractively produced. It is accompanied by a comprehensive bibliography. Whilst the treatment is mainly experimental in basis, theoretical considerations have been noted where they are essential to the understanding of the subject. The book provides a needed account of the present position in ultrasonic research and its applications.

A. H. D.

The Industry

A LEAFLET (in English) giving technical data regarding Elma H.F. transmission cable, which is made in various diameters, has been issued by Etablissements Elma, of Paris. The English agents are Hamrad Wholesale, 259, Ladbroke Grove, Kensington, London, W.10.

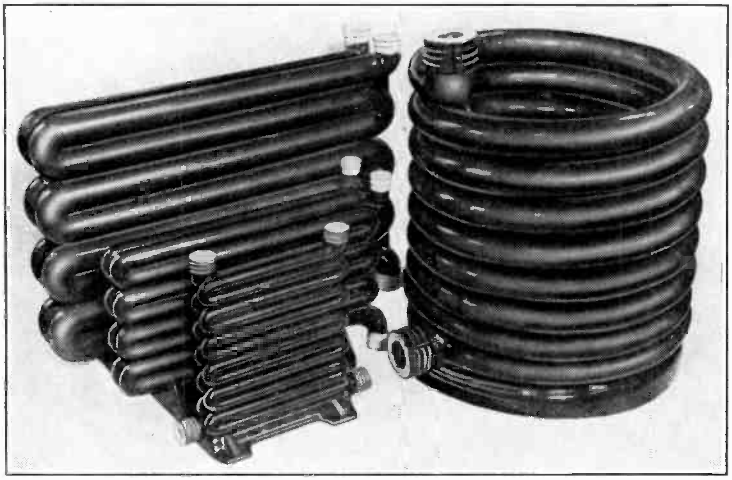
An illustrated booklet describing briefly the chief features of Scophony television (including supersonic light control) has been issued by Scophony Ltd., Thornwood Lodge, Camden Hill, London, W.8.

Urdox resistors are current-limiting devices with a negative temperature coefficient intended primarily for preventing the heavy surge of current that normally occurs in the heater circuits of A.C./D.C. sets at the moment of switching on. These resistors, mounted in a glass bulb, can be combined with an element of opposite temperature coefficient housed in the same envelope, and are supplied in this country by Erie Resistor, Ltd., Carlisle Road, The Hyde, Hendon, London, N.W.9.

Ceramic Insulators

THE wide variety of applications of ceramic insulating materials in transmitting apparatus, particularly of the high-powered short-wave type, was strikingly illustrated by the second annual exhibition of The United Insulator Co., Ltd., 12-16, Laystall Street, London, E.C.1. This exhibition, which was held at the Grand Hotel Central, Marylebone, during November, included examples of power plate condensers suitable for loads up to 400 kVA and stable inductances with metallised windings on "Calit" formers. Standard designs of ceramic cooling coils and aerial insulators were also shown.

The stable and controlled properties of the dielectric materials known as "Tempa," "Conda" and "Calan" (products of the Hermsdorf-Schomburg concern for whom the United Insulator Company are agents in this country) were demonstrated in innumerable applications to receiver and telephone cable technique.



Anode cooling coils for short-wave transmitting valves executed as one-piece glazed ceramic mouldings.

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

1. Velocity of Propagation of Micro-Waves in the Neighbourhood of the Earth's Surface [No Appreciable Difference in Velocity of 16 cm Waves along Two Paths at Different Heights].—A. Lo Surdo & G. Zanotelli. (*La Ricerca Scient.*, 15th/30th Sept. 1938, Series 2, 9th Year, Vol. 2, No. 5/6, pp. 272–275.)

Colwell, Hall, & Hill have found with a wave of about 100 m that the group velocity close to the earth's surface is noticeably lower than that in a vacuum (438 of 1937: but *cf.* Ross & Slow, 2050 of 1937). Savelli (U.R.S.I. Venice Assembly) reports that 80 cm waves near the ground have a phase velocity the same as in Lecher wires. "Having shown, in a previous work [3446 of 1938], the possibility of obtaining high-precision measurements of the propagation velocity of micro-waves by an interferometric method, it occurred to us to apply this method to the above important problem, to find out whether the propagation along trajectories at different heights above the ground takes place with different velocities." The original technique (using the lake surface as a reflector) was unsuitable for this particular application and was modified by providing each of the two paths (mean distance from surface about 6λ and 15λ respectively) with a plane reflector at 45° to the line of propagation. The path lengths were 50–300 m, over the surface of the lake, and 40–100 m, over an asphalt road; tests at longer distances were made impossible by the interference between the direct ray and the ray reflected from the surface. The receiving valve, without a reflector but screened from direct radiation, could be shifted easily up and down between the two fixed reflectors, to determine the exact position of a fringe by finding the positions of minimum signal. Since no displacement of the fringe could be detected as the distance between source and interferometer was varied between the limits mentioned, it was concluded that the mean phase velocities along the two paths were equal. It was considered that a difference of one in ten thousand would be detectable.

2. The Magnetic Permeability of Nickel for Hertzian Oscillations [Micro-Waves of 15.8–86 cm: Their Propagation Velocity along Very Thin Nickel Wires].—K. F. Lindman. (*Zeitschr. f. tech. Phys.*, No. 10, Vol. 19, 1938, pp. 323–324.)

For previous work (iron wires) *see* 3095 of 1938. Author's summary:—"The difference, both percentage and absolute, between the velocity of light and the propagation velocity of electric waves along 0.0172 mm-thick nickel wires increases with increasing wavelength at first quickly (so long as the normal wavelength λ_0 is smaller than about 50 cm) and then more slowly (curves I and II of Fig. 1), appearing to tend towards a constant value (about 8%, or 25 000 km/s). The permeability μ of nickel, calculated from the measured results, also increases with wavelength, at first rapidly (λ_0 smaller than about 50 cm) and then more slowly, reaching the value of 19.9 at $\lambda_0 = 86.0$ cm: the curves for nickel and iron may be compared in Fig. 2."

3. Experimental Investigations on the Propagation of Ultra-Short Waves.—W. Ochmann & H. Plendl. (*Hochf:tech. u. Elek:akus.*, Aug. 1938, Vol. 52, No. 2, pp. 37–44.)

These investigations deal with waves of length 7.17 and 4.1 m; the emitter was situated at a high point on the earth's surface, while the receiver was in an aeroplane. Relative measurements were made of the field strength as a function of distance and of the height of the receiver above the ground. § II describes undisturbed linear propagation, for which Fig. 1 shows the lay-out in a vertical plane, Fig. 2 the direct and reflected rays, Fig. 3 calculated field-strength diagrams for emitters whose data are given, the reflecting surface being taken as smooth. The measurements show that the range is not limited by the optical sight; this is attributed to curvature of the rays due to atmospheric refraction (Fig. 4) [for theory *see* following abstract]. These measurements are given in Figs. 5–14; their chief object was the determination of the point where the maximum occurred. The ray paths are represented on "profile cuts" (Figs. 15, 19, 22, 23) which are made (Figs. 33, 34) by drawing all vertical lines (really the earth's radii) parallel to one another and to the earth's radius at the point of contact of the tangent to the earth from the emitter. Distances along the radii are measured along this system of parallel lines, the tangent to the earth from the emitter being taken as the horizontal axis, with the result that straight lines radiating from the emitter now appear curved; the vertical units are much greater than the horizontal ones. In Fig. 15, curve A shows the locus of the reception maxima for linear propagation (Fig. 3); curves B & C give the measured positions and show the displacement caused by the ray curvature. The refraction conditions are found to vary from day to day.

The curvature gives rise also to secondary reflections (§ IV) which alter the diagrams by causing additional ground reflections (Fig. 20) and secondary maxima (Figs. 16–18, 21). Range measurements are described in § V; a horizontally polarised array of 16 dipoles (two rows of 8 at distances of half a wavelength apart) was used, though no effect of the emitted polarisation on propagation conditions was found. Ground reception at height 106 m at a distance of 120 km from an emitter at height 66 m was reliable (wavelength 4.1 m). Figs. 22, 23 give results of range measurements, Figs. 25, 27–29 records of ground reception, Figs. 30, 31 reception at 3000 m height. Alternate reception on the two wavelengths is shown in Fig. 32. The effect of the season and hour is referred to in § VI.

4. How Ultra-Short Waves surmount the Earth's Curvature by Ray Refraction in the Atmosphere [Theory].—G. Eckart & H. Plendl. (*Hochf:tech. u. Elek:akus.*, Aug. 1938, Vol. 52, No. 2, pp. 44–58.)

This theoretical investigation of tropospheric refraction is found to lead to a method of calculating ultra-short-wave field strengths and the appropriate dimensions for communication lay-outs on these wavelengths. The refractive properties of the atmosphere are discussed in § II, starting from a calculation of the dielectric constant of the appropriate mixture of gases as a function of height (Fig. 2). For further calculations, these curves are assumed to be parabolas (eqn. 5); approximate curves are shown in Fig. 3. The optical paths are calculated from Fermat's principle (§ II 1); for different values of the minimum height, Fig. 7 shows the height of any ray as a function of distance, and Fig. 8 the angle of inclination of the ray as a function of the height of the point of observation. The effects of the polar diagram of the emitter and of reflection at the earth's surface (without refraction) are next discussed; Fig. 11 shows a calculated vertical diagram for a plane and for a curved earth (*see* also 3, above). Fig. 12 shows the path differences for direct and reflected rays, for an infinite distance of the point of observation, as a function of the initial angle of the ray for various emitter heights. The effect of refraction on this is discussed (Figs. 13–18); Fig. 18 shows the refraction correction to be applied to the angle of elevation. From this the ray is deduced which belongs to a given path difference. The maximum field strength is now deduced as twice the value given by Hertz's solution; Fig. 19 shows its variation with distance.

The results of these calculations are compared with the experimental results of Ochmann & Plendl (*see* 3, above). The unrefracted and refracted rays are drawn on "profile cuts" (Fig. 21); Fig. 22 shows the effect of water vapour on the rays. It is found that the influence of refraction can already be neglected for an initial angle of inclination of 1.5° to the horizontal. Fig. 24 shows calculated values of field strength as a function of height for a given distance from the emitter, Figs. 25–27 comparisons of calculated and measured values. Fig. 28 gives curves of constant field strength, Fig. 29 field strength as a function of distance with a constant height of the point of observation. A practical example of the use of this work in calculating field strengths in advance is worked out (§ II 3). It is concluded that for distances greater than 100 km the earth's curvature can be surmounted by the effect of refraction alone.

5. The Diffraction Theory of the Propagation of Ultra-Short Waves.—G. Eckart. (*Hochf:tech. u. Elek:akus.*, Aug. 1928, Vol. 52, No. 2, pp. 58–62.)

The influence of diffraction in increasing the range of ultra-short waves is here discussed (§ I) in the light of previous work of other writers (Weyl, Watson, Strutt, etc.); the conclusion is reached that within the optical range the field can be described by superposition of direct and reflected plane waves, and the solution of the diffraction problem consists in constructing the polar diagram of the aerial, provided that this is so high above the ground that its lowest loop has drawn in to zero within the optical range. "The diffraction theory thus leads to the limit of the optical range as the propagation limit. Greater ranges are to be attributed to refraction."

In § II these conclusions are compared with those of van der Pol & Bremmer [*see* 3457 of September and back references] on diffraction round a sphere; their results (reproduced in Figs. 8–11) are discussed numerically with reference to the use of the reflection factor for a plane earth and the use of long-wave electromagnetic earth constants in short-wave problems. It is concluded, however, that the work of van der Pol & Bremmer shows that, for ranges greater than 200 km, used for aircraft communication, the present writer's view of diffraction is valid. A comprehensive list of literature references is given.

6. On the Propagation Phenomena of Ultra-Short Waves [over Long Distances: Remarks on Hess's Results: the Connection with Meteor Swarms: Hopes for Future Use as Auxiliary to Short-Wave Communication].—G. Schwarz. (*Funktech. Monatshefte*, Sept. 1938, No. 9, pp. 278–279.) For Hess's paper *see* 2660 (and also 4211) of 1938: for Leithäuser's work *see* 1753 of 1938.

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7. Range of Wireless Waves used on Aircraft.—J. Sylvestre. (*L'Air*, 20th July 1938, No. 449, pp. 453–454.)

8. The Velocity Distribution of Electrons subject to Elastic Collisions in a Gas whose Molecules are Moving according to Temperature [under Influence of Electric Field: Density of Distribution of Electrons, etc: Theory].—R. Lichtenstein. (*Physik. Zeitschr.*, 15th Sept. 1938, Vol. 39, No. 17/18, pp. 646–656.)

9. On Some Effects caused in the Ionosphere by Electric Waves: Part II.—V. A. Bailey. (*Phil. Mag.*, Oct. 1938, Series 7, Vol. 26, No. 176, pp. 425–453.)

For I *see* 2437 of 1937. A compact method is here first given for calculating the polarisation number and refractive & absorption indices of an ionised medium. A theoretical study is made of resonance in gyro-interaction, and practical effects caused by a powerful gyro-wave are deduced. It is concluded that:—"(1) The resonance curves may have either one or two maxima, depending on the height at which the auxiliary wave is reflected. (2) With an appropriate and simple aerial system observable interaction can be caused by radiating, in the form of a directed gyro-wave, a power as low as 50 watts." Details of an aerial system for producing an easily-visible electric discharge just below E region are given; the power required to produce a sufficient illumination for traffic on roadways over a large area is calculated.

10. Generation of Auroras by Means of Radio Waves [Details of Theoretical Radiator of Gyro-Waves capable of generating Visible Glow Discharge in E Region].—V. A. Bailey. (*Nature*, 1st Oct. 1938, Vol. 142, pp. 613–614.) *See* also 9, above.

11. Study of the Magneto-Ionic Theory of Wave Propagation by Means of Simple Formulae, Linkages, and Graphical Devices.—V. A. Bailey & J. M. Somerville. (*Phil. Mag.*, Nov. 1938, Series 7, Vol. 26, Supp. No. 178, pp. 888–905.) Scheme for arithmetical computation of polarisation, and refractive & absorption indices; simple linkage for determining polarisation; methods of determining refractive & absorption indices by linkage or charts.

12. Absorption of Corpuscles in the Ionosphere [Theory of Retardation and Absorption of Cosmic Rays by Electrons: Possibility of Production of Ionospheric Clouds by Soft Corpuscular Rays].—H. D. Rathgeber. (*Naturwiss.*, 26th Aug. 1938, Vol. 26, No. 34, p. 563.)

13. Scattered Reflections of Radio Waves from [Equivalent] Height of more than 1000 km [on Frequencies above Critical Frequencies for F Region: Probable Reflection from Ionospheric Clouds].—L. Harang & W. Stoffregen. (*Nature*, 5th Nov. 1938, Vol. 142, p. 832.)

14. Influence of Radiation on Ionisation Equilibrium [Theory].—B. N. Srivastava. (*Proc. Roy. Soc.*, Series A, 23rd Sept. 1938, Vol. 167, No. 931, pp. 484–499.)

15. An Ionising Radiation of a Spark Discharge [Photoelectrons, produced by Ionising Radiation, amplified to Electron Avalanche by Ionisation by Collision: Measurement of Absorption Coefficient of Radiation: Solar Radiation of This Wavelength might Penetrate to Ionosophere and Increase Its Conductivity].—H. Raether. (*Zeitschr. f. Physik*, No. 9/10, Vol. 110, 1938, pp. 611–624.)

16. Proof of Existence of Solar Radiation of Wavelength about 2150 AU.—K. O. Kiepenheuer. (*Naturwiss.*, 14th Oct. 1938, Vol. 26, No. 41, pp. 678–679.)

17. Radio Transmission and Solar Activity [Short Account of Present Knowledge].—E. V. Appleton. (*Nature*, 17th Sept. 1938, Vol. 142, pp. 499–501: from Presidential Address to U.R.S.I., Sept. 1938.)

18. Current Sunspots [Data for End of September, 1938].—(*Nature*, 1st Oct. 1938, Vol. 142, p. 610: short note.)

19. The Eleven-Year Cycle of Solar Activity and the Choice of Optimum Wavelengths for Short-Wave Radio Communication.—T. I. Shchukina. (*Izvestiya Elektroprom. Slab. Toka*, No. 7, 1938, pp. 38–43.)

On the basis of the information collected by the National Bureau of Standards, curves are plotted for different seasons of the year (Fig. 2 for summer, Fig. 3 for winter, and Fig. 4 for spring and autumn) showing the variation of the critical frequency of the F_2 layer as determined by the number of sunspots. A curve is also plotted showing the variation of the critical frequency of the E layer (Fig. 5). The information available covers the period from May 1934 to August 1937, but the curves are extrapolated to include 1939 (the next maximum of solar activity). From an analysis of these curves and a comparison with experimental results at the Berlin Radio Receiving Station between 1927 and 1934, the following main conclusions are drawn:—(1) During the coming period of maximum solar activity it will probably be possible to use the same wavelengths as in 1936/1937. (2) If however the increased absorption seriously affects communication, it would be advantageous to reduce the wavelengths in the ratio 1.1 or 1.2. *Cf.* Ohno, 4217 of 1938.

20. Two Dellinger Effects? [Fade-Outs from Tokio JZJ on 27th April, from German DJD on 28th].—W. Büll. (*Funktech. Monatshefte*, Sept. 1938, No. 9, p. 262.)

21. On the Influence of Terrestrial Magnetic Disturbances on the Round-the-Earth Echo Effect and on the Signal Strength at the Receiving Point [No Apparent Correlation with the Former, but Clear Connection with the Latter: Results on Japanese and American Signals].—W. Büll. (*Funktech. Monatshefte*, Sept. 1938, No. 9, pp. 279–281.)

22. DAILY EXPLORATION OF THE ATMOSPHERE BY RADIO SOUNDINGS.—Bourgeois. (*See* 56.)

23. ON THE RÔLE OF METEOROLOGICAL PROCESSES IN RADIO MEASUREMENTS.—Nasilov & Pogosyan. (*Tech. Phys. of USSR*, No. 6, Vol. 5, 1938, pp. 463–464.) Translation of the note dealt with in 3111 of 1938.

24. WEATHER CONDITIONS AND RADIO RECEPTION AT LONG DISTANCES.—Joshi. (*See* 131.)

25. THE IONOSPHERIC STATION OF THE NATIONAL GEOPHYSICAL INSTITUTE IN ROME [New Automatic Recording Equipment for Echoes in Range 5.5 to 10 Mc/s, with Discussion of Some Results].—I. Ranzi. (*La Ricerca Scient.*, 15th/30th Sept. 1938, Series 2, 9th Year, Vol. 2, No. 5/6, pp. 258–271.) The range is being increased to cover from 3 to 12.5 Mc/s.

26. CHARACTERISTICS OF THE IONOSPHERE AT WASHINGTON, D.C., AUGUST, 1938.—Gilliland, Kirby, & Smith. (*Proc. Inst. Rad. Eng.*, Oct. 1938, Vol. 26, No. 10, pp. 1295–1298.) This regular feature will not be referred to in future abstracts except for special reasons.

27. REPORT OF COMMITTEE ON RADIO WAVE PROPAGATION [C.C.I.R. Fourth Meeting, Bucharest, 1937].—(*Proc. Inst. Rad. Eng.*, Oct. 1938, Vol. 26, No. 10, pp. 1193–1234.)

28. A CONCENTRATION AND MEASUREMENT OF ATMOSPHERIC OZONE [Discussion of Various Methods].—W. C. Reynolds: Paneth & Edgar. (*Nature*, 24th Sept. 1938, Vol. 142, p. 571.) *See* also 3850 of 1938.

29. THE SPECTRUM OF THE AURORA BOREALIS AND THE CONDITION OF THE AURORAL REGION [Detailed Summary of Recent Work].—L. Vegard. (*Naturwiss.*, 30th Sept. 1938, Vol. 26, No. 39, pp. 639–644.)

30. ATOMIC LINES IN THE AURORAL SPECTRUM [indicate Presence and Probable States of Nitrogen and Oxygen Atoms in Auroral Region].—L. Vegard. (*Nature*, 8th Oct. 1938, Vol. 142, p. 670.)

31. VERY SMALL INTENSITY OF THE RED OI TRIPLET DURING THE AURORAL DISPLAYS OF SEPT. 14TH–16TH.—L. Vegard. (*Nature*, 5th Nov. 1938, Vol. 142, pp. 831–832.)

32. PHOTOGRAPHIC HEIGHT MEASUREMENTS AND SPECTRA OF THE GREAT AURORA OF 25TH/26TH JAN. 1938.—C. Störmer. (*Naturwiss.*, 30th Sept. 1938, Vol. 26, No. 39, pp. 633–638.)

33. THE PRESENCE OF SODIUM IN THE ATMOSPHERE ON THE BASIS OF INTERFEROMETER INVESTIGATIONS OF THE D-LINE IN THE LIGHT OF THE EVENING AND NIGHT SKY [Sodium of Terrestrial Origin present in Thin Air Layer just below 60 km Height].—R. Bernard. (*Zeitschr. f. Physik*, No. 5/6, Vol. 110, 1938, pp. 291–302.)

34. PROBABLE DISSOCIATION OF NITROGEN MOLECULES IN THE HIGH ATMOSPHERE [Discussion of Recent Observations of After-Glow Spectra].—J. Gauzit. (*Nature*, 24th Sept. 1938, Vol. 142, pp. 572–573.)

35. CH BANDS IN THE NIGHT-SKY SPECTRUM [Existence: Probable Emission at Very High Altitude or Outside Atmosphere], *and* CN BANDS IN THE NIGHT-SKY SPECTRUM [found among Radiations whose Intensity does not increase from Zenith to Horizon].—Cabannes, Dufay, & Gauzit. (*Nature*, 15th & 22nd Oct. 1938, Vol. 142, pp. 718–719: p. 755.)

36. WAVELENGTH OF THE NEW NITROGEN LINE [3466.3 AU].—Kaplan. (*Phys. Review*, 1st Oct. 1938, Series 2, Vol. 54, No. 7, pp. 541.)

37. SOME ASPECTS OF NITROGEN AFTERGLOWS [Observations with Argon/Nitrogen Mixtures: H.F. Discharges: Diffusion of Lewis-Rayleigh Afterglow: Magnetic Field has No Effect].—D. B. McNeill & K. F. Harvey. (*Phil. Mag.*, Oct. 1938, Series 7, Vol. 26, No. 176, pp. 502–506.)

38. THEORETICAL INTERPRETATION OF THE VARIATION OF ELECTRICAL CONSTANTS OF SOIL WITH MOISTURE CONTENT, TEMPERATURE, AND FREQUENCY.—R. D. Joshi. (*Science & Culture*, Calcutta, Sept. 1938, Vol. 4, No. 3, pp. 196–197.)

"The nature of the variation . . . with frequency has been explained by White (1931 Abstracts, p. 434) by applying Debye's dipole theory, but little has been said about the mode of the variation with moisture content and temperature. In this note the variation of the constants with moisture content, temperature, and also frequency has been explained by applying the theory of Wagner, which is a modification of Maxwell's theory. The Wagner-Maxwell model, where the conducting particles are spheres sparsely distributed throughout a material of low dielectric loss, has been applied in the case of moist soil." Experimental results agree fairly closely with the theory.

39. RADIO RECEPTION TESTS IN SOME MINES IN AUSTRIA [Some 1938 Results].—V. Fritsch. (*E.T.Z.*, 22nd Sept. 1938, Vol. 59, No. 38, pp. 1024–1025.) For previous work *see* 4273 of 1936, 2051 of 1937, and 3050 of 1938.

40. THE PATH OF A RAY OF LIGHT TANGENT TO THE SURFACE OF THE EARTH [with Table of Horizon Dip, Horizon Distance, and Refraction for Altitudes from Sea Level to 100 000 Feet].—J. Sweer. (*Journ. Opt. Soc. Am.*, Sept. 1938, Vol. 28, No. 9, pp. 327–329.)

41. DIFFRACTION [at Edge of Opaque Screen] OF CONVERGING LIGHT WAVES [Theory: Numerical Calculation of Diffraction Pattern].—I. Fränz-Gotthold & M. von Laue. (*Ann. der Physik*, Series 5, No. 3, Vol. 33, 1938, pp. 249–258.)

42. A New Method of Measuring the Velocity of Light [Fizeau's Method with Very Short Base Line, using Piezo-Quartz Oscillator].—R. A. Houstoun. (*Nature*, 5th Nov. 1938, Vol. 142, p. 833.)

ATMOSPHERICS AND ATMOSPHERIC ELECTRICITY

43. A New Cartridge Static Suppressor [for Air-Liners: Five-Foot Trailing Wire, shot out by Spring, dissipates Static Charges].—L. H. Engel. (*Science*, 21st Oct. 1938, Vol. 88, Supp. pp. 8 and 10.)

44. Progressive Lightning: VI [Anomalous Discharges behave on Same Principles as Usual Discharges].—Collens, Malan, & Schonland. (*Proc. Roy. Soc.*, Series A, 23rd Sept. 1938, Vol. 167, No. 931, p. S 114: abstract only.)

45. The Lightning Discharge [and the Question of the Reliability of the Magnetic Method of measuring Current Strength, as used in Europe and U.S.A.].—B. F. J. Schonland. (*E.T.Z.*, 29th Sept. 1938, Vol. 59, No. 39, pp. 1047–1048: summary only.)

46. The Development of the Spark Discharge: II.—T. E. Allibone & S. R. Meek. (*Proc. Roy. Soc.*, Series A, 10th Oct. 1938, Vol. 168, No. 932, p. S 119: abstract only.)

47. Point Discharges in Air at Pressures from 1 to 30 Atm. [Various Discharge Forms have Definite Existence Regions: Variation of Resistance to Breakdown with Pressure not a Monotonous Function].—W. Baer. (*Arch. f. Elektrot.*, 14th Oct. 1938, Vol. 32, No. 10, pp. 684–687.)

48. Visual Image Produced by a Photoflash Bulb [suggests that Some Reports of "Ball Lightning" may be Descriptions of an Optical Illusion produced by a Lightning Flash just outside the Observer's Visual Field].—R. L. Ives. (*Nature*, 17th Sept. 1938, Vol. 142, p. 540.)

49. Photographic Recording Apparatus for Lightning Research [including Later Types with Speeds of 2000 Metres per Minute].—H. Collens. (*E.T.Z.*, 22nd Sept. 1938, Vol. 59, No. 38, p. 1026: summary only.)

50. Russian Measurements on Thunderstorms.—Stekolnikov & Waleev. (*E.T.Z.*, 8th Sept. 1938, Vol. 59, No. 36, p. 973: summary only.)

51. The Effects of Thunderstorms and Lightning Discharges on the Earth's Electric Field [Records of Behaviour of Pre-Discharge Gradient, Recovery of Field after Discharge: Estimate of Electric Moment of Discharges, etc.].—T. W. Wormell. (*Proc. Roy. Soc.*, Series A, 6th Sept. 1938, Vol. 167, No. 930, pp. S 97–S 98: abstract only.)

52. Observations of the Electric Field of the Atmosphere at Sea [Higher Values after than before Noon].—J. Rouch. (*Comptes Rendus*, 17th Oct. 1938, Vol. 207, No. 16, pp. 678–679.)

53. Ionic Recombination in Air [Variation with Pressure and Ionisation Intensity: Nature of Recombination Process: Calculations of Equilibrium Ion Density and Electrical Conductivity at Various Levels in Lower Atmosphere].—J. Sayers. (*Proc. Roy. Soc.*, Series A, 10th Oct. 1938, Vol. 168, No. 932, p. S 119: abstract only.)

54. Guarding against Storms [including Note on Storm Detector Device which picks up Charges by Antenna, illuminates Neon Tube, and rings Bell].—(*Journ. Franklin Inst.*, Oct. 1938, Vol. 226, No. 4, p. 570: short note only.)

55. Symposium on Weather Prediction.—(*Science & Culture*, Calcutta, Sept. 1938, Vol. 4, No. 3, pp. 160–164.)

56. Daily Exploration of the Atmosphere by Radio Soundings: Its Development on Land and Sea [Some Recent Results: Floating Meteorological Station in Atlantic].—R. Bourgeois. (*Comptes Rendus*, 10th Oct. 1938, Vol. 207, No. 15, pp. 611–613.)

57. New Mechanical Weather Observer replaces Airplanes at Six Stations [Note on Use of the Radio-Meteorograph for Upper-Air Soundings].—(*Journ. Franklin Inst.*, Oct. 1938, Vol. 226, No. 4, pp. 568–569: short note only.)

58. A Method for the Investigation of Upper-Air Phenomena, and Its Application to Radio-Meteorography.—Diamond, Hinman, & Dunmore. (*Proc. Inst. Rad. Eng.*, Oct. 1938, Vol. 26, No. 10, pp. 1235–1265.) *See* 2682 of 1938.

PROPERTIES OF CIRCUITS

59. A Contribution to Tube and Amplifier Theory.—Benham. (*See* 148.)

60. Self-Excitation of Oscillations: Mathematical Theory of Retroaction and the "Pulling into Tune" [Mitnahme] of Oscillating Circuits [with General Formula including Modulation, "Mitnahme," and Self-Excitation: Solution of Hill's Differential Equation: Stability Criterion].—C. L. Kober. (*Arch. f. Elektrot.*, 10th Sept. 1938, Vol. 32, No. 9, pp. 581–607.) Extension of van der Pol's work on relaxation oscillations; *see* also Erdélyi, 3369 of 1935.

61. Correction to "On the Frequency and Stability of Auto-Oscillations."—B. K. Shembel. (*Izvestiya Elektroprom. Slab. Toka*, No. 3, 1938, p. 64.) *See* 2493 of 1937.

62. Distortions in the Beat-Oscillator: on the Functioning of a Self-Excited Oscillator synchronised Outside the Region of Synchronisation [Analysis, with Experimental Confirmation].—Z. Jelonek. (*Wiadomości i Prace, Państwowego Instytutu Telekomunikacyjnego*, Warsaw, No. 5/6, Vol. 8, 1937, pp. 105–108: short French summary p. 11.)

63. A Type of Electrical Resonator [Theory of Certain Shapes of "Hohlraums": Equivalence to Lumped-Constant Circuits: Theory of Coupling on to "Hohlraums"].—W. W. Hansen. (*Journ. of Applied Phys.*, Oct. 1938, Vol. 9, No. 10, pp. 654–663.)

64. Differential Negative Resistances [Types "N" and "S"] and Relaxation Oscillations.—N. Carrara. (*Bollettino del Centro Volpi di Elettrologia*, English Edition, April/May/June 1938, Year 1, No. 2, pp. 21–34.) For a paper in Italian covering the same ground *see* 1816 of 1938. For this new "Bulletin" *see* 3822 of 1938.

65. A Method of calculating Harmonics in Non-Linear Circuits.—C. Sugi. (*Nippon Elec. Comm. Eng.*, Sept. 1938, No. 12, pp. 393–394: summary only.)

66. Half-Wave Gas-Rectifier Circuits [Simple Operational Calculus gives Rigorous Analysis].—C. M. Wallis. (*Electronics*, Oct. 1938, Vol. 11, No. 10, pp. 12–14.)

67. Time Delays due to Smoothing Circuits [for removing A.C. Components in Rectified Current used for Measuring or Control Purposes: Effect of Lag on Response to Sudden Variations: Comparison of Various Smoothing Circuits].—W. Ostendorf. (*E.T.Z.*, 3rd Nov. 1938, Vol. 59, No. 44, pp. 1173–1176.)

68. The Effect of Stray Admittances in Four-Arm Bridge Networks [Conditions of Balance with Cross Admittances between Junctions in Adjacent Arms and in Opposite Arms: Lack of Symmetry of Equations of Balance: Treatment by Circuit Arrangement and by Screening: Application to High-Precision Audio-Frequency Work].—N. F. Astbury. (*Phil. Mag.*, Oct. 1938, Series 7, Vol. 26, No. 176, pp. 507–519.)

69. An Investigation of the Complex Bridge Neutralising Circuit.—Neiman. (*See* 98.)

70. The Theory of Complex Neutralising Circuits.—G. A. Zeitlenok. (*Izvestiya Elektroprom. Slab. Toka*, No. 7, 1938, pp. 19–25.)

The operation of the usual push-pull neutralising circuit is discussed and it is shown that since the design of this circuit is based on the assumption that the inductance of the leads is negligible, the stability of the circuit, especially when operating on short waves, is not independent of the wavelength. An analysis of the operation of a push-pull circuit is therefore presented in which the inductance of the leads is taken into consideration, and conditions are determined for making the stability of the circuit independent of the operating wavelength. These conditions are met by a circuit (Fig. 6) which can be represented by a bridge with two additional diagonal arms, each connected between the main diagonal arm and one of the side arms (Fig. 5). The tuning of this circuit is discussed and a vector diagram derived (Fig. 7).

71. The Coupling of an Oscillating Circuit with a Geissler Tube [Calculations based on Number of Positive Ions].—T. V. Jonescu. (*Comptes Rendus*, 3rd Oct. 1938, Vol. 207, No. 14, pp. 567–569.)

72. Coupling Oscillations in Mechanical and Electrical Systems.—Awender & Lange. (*Funktech. Monatshefte*, Sept. 1938, No. 9, pp. 263–276.) Concluded from 4290 of 1938.

73. The Impedance of a Tapped Resonant Circuit [Theory and Experimental Confirmation, in connection with Coupling between R.F. Amplifier Valves: Over-All Amplification of Amplifier containing Tapped Parallel-Tuned Circuit in Anode Circuit: etc.].—K. R. Sturley. (*Marconi Review*, Oct./Dec. 1938, No. 71, pp. 1–8.)

74. Coupling Networks: Part I [Analysis and Curves].—W. L. Everitt. (*Communications*, Sept. 1938, Vol. 18, No. 9, pp. 12–18 and 50.)

75. The Effect of Retroaction and Negative Feedback on the Form of the Resonance Curve of the Two-Circuit Detuning [Curve-Widening] Filter and Coupling Filter.—H. Frühauf. (*Hochf:tech. u. Elek:akus.*, Sept. 1938, Vol. 52, No. 3, pp. 96–102.)

Calculations for the detuning filter with symmetrical retroaction or mutual coupling; propagation constant, asymmetry, form factor. Oscillation conditions for the detuning filter with ohmic retroaction. The coupling filter with symmetrical retroaction; oscillation conditions. Conditions for symmetrical resonance curves. Production of form values greater and less than 1/4. For previous work *see* 3624 of 1937 and 1335 of 1938.

76. Constructional Determination of the Frequency Curves of Oscillating Circuits and Coupled Oscillating Circuits [also Resonance Transformers: Construction of Band-Filter Resonance Curves for Various Degrees of Coupling].—F. Benz. (*Hochf:tech. u. Elek:akus.*, Sept. 1938, Vol. 52, No. 3, pp. 102–106.)

77. Generalised Resonance Curves for Parallel-Resonant Circuits with Losses.—A. Ferrari-Toniolo. (*Alta Frequenza*, Oct. 1938, Vol. 7, No. 10, pp. 703–720.)

Author's summary:—A series of generalised curves is given for determining, by variation of frequency or capacity, the different components of the impedance of a circuit consisting of an inductance with losses and a condenser in parallel. The minimum values (7–10) of the "quality factor" Q are given for which the ideal resonance formulae can be used with an error not exceeding 1%. More rigorous calculations, such as must be used when Q is smaller or when a higher accuracy is required, bring to light certain facts (not always recognised) which distinguish the ideal case from the practical [*e.g.* that for specially low values of Q, however the frequency is varied the circuit has an impedance which is always capacitive; that is to say, the phenomenon of resonance completely disappears].

78. ON THE DESIGN OF ONE AND TWO SECTION CUT-OFF FILTERS.—G. V. Dlugach. (*Izvestiya Elektroprom. Slab. Toka*, No. 3, 1938, pp. 51–52.) Concluded from 3155 of 1938.

79. TRANSIENTS OF RESISTANCE-TERMINATED DISSIPATIVE LOW-PASS AND HIGH-PASS ELECTRIC WAVE FILTERS.—W. Chu & C. K. Chang. (*Proc. Inst. Rad. Eng.*, Oct. 1938, Vol. 26, No. 10, pp. 1266–1277.) Based on the papers dealt with in 3707 of 1936 and 1720 of 1937.

80. THEORY OF DESIGN OF FILTERS CONSTRUCTED FROM RESONANT LINES.—Mizuhasi. (*See* 140.)

81. CRYSTAL BAND-PASS FILTERS [Present State of Knowledge, and Practical Applications].—E. L. Gardiner. (*Wireless World*, 3rd, 10th, 17th, & 24th Nov. 1938, Vol. 43, pp. 382–384, 407–408, 447–448, & 463–464.)

82. THEORY OF FOUR-TERMINAL IMPEDANCE TRANSFORMATION AND MATCHING CIRCUITS.—T. Mizuhasi. (*Nippon Elec. Comm. Eng.*, Sept. 1938, No. 12, p. 394.) *See* 3158 of 1938.

83. ALGEBRAIC EXPRESSIONS RELATIVE TO SIMPLE PARTIAL PATHS IN THE RELAY CIRCUIT.—A. Nakasima. (*Nippon Elec. Comm. Eng.*, Sept. 1938, No. 12, pp. 310–314.)

84. THE INFLUENCE OF THE INDUCTANCE AND THE SPARK RESISTANCE OF A PULSE DISCHARGE CIRCUIT ON THE MAXIMUM STEEPNESS OF THE VOLTAGE RISE [Theory].—W. Beindorf. (*Arch. f. Elektrot.*, 14th Oct. 1938, Vol. 32, No. 10, pp. 654–664.)

85. NEGATIVE FEEDBACK IN R-C AMPLIFIERS.—(*See* 122.)

TRANSMISSION

86. OSCILLATION PRODUCTION BY AN ELECTRON BEAM IN THE FIELD OF A PLATE CONDENSER, WITH CONSIDERATION OF THE EFFECT OF THE STRAY FIELDS [Theory].—H. E. Hollmann & A. Thoma. (*Hochf:tech. u. Elek:akus.*, Sept. 1938, Vol. 52, No. 3, pp. 94–96.)

This work is based on the writers' "inversion theory" (*see*, for example, 2914 of 1937 and 3687 of 1938); it discusses "an electron beam passing through a plate condenser with stray fields spread out on both sides, under the assumption that the beam practically remains in the median plane." The same inversion function is found as was previously deduced for a homogeneous field (the stray fields being neglected), "except that the length of the homogeneous median field . . . is shortened when compared with the plate length in a degree depending on the distance apart of the plates."

87. BARKHAUSEN OSCILLATIONS OF DOUBLE THE FREQUENCY OF THE ELECTRON SWINGS.—H. Mohr. (*E.N.T.*, Sept. 1938, Vol. 15, No. 9, pp. 284–293.)

Möller's theory of Barkhausen oscillations of the same frequency as the electron swings (Abstracts, 1930, p. 157, and 1931, p. 95 and back ref.) assumes a constant grid potential and cathode and anode potentials oscillating out of phase. Here it is shown experimentally and theoretically that "the possibility of an electron oscillation of double frequency arising from electron swings of single frequency is given by the principle of 'phase sorting' [Phaseneinsortierung] when the cathode and anode potentials are assumed to be constant while the grid potential varies." This "phase sorting" gives rise to two space-charge clouds which sustain the external oscillation. The excitation conditions are investigated mathematically; the excitation factor is calculated. The constructional development of the valves used, the optimum construction of their electrodes, and their working conditions are described." Wavelengths down to 14 cm were produced.

88. A THEORY OF VALVE OSCILLATORS IN WHICH ACCOUNT IS TAKEN OF ELECTRON INERTIA.—G. A. Zeitlenok. (*Izvestiya Elektroprom. Slab. Toka*, No. 3, 1938, pp. 1–10.)

For previous papers *see* 2267 & 3610 of 1938. An equation is quoted determining the conditions necessary for self-excitation of an oscillator, and is modified (5) so as to take account of the phase displacement ϕ, between the anode current and the anode voltage, due to the time taken by electrons in travelling between the valve electrodes. It is pointed out that this factor is particularly important for ultra-short waves, where the time delay of electrons becomes commensurable with the duration of the oscillation cycle. Methods are indicated for determining ϕ, and the design of an u.s.w. oscillator is discussed in the light of the results obtained.

89. AMPLITUDE MODULATION OF A FREQUENCY-MULTIPLYING STAGE.—A. B. Ivanov. (*Izvestiya Elektroprom. Slab. Toka*, No. 7, 1938, pp. 34–38.)

In short- and ultra-short-wave radio transmitters it may be found desirable to modulate on one of the frequency-multiplying stages. In the present paper equations are derived for determining the modulation characteristics of a frequency doubler when (a) grid modulation is used, and (b) the frequency doubler is driven by a modulated carrier. The main conclusions reached are that the modulation characteristics are generally similar to those of a straight amplifier, and that when a modulated carrier is applied to the grid the depth of modulation in the anode circuit is 2 to 3 times that of the grid drive. The maximum amplification factors of a frequency doubler are also determined for the cases when this uses (a) a triode and (b) a screen-grid valve.

90. A NEW METHOD OF MODULATION FOR DECIMETRE-WAVE EMITTERS.—O. Schäfer. (*Hochf:tech. u. Elek:akus.*, Sept. 1938, Vol. 52, No. 3, pp. 83–85.)

Author's summary:—Modulation up to 50%, suitable for speech transmission, can be obtained by inserting a condenser, electrodynamically controlled by the a.c. modulation current, in the energy lead between emitter and aerial. The method can be used for any decimetre-wave emitters and is extremely adaptable. The power required for control is very small, so that it is especially suitable for transportable apparatus.

91. Wide-Band Frequency Modulation [Summarising Account: Literature References].—H. Roder. (*E.N.T.*, Aug. 1938, Vol. 15, No. 8, pp. 263–270.)

92. Phase Modulation [Method of Transmission and Reception].—M. G. Crosby. (*Journ. Franklin Inst.*, Aug. 1938, Vol. 226, No. 2, p. 241: short note only.)

93. Papers on Asymmetric-Sideband Broadcasting and Single-Sideband Telephony.—Eckersley: Koomans. (*See* 312 & 313.)

94. The Transmission of Sidebands when Anode Modulation is used.—Z. I. Model, S. V. Person, & M. A. Sobolev. (*Izvestiya Elektroprom. Slab. Toka*, No. 3, 1938, pp. 18–27.)

It is pointed out that in designing circuits for class B anode modulation it is usual to assume that the modulated amplifier presents a purely ohmic load to the modulator (Fig. 1), whereas in reality this load is of a complex character. Accordingly a modified equation (3) is derived determining the voltage variation at the anode of the modulator, and an analysis is presented of the processes taking place in the circuit during modulation. Methods are indicated for designing the circuit, and the accuracy of these methods is confirmed, in the case of a push-pull modulator, by a comparison between calculated and experimental modulation curves. The theory developed is compared with that of Hofer (1386 & 2609 of 1935) and the main conclusion reached is that the frequency distortion introduced by class B anode modulation at the output stage is of the same order as for low-power modulation with subsequent amplification.

95. On the Influence of the Load Frequency-Characteristic on Distortion when Anode Modulation is used.—S. I. Evtyanov. (*Izvestiya Elektroprom. Slab. Toka*, No. 3, 1938, pp. 27–40.)

Equations (8) and (20) are derived, determining respectively the static modulation characteristics of a modulated amplifier when this is operating into (a) a tuned circuit and (b) a de-tuned circuit. An equivalent circuit to the modulation system is suggested (Fig. 6), and with reference to this an analysis is made of the distortion introduced when the modulated amplifier is loaded with (a) a single resonant circuit and (b) two inductively coupled resonating circuits. For each of these two cases, modulation characteristics are calculated and equations derived determining the a.c. component of the anode current of the modulated amplifier and currents flowing through the loading circuits.

96. Automatic Phase Regulation at Very High Frequencies.—I. S. Gonorovski. (*Izvestiya Elektroprom. Slab. Toka*, No. 6, 1938, pp. 1–7.)

During recent years attempts have been made to raise the power of short-wave radio transmitters by adding the outputs of two separate power-amplifier systems driven by a common exciter. In the present paper various factors affecting the phase stability of the two channels are discussed, and it is shown that the necessary phase regulation could be obtained by a variable condenser in one amplifier controlled by an automatic phase regulator responding to the phase difference between the two outputs. It is pointed out however that the usual phase regulators are not suitable for operation at frequencies higher than $2 \,.\, 10^3$–$3 \,.\, 10^3$ kc/s, and it is suggested that the frequencies applied to the phase regulator could be reduced by means of an oscillator beating with the carrier frequency (Fig. 7). The operation of the proposed system is discussed and preliminary experiments with a transmitter having two 100 watt amplifiers and operating at $15 \,.\, 10^3$ kc/s have shown that the system begins to respond to phase differences of the order of 4°.

97. The Compensation of Distortion in Radio Transmitters by the Use of Feedback Amplification.—Z. I. Model & S. V. Person. (*Izvestiya Elektroprom. Slab. Toka*, No. 7, 1938, pp. 4–18.)

The general principles underlying the operation of a feedback amplifier are considered, and this is followed by a discussion of practical circuits using these principles. Formulae are derived for determining the phase distortion introduced at various stages of the transmitter, and methods are discussed for preventing parasitic self-oscillation when feedback amplification is used. In conclusion, the suitability of feedback amplification for use in short, medium, and long-wave radio transmitters (with grid or anode modulation) is discussed, and a number of practical suggestions are made.

98. An Investigation of the Complex Bridge Neutralising Circuit.—M. S. Neiman. (*Izvestiya Elektroprom. Slab. Toka*, No. 3, 1938, pp. 10–18.)

It is pointed out that the usual push-pull neutralising circuit is not quite satisfactory, especially when operating at high frequencies and with large power outputs. A system is therefore put forward using a neutralising circuit based on the principle of a complex or double bridge (Fig. 2) in which the grid/filament capacity and the inductance of the leads and valve anodes are taken into consideration. The necessary conditions for the stability of the circuit are established, and methods of tuning discussed. A report is given on experiments with 20 kw valves on wavelengths from 8 to 20 m, and a number of practical suggestions are made.

The main conclusion reached is that the circuit under consideration presents definite advantages over the ordinary push-pull circuit, particularly in being more independent of the operating frequency.

99. Correction to "Automatic Adjustment for Modulation Indicator."—R. W. Carlson. (*Electronics*, Oct. 1938, Vol. 11, No. 10, p. 7.) *See* 4305 of 1938.

100. PARASITIC CIRCUITS [in Transmitters: particularly the Parasitic Oscillations at the Fundamental Frequency, and Remedies].—P. A. Erkstrand. (*Electronics*, Oct. 1938, Vol. 11, No. 10, pp. 26–27.)

101. H.T., D.C. QUICK-ACTING AUTOMATIC CIRCUIT BREAKERS FOR RADIO TRANSMITTING STATIONS.—Spirov. (*See* 317.)

102. GRID BIAS FOR CRYSTAL OSCILLATORS [Failure to Start caused by Excessive Damping at Very Small Amplitudes, sometimes Mechanical (Adhesion) but often due to Working Point on Grid-Current Characteristic being Unsuitable for Building-Up Process].—D. A. Bell. (*Marconi Review*, Oct./Dec. 1938, No. 71, pp. 20–21.)

103. CRYSTALS [Properties and Applications of Quartz Crystals, with Practical Information on Oscillator Stabilisation].—H. B. Dent. (*Wireless World*, 13th Oct. 1938, Vol. 43, pp. 329–330.)

104. THE BRIDGE-STABILISED OSCILLATOR.—Meacham. (*See* 263.)

105. CONTRAST COMPRESSOR AND EXPANDOR.—K. H. R. Weber. (*Telefunken Hausmitteilungen* [originally *Telefunken-Zeitung*], Sept. 1938, Vol. 19, No. 79, pp. 40–52.)

Discussion of the exact meaning and purpose of a contrast compressor (as distinct from other automatic controls—voltage stabilisers, limiters, control-room regulators). Preliminary considerations in the development of a new compressor and expandor (section IV), including the regulating characteristic (and the limits imposed in cases where no corresponding expandor exists at the receiving end, as in broadcasting); the choice of regulating time (with data on the building-up times of various musical instruments); and the question of variation with frequency. Description (section V) of the new apparatus, compressor and expandor.

106. SOME REMARKS ON THE THEORY OF DEVICES FOR AUTOMATIC VARIATION OF THE DYNAMIC RANGE [Automatic Volume Compression & Expansion].—B. S. Grigor'ev, B. S. Dulitski, & A. F. Egorov. (*Izvestiya Elektroprom. Slab. Toka*, No. 3, 1938, pp. 53–57.)

A critical survey is presented of the methods used in designing compandor systems, and the following main remarks are made:—(1) The operation of a straight amplifier is normally investigated at a number of separate frequencies. This method is not applicable to the systems under consideration, since their operation varies according to whether several frequencies are applied simultaneously or at different times. (2) The conditions laid down by Ballantine (1934 Abstracts, p. 379) for satisfactory operation of the system are not sufficient. (3) It is necessary to take into account the phase characteristic of the system. (4) In the case of a complex wave applied to the system, there is no advantage in using a full-wave rectifier instead of a half-wave rectifier. (5) In designing the l.f. filter the lowest frequency which can be perceived by the human ear should be taken into account (30 c/s approx.) and not the lowest frequency transmitted by the speech-input channel. For previous work *see* 1636 of 1938.

107. A LEVEL LIMITER FOR COMPRESSORS.—S. L. Rosenberg. (*Izvestiya Elektroprom. Slab. Toka*, No. 6, 1938, pp. 52–53.)

Background noises (microphone noise, studio noise, etc.) hardly noticeable during ordinary transmission may be raised to the level of the transmitted speech when compressor systems are used. To avoid this a circuit is proposed which does not allow full compression to be obtained of sounds below a certain loudness level.

108. PRODUCTION AND FREQUENCY-MEASUREMENT OF CURRENTS HAVING FREQUENCIES FROM 10 TO 100 CYCLES PER SECOND [Dynatron Oscillator of 10 Watts Output: Frequencies maintained, and measured, to 1 Part in 30 000 over Several Hours: Photographic Measurement Method].—A. L. Clark & L. Katz. (*Canadian Journ. of Res.*, Sept. 1938, Vol. 16, No. 9, Sec. A, pp. 183–189.)

109. THE PRODUCTION OF H.F. "KIPP" OSCILLATIONS WITH GASEOUS-DISCHARGE TUBES.—H. Pieplow. (*E.N.T.*, Sept. 1938, Vol. 15, No. 9, pp. 271–276.)

A discussion is first given of the factors which limit the efficiency of the discharge tubes used for producing "kipp" [relaxation] oscillations; the "kipp" mechanism is described (§ 2; fundamental circuit Fig. 1). Figs. 2–4 show tube characteristics. The influence of the grid bias is analysed in § 4; it is found advisable to produce "a very rapid rise in the negative grid bias, so that the layers of space charge in the gaps of the grid join up before ions can diffuse out of the rest of the plasma." A "controlled" generator for doing this is shown in Fig. 6 and described in § 5; it is found that with this circuit "kipp" frequencies up to 1 Mc/s and very high charging velocities can be attained.

110. AUTOMATIC AIR SIGNALS [Automatic Short-Wave Transmitter (Size of Football) in Tail of Aeroplane, to help Tracing after Crash].—(*World-Radio*, 4th Nov. 1938, Vol. 27, p. 5.)

111. MOBILE SHORT-WAVE TRANSMITTERS FOR BROADCAST COMMENTARIES.—Hofmann. (*See* 315.)

RECEPTION

112. VALVE INPUT RESISTANCE: ITS IMPORTANCE AT WAVELENGTHS BELOW 10 METRES [and Methods of reducing Detrimental Effects—Valve & Valve-Holder Design, Tapping of Tuned Circuit].—M. G. Scroggie. (*Wireless World*, 10th Nov. 1938, Vol. 43, pp. 400–402.)

113. INVESTIGATIONS ON CRYSTAL DETECTORS IN THE MICRO-WAVE REGION.—Rottgardt. (*See* 241.)

114. On the Effect of Aperiodic Interference on the Reception of Frequency-Modulated Signals when a Current Limiter is used and the Noise to Signal Ratio is High.—V. B. Pestryakov. (*Izvestiya Elektroprom. Slab. Toka*, No. 7, 1938, pp. 26–34.)

In the previous investigation (3535 of 1938) the effect, on the operation of the receiver, of beating between the frequency components of the noise spectrum was neglected and the results obtained are therefore applicable mainly to the case when the noise-to-signal ratio (β) is low. In the present paper a more detailed analysis is given of the operation of a receiver using a current limiter when the above-mentioned effect is taken into consideration. The ratio (Q) of the noise-to-signal ratio at the output of the receiver to that obtained when amplitude-modulated signals are received is determined, and curves are plotted showing how Q is affected by the width of the frequency band employed for transmission and by the value of β. These curves agree closely with those obtained experimentally by Armstrong. It is also shown that for a given β there is an optimum width for the frequency band transmitted.

115. Reduction of Interference by Frequency Modulation.—E. H. Plump. (*Hochf:tech. u. Elek:akus.*, Sept. 1938, Vol. 52, No. 3, pp. 73–80.)

The component parts of a frequency-modulation receiver are shown in Fig. 1; their action is theoretically analysed in § II, which also gives a comparison between frequency and amplitude modulation. The experiments (§ III) were made at low frequencies (Fig. 18); the effects for different ranges of the frequency modulation were investigated. Fig. 21 shows the ratio of l.f. to h.f. noise amplitude for various values of the ratio of the frequency-modulation band width to the band width of the l.f. filter, Fig. 23 the relation between l.f. noise amplitude as a percentage of the signal amplitude and the h.f. noise amplitude. The practical improvements obtained by adopting frequency modulation are discussed for various cases of noise interference and disturbance due to an emitter of neighbouring frequency.

116. The Elimination of Interference with Broadcast Reception in Switzerland: Annual Report of the "Pro Radio" Association.—Leithäuser. (*Funktech. Monatshefte*, Sept. 1938, No. 9, pp. 277–278.)

117. High-Frequency Interference from Mercury-Vapour Rectifiers.—A. Dennhardt. (*E.T.Z.*, 8th Sept. 1938, Vol. 59, No. 36, p. 968: summary only.)

118. On the Prevention of the Propagation of Interference along the Mains feeding the Source of Interference.—S. A. Lyutov. (*Izvestiya Elektroprom. Slab. Toka*, No. 3, 1938, pp. 40–45.) Concluded from 3191 of 1938.

119. Measurement of the Time Constants of Measuring Instruments [*e.g.* for Interference Tests].—Goffin & Marchal. (*See* 205.)

120. A Compensation Method for Eliminating the Disturbing Influence of Magnetic A.C. Fields [such as Leakage Fields of Mains Transformers, acting on L.F. Transformers or Chokes].—G. Schadwinkel. (*Funktech. Monatshefte*, Sept. 1938, No. 9, pp. 257–259.) By the addition of a duplicate, situated and connected so as to give the required compensation.

121. Remedies for Hand-Capacity [on Short-Wave Receivers: Experimental Investigation].—(*World-Radio*, 11th Nov. 1938, Vol. 27, p. 12.)

122. Negative Feedback in R-C Amplifiers ["Series" Method for Pentodes, used in Australian Receivers].—(*Wireless World*, 17th Nov. 1938, Vol. 43, pp. 437–438.) *Cf.* 2286 of 1938.

123. The Ill-Effects of Certain "Current-Economising" Devices in Broadcast Receivers where the Heating Voltage is dropped as well as the Anode Voltage.—Mie. (*See* 152.)

124. Single Signal—and Why [Method of Superheterodyne Reception for C.W. Telegraphy, giving Signal on One Side Only of Zero Beat].—S. K. Lewer. (*Wireless World*, 29th Sept. 1938, Vol. 43, pp. 284–286.)

125. Push-Pull Output Stages in Broadcast and Power Amplifiers.—Th. Tillmann. (*Telefunken-Röhre*, Aug. 1938, No. 13, pp. 73–89.)

Table of sound pressures and intensities, etc., of various sources (orchestras, etc.); the question of contrast compression; the necessary performance of the output stages of broadcast and gramophone amplifiers, and the problem of its fulfilment by commercial broadcast valves. The push-pull AD1 triode stage compared with the single AL5 pentode (with negative feedback to improve the quality): the push-pull AL5 stage. Increasing the output by use of higher anode voltages, and the special selected triodes and pentodes designated AD1/350, AL5/375, etc: special need for variable cathode resistance or variable bias from battery or rectifier when using push-pull AD1 at the higher voltage. The use of the push-pull "AB" connection. Circuit design for the use of the AL5 at 375 v, to give 25 w with 1.7% distortion, without overloading the screen grid. Objections to this circuit (particularly the difference—100 v—between anode and s.g. voltages); the usual hindrance to the use of high s.g. voltage (overloading of screen grid) overcome by use of flat struts, giving better heat transference, and of equal pitch for first and second grids, with consequent shadowing of latter by former, so that s.g. surface can be increased considerably without increase of s.g. current: final circuit, with 300 v on anode and 325 v on screen grid, giving 25 w with 2% distortion in an economical and convenient manner. Importance of good design of output transformer. Still larger powers by parallel connection of such stages.

126. ON THE THEORY OF VALVE SYSTEMS FOR AUTOMATIC FREQUENCY REGULATION [in Superheterodyne Receivers: "Automatic Tuning Correction"].—N. I. Chistyakov. (*Izvestiya Elektroprom. Slab. Toka*, No. 6, 1938, pp. 7–16.)

Dealing with the automatic frequency stabilisation of the beating oscillator in a superheterodyne receiver by employing a discriminating and a regulating circuit, both using valves and both connected between the beating oscillator and the second detector (Fig. 1). Various types of circuit are considered, together with their operation. A detailed discussion follows on the frequency stabilisation effected by a discriminating circuit employing one valve with two inductively coupled tuned circuits (Fig. 4), and a regulating circuit in which the regulating valve is connected across the tuned circuit of the beating oscillator (Fig. 3). For a previous paper *see* 3188 of 1938.

127. TEMPERATURE AND HUMIDITY [Effect on Broadcast Receivers, particularly since Inclusion of Automatic Tuning and Short-Wave Facilities].—A. W. Scott. (*Wireless World*, 29th Sept. 1938, Vol. 43, pp. 291–293.) Based on a Sydney World Radio Convention paper.

128. "A.B.C. OF AUTOMATIC TUNING" [Book Notice].—(*Electrician*, 23rd Sept. 1938, Vol. 121, p. 347.) A booklet giving an exposition of the principles of the many systems used in 1938/1939 receivers.

129. THEORY AND DESIGN OF "PROGRESSIVE UNIVERSAL" COILS [combining Features of "Universal" and Solenoid Winding Methods: Relatively High Q and Low Distributed Capacity].—A. A. Joyner & V. D. Landon. (*Communications*, Sept. 1938, Vol. 18, No. 9, pp. 5–11 and 50.)

130. TUNING COILS IN PRODUCTION [Radio Manufacturers' Methods of checking Coil Characteristics].—(*Wireless World*, 29th Sept. 1938, Vol. 43, pp. 287–288.)

131. WEATHER CONDITIONS AND RADIO RECEPTION AT LONG DISTANCES [Prolonged Observations on 340 m Delhi Carrier].—R. D. Joshi. (*Science & Culture*, Calcutta, Oct. 1938, Vol. 4, No. 4, p. 250.)

"It has been found that the rapid fluctuation in signal intensity is greater in winter and on clear nights. From day-to-day variations it is concluded that the signal intensity varies inversely as the temperature and decreases with the falling-off of the barometer at the receiving station. It is generally found that the falling of the signal intensity indicated the following day as rough and cloudy, while a continuous increase showed a clearing weather. These results seem to be different from those found previously by some investigators for short distances."

132. WHAT CAUSES GOOD AND BAD RECEPTION? [Investigation of Effects of Barometric Pressure and Temperature, Direction of Propagation, etc.].—(*World-Radio*, 7th Oct 1938, Vol. 27, p. 16.)

133. A.C. SHORT-WAVE THREE [5.9 to 97 Metres by Interchangeable Inductances: "Straight" Circuit].—H. B. Dent. (*Wireless World*, 6th Oct. 1938, Vol. 43, pp. 306–310.)

134. CAR RADIO EQUIPMENT [at Motor Exhibition, 1938].—(*Wireless World*, 20th Oct. 1938, Vol. 43, pp. 350–352.)

135. THE BROADCAST-RECEIVER INDUSTRY OF THE GERMAN OSTMARK.—W. F. Ewald. (*Telefunken Hausmitteilungen* [originally *Telefunken-Zeitung*], Sept. 1938, Vol. 19, No. 79, pp. 20–22.)

136. RADIOS THAT REMEMBER [General Electric "Time Tuning" covering 24-Hour Day].—(*Gen. Elec. Review*, Oct. 1938, Vol. 41, No. 10, p. 464.) *See* also 4327 of 1938.

AERIALS AND AERIAL SYSTEMS

137. RADIATION IN THE EARTH FROM A HERTZIAN DIPOLE.—Y. Kato. (*Nippon Elec. Comm. Eng.*, Sept. 1938, No. 12, pp. 364–369.) A summary of the full paper, of which this is a condensed translation, was dealt with in 3197 of 1938.

138. RHOMBIC AND V ANTENNAS EXCITED BY TRAVELLING WAVES.—Y. Kato. (*Nippon Elec. Comm. Eng.*, Sept. 1938, No. 12, pp. 391–392: summary only.) A shorter summary was dealt with in 2758 of 1938.

139. AERIAL ARRANGEMENT FOR IMPROVING THE POLAR DIAGRAM OF HALF-WAVE VERTICAL AERIALS [Short Aerials disposed round the Half-Wave Mast, fed by Radiation Coupling or Feeder Lines].—W. Berndt: Telefunken. (*Hochf:tech. u. Elek:akus.*, Sept. 1938, Vol. 52, No. 3, pp. 111–112: German Patent 658 978 of 20.8.35.)

140. THEORY OF DESIGN OF FILTERS CONSTRUCTED FROM RESONANT LINES [to cut off Several Given Frequencies and pass Several Other Frequencies: the Modified "Half-T" Circuit].—T. Mizuhasi. (*Nippon Elec. Comm. Eng.*, Sept. 1938, No. 12, pp. 319–323.)

Further development of the work dealt with in 1877 & 1878 of 1938 (also 2959 & 2960 of 1937); *cf.* also Mason & Sykes, 3671 of 1937.

141. HIGH-FREQUENCY CONCENTRIC CONDUCTORS [Method of Accurate and Adjustable Spacing by means of Insulating Point-Contact Rod-like Spacing Members].—RCA Patent. (*Marconi Review*, Oct./Dec. 1938, No. 71, pp. 22–23.)

142. RECEIVING AERIALS [and Signal/Noise Ratio: particularly the Question of "Effective Height"].—F. R. W. Strafford. (*Wireless World*, 13th Oct. 1938, Vol. 43, pp. 324–325.)

143. A SHIELDED LOOP FOR NOISE REDUCTION IN BROADCAST RECEPTION [used in General Electric Company's Receivers].—S. Goldman. (*Electronics*, Oct. 1938, Vol. 11, No. 10, pp. 20–22.)

144. CAR AERIALS [Present State of Knowledge].—F. R. W. Strafford. (*Wireless World*, 20th Oct. 1938, Vol. 43, pp. 344–346.)

VALVES AND THERMIONICS

145. THE MAGNETRON WITH OXIDE-COATED CATHODE.—J. Groszkowski & S. Ryzko. (*Wiadomósci i Prace, Państwowego Instytutu Telekomunikacyjnego*, Warsaw, No. 5/6, Vol. 8, 1937, pp. 103–105: French summary pp. I–II.)

The anodic efficiency of the magnetron in the dynatron régime often exceeds 50%, but the overall efficiency is very much smaller. The first step towards increasing this total efficiency is to use a modern permanent magnet in place of an electromagnet. The second step, the use of a more highly emissive cathode, has hitherto been prevented by certain phenomena which cause a destructive bombardment of such a cathode. Experiments with a four-slit magnetron with an ordinary tungsten cathode and internal oscillatory circuit led the writers to find a low-anode-voltage régime (giving an output of a few watts, on a 45 cm wave, with an anodic efficiency of 30%) which was exempt from this effect except at the highest powers. This result led them to try an oxide-coated cathode under these conditions. For the same output (2.2 w) and same anodic efficiency (32%), the new cathode gave an over-all efficiency of 29% compared with the previous (tungsten-cathode) value of 15%. The danger of destroying such a magnetron by leaving the anode voltage "on" in the absence of the magnetic field is considerably decreased by the use of a permanent magnet.

146. CHARACTERISTICS OF A SPLIT-ANODE MAGNETRON OSCILLATOR AS A FUNCTION OF SLOT ANGLE [Experimental Determination of Effect on Power Output and Efficiency: Broad Maximum of Output between 15° and 30°, for Negative-Resistance Oscillator].—L. Rosen. (*Review Scient. Instr.*, Nov. 1938, Vol. 9, No. 11, pp. 372–373.)

147. SOME DYNAMIC MEASUREMENTS OF ELECTRON MOTION IN MULTIPLE-GRID VALVES.—M. J. O. Strutt & A. van der Ziel. (*E.N.T.*, Sept. 1938, Vol. 15, No. 9, pp. 277–283.)

Electron motion in multiple-grid valves may be deduced from measurements of the input admittance between the cathode and its nearest grid, and of the steepness of slope of the characteristic relating this grid and the anode. The experimental methods have been referred to in 3211 of 1938 (Strutt), 1449 of 1936 (Ferris), and 1934 Abstracts, p. 619 (Llewellyn). In § II a theoretical discussion is given of the effect, on the input admittance, of electrons repelled from a grid with negative bias in multiple-grid valves; formulae are deduced which are applied in § III to measurements of the input admittance of pentodes, heptodes, and octodes. § IV gives calculations of the electron motion from the measurements of § III. In § V, formulae for the effect of the returning electrons on the magnitude and phase angle of the slope are deduced; these formulae are applied in § VI to dynamic slope measurements. The results on electron motion are found to agree satisfactorily with those of § IV.

148. A CONTRIBUTION TO TUBE AND AMPLIFIER THEORY [Improved Formula (from Maxwell's Solution) for Plane Triode and (by Conformal Representation) for Cylindrical Triode: "Grating Effect" Not Marked at Cathode Surface: Effects of Space Charge on μ: Temperature- and Space-Charge-Limited Diodes (with Inclusion of Initial Velocities): Extension to Large Signals: Electron-Damping by Harmonics in Receiving Valves: the Magnetron: etc.].—W. E. Benham. (*Proc. Inst. Rad. Eng.*, Sept. 1938, Vol. 26, No. 9, pp. 1093–1170.)

149. CURRENTS TO CONDUCTORS INDUCED BY A MOVING POINT CHARGE [General Expressions: Applications to Various Shapes of Valve Electrodes].—W. Shockley. (*Journ. of Applied Phys.*, Oct. 1938, Vol. 9, No. 10, pp. 635–636.)

150. CALCULATION OF THE CHARACTERISTICS OF ELECTRON VALVES (TRIODES) [Case when Pitch of Grid is Greater than Grid/Cathode Distance: Method: Tabulated Results for Selected Valves].—T. Glosios. (*Hochf:tech. u. Elek:akus.*, Sept. 1938, Vol. 52, No. 3, pp. 88–93.)

151. ON A METHOD FOR MEASURING THE NON-LINEARITY OF VALVES [for Rapid Comparison: "Anode Impression" Method using Bridge Circuit].—Watanabe, Okamura, & Chonan. (*Nippon Elec. Comm. Eng.*, Sept. 1938, No. 12, pp. 315–318.)

152. COMMERCIAL CATHODES AND THEIR USE IN PRACTICE [Pure Metal Cathodes: Metal with Metal Coating: Oxide-Coated Cathodes (Their "Centres": Discussion of Emission Equation: Emission from an Inhomogeneous Surface: Processes in the Oxide Layer: Damage and Its Causes: Necessity for operating in the Space-Charge Régime: etc.)].—K. Mie. (*Telefunken-Röhre*, Aug. 1938, No. 13, pp. 137–158.)

The complete wrongness of certain "current-economising" arrangements in some broadcast receivers, where the heating voltage is lowered as well as the anode voltage, is emphasised.

153. THE SURFACE MIGRATION OF BARIUM [Ba does not migrate over W or Ni].—M. Benjamin & R. O. Jenkins. (*Proc. Roy. Soc.*, Series A, 6th Sept. 1938, Vol. 167, No. 930, p. S 105: abstract only.)

154. THE INFLUENCE OF CONTACT POTENTIAL ON THE CHARACTERISTICS OF RECEIVING AND TRANSMITTING VALVES.—B. Gysae & S. Wagener. (*Zeitschr. f. tech. Phys.*, No. 9, Vol. 19, 1938, pp. 264–269.)

Authors' summary:—"It is shown from calculations that the situation of the characteristics of receiving and transmitting valves, both in the initial-current region and in the space-charge region, is affected by the geometrical dimensions of the valve, by the cathode temperature, and (apart from these factors) only by the work function of the anode; the work function of the cathode, contrary to opinions hitherto expressed, has no influence on the situation of the characteristic.

The truth of this law is also confirmed experimentally as regards the space-charge region. The calculations and experimental results finally allow a statement to be made regarding the behaviour of the *A*-value of the Richardson emission equation for coated cathodes: it is found that this *A*-value is independent of the thickness of the coating." Both Rothe (1933 Abstracts, pp. 95–96) and Strutt (1358 of 1937) have maintained that the cathode work function and the corresponding contact potential influence the displacement of the characteristic. Incidentally, the new result simplifies the measurement of the anode work function by the method of displacement of characteristic, since there is no need to take precautions to keep the cathode work function constant during the measurement, as specified by Lukirsky & others (1931 Abstracts, p. 618).

155. The Noise in Secondary Emission [Theoretical Proof, with Experimental Confirmation, that Increasing the Slope of a Valve by the Use of Secondary Emission cannot Decrease the Equivalent Noise Resistance].—W. Engbert. (*Telefunken-Röhre*, Aug. 1938, No. 13, pp. 127–136.)

"For the experimental confirmation of eqn. 20 [giving the relation between the equivalent resistances of the 'normal' valve and the valve with 'multiplication,' when the two primary systems are the same: eqn. 21 applies to the case where the "normal" and the output stage of the "multiplier" valve have equal final slopes], noise measurements were made on a sample valve with a secondary-emission stage. Fig. 4 shows the characteristics and slopes of the primary system (*P*) and of the whole system (*M*). The output γ of the secondary-emission plate is about 5.5. The measured equivalent noise resistances of the two systems are shown in Fig. 5.

"The s.e. valve is worse than the primary system by the factor $a = 1.35$, in spite of the considerably steeper slope. In the valve examined a small portion of the electrons came direct to the anode. This direct current can be regarded as a current from the s.e. plate with an ideal emission output $\gamma_i = 1$; but this means (in view of the measured mean output for the noise, $\gamma = 5.5$) a non-uniform emission from the s.e. plate. Our measured $a = 1.35$ therefore gives a value for the output spectrum of the valve, while the value for the s.e. plate itself is smaller. For the construction, therefore, of a low-noise s.e. valve care should be taken to make the stream flowing direct to the anode as small as possible; this end is already pursued for the attainment of the steepest possible slope."

156. The Secondary-Electron Emission from Beryllium [Measurements under Various Experimental Conditions: Oxidation alone does not give Highest Yields: Processes in Beryllium Film are required, connected with Arrangement of Atoms].—R. Kollath. (*Ann. der Physik*, Series 5, No. 4, Vol. 33, 1938, pp. 285–299.)

157. Measurements on the Secondary Electrons emitted from "Recoil Nets."—Sandhagen. (*See* 218.)

158. Field Emission from Stratified [Composite] Cathodes on Irradiation by Electrons: Part II.—H. Mahl. (*Zeitschr. f. tech. Phys.*, No. 10, Vol. 19, 1938, pp. 313–320.)

Author's summary:—In continuation of previous work [983 of 1938] on the secondary field emission of stratified cathodes (Al/Al-oxide/Cs-oxide), new results are reported:—(1) As a function of the primary-electron energy, the secondary field emission sets in at about 15 ev, then increases steeply, passes through a flat maximum, and finally at high primary energies (around 1000 ev) returns to zero. (2) With increasing collector voltage *V* the secondary field emission first increases in proportion to *V* [and then tends towards saturation]; saturation is only reached at a very high collector voltage, above 1000 v [Fig. 1a]. (3) On the production of negative surface charges on the stratified cathode [which occurs when the impinging energy of the primary electrons sinks below about 15 v] the intermediate layer of the latter becomes polarised, by which the emission properties of the cathode are considerably altered. An explanation of this result is given.

(4) An interpretation of the "activating" of the stratified cathode, given by Mühlenpfordt [2802 of 1938], is adversely criticised and a different explanation suggested. (5) The stability of positively charged regions of the surface, revealed by electron-optical examination, is explained by the non-metallic character of the neutral surface layer. (6) Tests on the equilibration of charges, particularly in breakdowns [of the Al-oxide layer, by excessive secondary-field-emission current], show that the ionised surface has a considerable conductivity for electrons. (7) From the partial neutralisation of the surface charge by the momentary cutting-off of the collector voltage, the capacity of the cathode surface to the Al under-layer is calculated roughly: the value agrees satisfactorily with the capacity calculated from the oxidation voltage. (8) In breakdowns, the secondary-electron emission in the breakdown zone is increased, from which it follows that the neutral stratified-cathode surface has a greater secondary-electron emission than the ionised (positively charged) surface [section 4]. (9) It was found possible to produce a field emission by the direct application of voltage to a stratified (Al/Al-oxide/Ag) cathode [the special construction of the cathode for this purpose is seen in Fig. 8; the two difficult conditions are here fulfilled, that the positive electrode should not hinder the emergence of the field electrons into the vacuum and yet should act as a perfect lead-in for the positive voltage. Another design, by Brunke, is referred to in footnote 19.]

159. The Formation of Negative Ions by Positive-Ion Impact on Surfaces.—R. Press & R. H. Sloane. (*Proc. Roy. Soc.*, Series A, 6th Sept. 1938, Vol. 167, No. 930, p. S 100: abstract only.)

160. Formation of Negative Ions at Metal Surfaces [Theory].—R. A. Smith. (*Proc. Roy. Soc.*, Series A, 10th Oct. 1938, Vol. 168, No. 932, pp. 19–42.)

161. A New Process of Negative-Ion Formation: IV [Impinging Positive Ion causes Atom adsorbed on Surface to come off as Negative Ion: Negative Oxygen Ions appear from Tungsten Filament cleaned by Flashing: Effect of Increased Work Function of Oxidised Filament].—F. L. Arnot & C. Beckett. (*Proc. Roy. Soc.*, Series A, 10th Oct. 1938, Vol. 168, No. 932, pp. 103–122.)

162. Striking-Voltage Curves for the Rare Gases at Low Pressures [and the Suitability of Krypton and Xenon for Electronic Valves, at To-day's Reduced Prices].—H. Klemperer. (*Zeitschr. f. tech. Phys.*, No. 9, Vol. 19, 1938, p. 270.)

163. The Radiation-Cooled Telefunken Transmitting Pentodes [Types RS 384, 337, 391, and 287, with Outputs 800, 100, 100, and 50 Watts].—A. Engelmann. (*Telefunken Hausmitteilungen* [originally *Telefunken-Zeitung*], Sept. 1938, Vol. 19, No. 79, pp. 53–59.)

Of the two 100-watt types, the first is directly heated, the second indirectly (and is very strong against the shocks and vibrations of mobile equipments). The 800-watt type will give 450 watts at 6 m, working at 1500 volts instead of up to 3000.

164. Single-Ended R.F. Pentodes [Successful New Designs with Shield Cone and Cylinders for reducing Inter-Electrode Capacity: Advantages over Top Lead-Out of Control Grid].—R. L. Kelley & J. F. Miller. (*Electronics*, Sept. 1938, Vol. 11, No. 9, pp. 26–28.) From RCA Research Dept.

165. American Metal Valves.—B. M. Tsarev. (*Izvestiya Elektroprom. Slab. Toka*, No. 6, 1938, pp. 33–47.)

166. Steel Valves: New German Productions compared with Glass and Earlier Metal Types.—W. E. Felix. (*Wireless World*, 10th Nov. 1938, Vol. 43, pp. 403–404.)

167. The Regulating Properties of the Steel-Valve Series [with Particular Attention to AVC in a 4-Valve Superhet by a Combination of Types ECH 11 and EBF 11, with "Sliding" Screen-Grid Voltage].—K. Steimel & R. Schiffel. (*Telefunken-Röhre*, Special Valve Number, Aug. 1938, Supp. to No. 13, pp. 28–40.) For the use of this "sliding" (gleitende) s.g. voltage technique *see* also Schiffel, pp. 41–49.

168. The Broadcast Valve Programme 1938/1939.—K. Steimel. (*Telefunken - Röhre*, Special Valve Number, Aug. 1938, Supp. to No. 13, pp. 2–27.)

169. An Indexed Bibliography of Electron Tubes and Their Applications.—E. D. McArthur. (*Gen. Elec. Review*, Oct. 1938, Vol. 41, No. 10, pp. 455–460.)

170. Industrial Tube Terminology [Table giving Names and Definitions].—Gen. Elec. Company & Westinghouse. (*Electronics*, Sept. 1938, Vol. 11, No. 9, p. 29.)

171. The *Wireless World* Valve Data Supplement, 1938.—(*Wireless World*, 10th Nov. 1938, Vol. 43, pp. 409–432.)

172. Valve Characteristics with Logarithmic Current Scale [and the Need for Caution in Their Use: with Particular Reference to Valves for AVC].—F. Bergtold. (*Funktech. Monatshefte*, Sept. 1938, No. 9, pp. 259–262.)

173. Porcelain Pipe at WHAM [for Water System of Valve-Cooling Installation].—J. J. Long, Jr. (*Electronics*, Oct. 1938, Vol. 11, No. 10, pp. 24–25.)

DIRECTIONAL WIRELESS

174. Methods of Aircraft Wireless Navigation [General Description of Use of Rotating Frame Aerial, Blind-Landing Beacons, etc.].—E. C. Metschl. (*Naturwiss.*, 26th Aug. 1938, Vol. 26, No. 34, pp. 553–561.)

175. Wireless Services for the North Atlantic Air Routes, with Particular Reference to the Eire/Newfoundland Route.—C. B. Carr. (*Marconi Review*, Oct./Dec. 1938, No. 71, pp. 24–34.)

176. Errors in Radiogoniometers [particularly the Aperiodic Tight-Coupled Type: Methods of Measurement, with Special Reference to Accuracy Checks at Frequencies up to 20 Mc/s, and Eckersley's Over-All Check (Aerials & Radiogoniometer) by Small Central Loop-Aerial].—S. B. Smith & J. F. Hatch. (*Marconi Review*, Oct./Dec. 1938, No. 71, pp. 9–15.)

177. Metcalf-MIT Blind-Landing System using Infra-Red or Micro Wireless Waves.—(*Aviation*, July & Aug. 1938, Vol. 37, Nos. 7 & 8, p. 40: p. 38.)

178. Flight Tests of Simon Radio Guide.—(*Aviation*, July 1938, Vol. 37, No. 7, p. 41.)

179. Range of Wireless Waves used on Aircraft.—J. Sylvestre. (*L'Air*, 20th July 1938, No. 449, pp. 453–454.)

180. Stark Position Finder for Radio Compass Work, *and* Stark Position Finder for Wireless Navigation.—(*Aviation*, July 1938, Vol. 37, No. 7, p. 41: *American Aviation*, 1st Aug. 1938, Vol. 2, No. 3, p. 8: *Flight*, 21st July 1938, Vol. 34, No. 1543, p. 65.)

181. Device shows Dispatchers the Direction of Incoming Planes.—Bell Tel. Laboratories. (*Science News Letter*, 24th Sept. 1938, Vol. 34, p. 199.)

182. "Wireless Direction Finding: 3rd Edition" [Book Review].—R. Keen. (*Electrician*, 23rd Sept. 1938, Vol. 121, pp. 341–342.)

ACOUSTICS AND AUDIO-FREQUENCIES

183. INVISIBLE LOUDSPEAKERS [" Ground " or " Buried " Type (3986 of 1938) and " Flat " Type (with Magnet System in Concave Side of Diaphragm, Overall Depth only 43 mm : the Question of Wall-Mounting) : Mathematics of the Reflection Effect].—H. Benecke. (*Telefunken Hausmitteilungen* [originally *Telefunken-Zeitung*], Sept. 1938, Vol. 19, No. 79, pp. 66–71.)

184. MAKING A CURVED DIAPHRAGM [for Loudspeaker : Use of Narrow Paper Rings glued together].—W. Brewer. (*Wireless World*, 29th Sept. 1938, Vol. 43, pp. 289–290.)

185. RESONANCE IN TRUNCATED CONES [Experiments on Open-End Correction].—A. E. Bate & E. T. Wilson. (*Phil. Mag.*, Nov. 1938, Series 7, Vol. 26, Supp. No. 178, pp. 752–757.)

186. THE PIEZOELECTRIC BEHAVIOUR OF CRYSTALS, WITH SPECIAL REFERENCE TO ROCHELLE SALT.—W. Ernsthausen. (*Telefunken Hausmitteilungen* [originally *Telefunken-Zeitung*], Sept. 1938, Vol. 19, No. 79, pp. 71–77.)

The molecular theory of piezoelectricity : the quantitative theory : the crystallographic and physical properties of Rochelle salt : special cases. From the author's summary :—" The data given in the literature show that the electrical excitations observed in crystals under mechanical forces arise from the presence of dipole molecules, whose resultant moment alters with the deformations of the crystal lattice. The anomalous behaviour of Rochelle salt in the direction of the *a*-axis can be accounted for on a ferromagnetic analogy [Forbes & Müller, 1934 Abstracts, p. 446 : *see* also Russian work, 3606 of 1935], according to which this material is composed of dipole groups [corresponding to the " Weiss domains " in magnetism] which are spontaneously polarised through their internal field-preference in the direction of the *a*-axis, and which therefore require, in this direction, only small fields for their complete orientation . . ."

187. THE ANOMALOUS CHARGING CURRENT IN ROCHELLE-SALT CRYSTALS.—Seidl. (*See* 265.)

188. PICK-UP DESIGN [Importance of Mechanical System, and an Improved Pick-Up obtained by designing This around a New Type of Needle].—(*Wireless World*, 27th Oct. 1938, Vol. 43, pp. 364–366.)

189. ELECTROACOUSTIC MEASUREMENTS WITH THE RAYLEIGH DISC [Theory and Practical Details : Curves of Results of Measurements on Loudspeakers and Microphones].—B. Woelke. (*Funktech. Monatshefte*, Sept. 1938, No. 9, pp. 281–286.)

190. THE FILTRATION OF SOUND : I [Summarising Account].—R. B. Lindsay. (*Journ. of Applied Phys.*, Oct. 1938, Vol. 9, No. 10, pp. 612–622.)

191. A TYPE OF ELECTRICAL RESONATOR [Theory of Certain Shapes of " Hohlraums " : Equivalence to Lumped-Constant Circuits : Theory of Coupling on to " Hohlraums "].—W. W. Hansen. (*Journ. of Applied Phys.*, Oct. 1938, Vol. 9, No. 10, pp. 654–663.)

192. CONTRAST COMPRESSOR AND EXPANDOR, *and* SOME REMARKS ON THE THEORY OF AUTOMATIC VOLUME COMPRESSION AND EXPANSION.—Weber : Grigor'ev, Dulitski, & Egorov. (*See* 105 & 106.)

193. ECHO- AND FEEDBACK-BLOCKED DUPLEX [Telephone] TRAFFIC CONNECTIONS WITH AMPLIFIERS.—H. Kimmel. (*E.N.T.*, Aug. 1938, Vol. 15, No. 8, pp. 247–262.)

Examples of circuits to render disturbances in long telephone cables ineffective are a speech-controlled four-wire cable with echo blocking (Fig. 1) and a wireless connection with feedback blocking (Fig. 2). The working of these circuits is explained. A classification of all such circuits in one system is made ; the action of the various classes is described and their advantages and disadvantages are indicated. A new circuit with feedback blocking is described.

194. A NEW THEORY OF THE ACTION OF THE CARBON MICROPHONE FROM THE STANDPOINT OF NON-LINEAR DISTORTION.—K. Nakamura. (*Nippon Elec. Comm. Eng.*, Sept. 1938, No. 12, pp. 390–391 : summary only.)

195. THE E.M.F. OF A CARBON MICROPHONE.—A. I. Yakoulev. (*Izvestiya Elektroprom. Slab. Toka*, No. 6, 1938, pp. 47–51.)

196. MICROPHONE AMPLIFIERS.—F. W. Alexander & D. E. L. Shorter. (*World-Radio*, 28th Oct. 1938, Vol. 27, pp. 14–15.)

197. A SOUND ILLUSION PRE-AMPLIFIER [for Sound Effects : Usual Filter Combination replaced by Pre-Amplifier with Series Bank of Antiresonant Circuits].—C. F. Sheaffer. (*Electronics*, Sept. 1938, Vol. 11, No. 9, pp. 14–15.)

198. MAGNETIC RECORDING [Short Survey, including Begun's Recording Machine for Study of Music, Voice, and Languages].—S. J. Begun. (*Electronics*, Sept. 1938, Vol. 11, No. 9, pp. 30–32.)

199. " SQUEEZE " OR " MATTED " TRACK [for Noise Reduction in Sound Films].—J. K. Hilliard. (*Electronics*, Oct. 1938, Vol. 11, No. 10, p. 23.)

200. CORRECTIONS TO " VOLUME INDICATOR-ATTENUATOR."—Carter. (*Electronics*, Sept. 1938, Vol. 11, No. 9, p. 9.) *See* 4402 of 1938.

201. CORRECTION TO " PRACTICAL FEEDBACK AMPLIFIERS."—Day & Russell. (*Electronics*, Oct. 1938, Vol. 11, No. 10, p. 7.) *See* 2627 of 1937.

202. PUSH-PULL OUTPUT STAGES IN BROADCAST AND POWER AMPLIFIERS.—Tillmann. (*See* 125.)

203. THE EFFECT OF STRAY ADMITTANCES IN FOUR-ARM BRIDGE NETWORKS [for High-Precision Audio-Frequency Work].—Astbury. (*See* 68.)

204. AUDIO-FREQUENCY OSCILLATOR [of High Stability and Good Wave-Form].—Muirhead & Company. (*Journ. Scient. Instr.*, Oct. 1938, Vol. 15, No. 10, pp. 347–348.)

205. MEASUREMENT OF THE TIME CONSTANTS OF ELECTRICAL MEASURING INSTRUMENTS [in Connection with the C.I.S.P.R. Rules for Indicating Instruments for Noise-Meters, etc.].—Goffin & Marchal. (*E.T.Z.*, 29th Sept. 1938, Vol. 59, No. 39, p. 1046: summary only.)

206. "DIE GESTALTUNG VON RÄUMEN [Design of Rooms] NACH AKUSTISCHEN GESICHTSPUNKTEN."—W. H. Makowski. (At Patent Office Library, London: Cat. No. 78 924: 76 pp.) A Berlin thesis.

207. BELGIUM'S BROADCASTING HOUSE [and the Acoustic Treatment of the Studios].—(*Wireless World*, 27th Oct. 1938, Vol. 43, p. 367.)

208. THE ACOUSTICAL DESIGN OF BROADCASTING STUDIOS.—J. McLaren. (*World-Radio*, 4th Nov. 1938, Vol. 27, pp. 14–15.)

209. COMBINATION TONES IN NON-LINEAR SYSTEMS [often greatly Exceeding in Amplitude the Simple Harmonics: Experiment and Calculations].—F. Massa. (*Electronics*, Sept. 1938, Vol. 11, No. 9, pp. 20–21.)

210. ON THE FREQUENCY OF ALTERNATING CURRENT AND THE PITCH OF THE TONE DURING ELECTRICAL STIMULATION ON THE AUDITORY APPARATUS [with an Electrostatic Theory of the Frequency-Doubling Action: in English.].—A. Arapova & G. Gersuni. (*Tech. Phys. of USSR*, No. 6, Vol. 5, 1938, pp. 447–462.)

211. THE AUDIBILITY OF VARIATIONS IN FREQUENCY BAND IN SPEECH TRANSMISSION.—E. Schäfer. (*E.N.T.*, Aug. 1938, Vol. 15, No. 8, pp. 237–240.)

The purpose of this work is the determination of the threshold values of the frequency-band variations which the ear just perceives. Figs. 2 & 4 show the threshold values of perceptible frequency change for the upper and lower limits respectively. It is found that the frequency band can be considered as composed of stages whose number is represented by the curves of Fig. 3; the ear is found to distinguish about 30 stages, which are independent of the intensity. Naturalness of speech is a necessity for good-quality telephone transmission; it is analysed and found to depend on the number of the above mentioned stages. Measurements of the number of stages and degree of naturalness in transmission from various stations are also described (Fig. 5). The effect of surrounding noise (Fig. 6) is a marked decrease in the number of stages.

212. INTERNATIONAL STANDARD OF MUSICAL PITCH.—G. W. C. Kaye. (*Nature*, 5th Nov. 1938, Vol. 142, pp. 820–821.)

213. THE ACOUSTICAL TESTING OF THE MUSICAL QUALITY OF VIOLINS [including Effects of Wood Thickness and of Varnish: Importance of Measurements of Wagner "Dynamic" (Volume Range, Contrast): etc.].—H. Meinel. (*Zeitschr. f. tech. Phys.*, No. 10, Vol. 19, 1938, pp. 297–307.)

214. AN ULTRASONIC SOURCE OF IMPROVED DESIGN: OPTICAL STUDIES OF ULTRASONIC WAVES IN LIQUIDS.—F. E. Fox & G. D. Rock. (*Review Scient. Instr.*, Nov. 1938, Vol. 9, No. 11, pp. 341–345.)

215. THE SUPERSONIC ANALOGY OF THE ELECTROMAGNETIC FIELD.—D. Riabouchinsky. (*Comptes Rendus*, 24th Oct. 1938, Vol. 207, No. 17, pp. 695–698.)

PHOTOTELEGRAPHY AND TELEVISION

216. THE IMPORTANCE OF THE "STRAY ELECTRON EFFECT" IN THE FUNCTIONING OF TELEVISION SCANNING TUBES.—M. Knoll. (*Zeitschr. f. tech. Phys.*, No. 10, Vol. 19, 1938, pp. 307–313.)

Author's summary:—An uneven charge-distribution on an insulating surface, produced by irradiation by small electron currents (of the order of 10^{-7} A/cm^2), can be made visible on the cathode-ray-tube screen by a line-by-line scanning of this surface with a sharply focused electron beam. To this uneven charge-distribution there are corresponding different equilibrium-potentials of the irradiated surface, before and just after contact with the scanning beam, whose difference gives the image-signal of the charge-distribution.

The equilibrium-potentials are different, if the velocity of the irradiating electrons falls in the range where the secondary-emission factor is greater than unity and that of the scanning electrons in the range where the secondary-emission factor is less than unity, or *vice versa*. It is found, however, that even for an equal velocity for both (secondary-emission factor greater than unity) the charge-distribution of the irradiating electrons is clearly visible. From this it is deduced that the visibility of the charge image is due primarily to the secondary electrons of the scanning beam ("stray" electrons) which, owing to their low velocity, have a secondary-emission factor smaller than unity and form a space-charge in front of the screen. They lie as a negative-charge film on the insulating surface and, on scanning, give by the destruction of their negative charge a positive electric impulse to the amplifier connected to the collector electrode. At the points continuously irradiated with additional electrons, where the secondary-emission factor is always greater than unity, no negative charge can accumulate and therefore no signal amplitude can occur on scanning. Thus the electron-irradiated places appear in the image as black on a light ground, when the amplifier has an even number of stages.

The interpretation of the phenomena here described as the results of "stray" electrons explains the following observed facts:—(1) the small (in comparison with other scanning methods) contrast range of the iconoscope, often reduced only in certain parts of the image; (2) the fly-back trace of the scanning beam in the iconoscope [Fig. 5: white lines in a positive image, corresponding to the black lines of the fly-back trace in the scanning of an Al_2O_3 plate, Fig. 2, where the amplifier had an *uneven* number of stages]; (3) the interference signals of the iconoscope ("black spot," "tilting effect"), in which a static and a dynamic component are to be distinguished; (4) the relatively high sensitivity of "image converter" type of scanning tube even for equal velocities of photo-electrons and scanning electrons [this much higher sensitivity has hitherto been explained partly by the greater electron output of the photocathode, working—unlike the iconoscope cathode—with full anode voltage; but chiefly by the secondary-electron multiplication of the photoelectrons at the screen: this explanation, however, fails to explain certain results—see p. 311, r-h column]; (5) line displacements and "flutter effect" in high-voltage reproducing tubes [with interlaced scanning: *see* last paragraph of l-h column, p. 312].

217. Resistance-Controlled Image-Scanning Tubes [using Semiconducting Layers with Internal Photoelectric Effect: Theoretical and Experimental Investigations].—R. Theile. (*Telefunken-Röhre*, Aug. 1938, No. 13, pp. 90–126.)

"The use of the internal photoeffect in scanning tubes has already been suggested in comparatively early days in various patent specifications [some examples are cited], but these specifications, almost without exception, limit themselves to the general use of such effects without going further into the mechanism of image-signal production. As to the exact mode of action of the semiconductor scanning tube, nothing was known when the present work was begun; the first thing to do was therefore to elucidate this. The theoretical treatment and the experiments were based on an arrangement shown in Fig. 1, where the screen consists of a uniform thin semiconducting film applied to a metallic layer and varied as to its specific resistance by the action of light. Tubes with such screens are called 'resistance-controlled image-scanning tubes,' or 'resistance-scanners' for short."

Author's summary:—(1) Assuming a light-dependent resistance variation of the semiconducting film on the screen, and neglecting any photoelectric influence on the secondary-emission process, a theory of image-signal production is given.

The magnitude of the resistance-controlled image signal is dependent on (a) the shape of the SE [secondary-emission] characteristic; (b) the matching of the image-element resistance [r_1 r_2 r_3 . . . in Fig. 4] to the internal resistance of the SE path [from screen to ring-shaped secondary-emission anode R in Fig. 3; R_i in equivalent circuit of Fig. 4]; (c) the value of the collector voltage U_p; and (d) the value of the time constant τ, depending on the image-element capacity, its resistance, and the resistance of the SE path.

(2) An image signal can only be obtained if the signal current flows in a positive direction from the signal plate. The secondary-emission factor must be greater than unity. (3) Measurements on the experimental tubes [with cuprous-oxide layer] constructed for testing the theory confirm the theoretically derived properties of the semiconductor scanning tube given under (2).

(4) The experimental tubes show certain interference effects which arise from the angular variation of the secondary emission and from the inhomogeneities of the semiconducting layer. On the elimination of these interference effects depends, to a large extent, the practical usefulness of the resistance-scanner. (5) No storage action [such as that in the iconoscope] on the image-change duration was observable, so that directly-controlled scanning tubes must be considered as having an instantaneous action.

218. Measurements on the Secondary Electrons emitted from "Recoil Nets" [Wire Mesh between Two Stops with Variable Voltage: Effect of Accelerating and Retarding Fields on Secondary-Electron Paths: Possibilities of Use of Small Plates as Secondary-Electron Multipliers].—M. Sandhagen. (*Zeitschr. f. Physik*, No. 9/10, Vol. 110, 1938, pp. 553–572.) For previous work *see* 285 of 1938.

219. Papers on Secondary and Field Emission.—(*See* also under "Valves & Thermionics.")

220. The Origin of the Multiple Spectral Maxima observed with Composite Photo-cathodes, deduced from Spectral Sensitivity Curves at 293° and 83° abs.—R. Suhrmann & A. Mittmann. (*Zeitschr. f. Physik*, No. 1/2, Vol. 111, 1938, pp. 18–35.)

The long-wave maxima are ascribed to the finely grained alkali metal adsorbed on the cathode surface, the short-wave maxima to internal centres in the substance between the alkali film and the carrier metal, formed by the interaction of the intermediate substance and the alkali atoms which have diffused into it.

221. Correlation of Optical Properties and Photoelectric Emission in Thin Films of Alkali Metals [New Experimental Data for Potassium, Rubidium, and Caesium confirm Extended Theory developed by Authors].—H. E. Ives & H. B. Briggs. (*Journ. Opt. Soc. Am.*, Sept. 1938, Vol. 28, No. 9, pp. 330–338.) An abstract was referred to in 3304 of 1938. For previous work *see* 622 of 1938 and back reference.

222. The Time Lag in Gas-Filled Photoelectric Cells.—A. M. Skellett. (*Journ. of Applied Phys.*, Oct. 1938, Vol. 9, No. 10, pp. 631–635.) *See* also 3797 of 1937 and 2890 of 1938.

223. The Action of Soft X-Rays upon Selenium Barrier-Layer Cells [Main Current and Voltage Response similar to That to Visible Light: Anomalous Behaviour of Barrier-Layer Resistance: Photocurrents Too Small for Intensity Measurements in Spectrally Dispersed Radiation].—A. E. Sandström. (*Phil. Mag.*, Nov. 1938, Series 7, Vol. 26, Supp. No. 178, pp. 906–920.)

224. The Question of the Number of Lines in Television Transmissions.—F. Kirschstein. (*E.N.T.*, July 1938, Vol. 15, No. 7, pp. 218–234.)

This paper aims at assessing the quality of picture transmission with modern television technique, from as many examples as possible, and discusses the electrical difficulties in the way of an immediate increase in the number of lines. A discussion is first given (§ I.1) of former investigations on the subject. § I.2 deals with the variation of picture quality with line number above 300 on the basis of picture-telegraphy apparatus. Figs. 2–10 give examples of original pictures and their reproductions by half-tone print and picture telegrams of 600 and 300 lines. The improvement with 600 lines over the quality with 300 lines is particularly marked with small-sized objects in the picture (Figs. 9, 10). The writer thinks that at least 600 lines are needed for good quality, even for home reception on a small screen (§ I.3); he supports his view by arguments drawn from the quality of half-tone pictures in the daily press (§ I.4), whose production he describes (Fig. 11).

In the discussion of the electrical problem (§ II) the chief difficulty is found to lie in the high values of frequency which must be transmitted over long distances. In § II.1 the connection is worked out between the line number and the highest frequency to be transmitted, with a consideration of the optical and electrical distortions. Fig. 13 illustrates the television reproduction of a brightness discontinuity for various widths of the transmitted frequency band. § II.2 deals with the decrease of the power of an ultra-short-wave transmitter with the height of the highest modulation frequency (Fig. 14, end stage of transmitter), a difficulty which cannot be avoided either by increasing the carrier frequency or giving the output stage of the transmitting valve the character of a band filter (Fig. 15). Transmitter output can only be increased by the development of valves with high ratio of saturation current to anode/cathode capacity.

The received field strengths of ultra-short-wave stations in large cities is discussed in § III (Fig. 16, field strength as a function of distance from station). The transparency of the transmitting aerial to high modulation frequencies is worked out (§ III.1) and shown in diagrammatic form in Fig. 17. Fig. 18 gives impedance and current at the base of a quarter-wavelength aerial with a shortening condenser. For high modulation frequencies, special circuits must be used to match the end impedance to the wave impedance of the feeding cable for the whole sideband-frequency range. The transparency of a receiving circuit with a quarter-wavelength aerial to high modulation frequencies is dealt with in § III.2 (Fig. 19), where eqn. 27 gives the drop in useful voltage with increasing modulation frequency. Internal disturbing voltages in the television receiver are discussed in § III.3; they arise from the shot effect in the first valve and the thermal movements of the molecules in the input oscillating circuit. The minimum field strength and the transmission range for increasing modulation frequency (§ III.4) are limited by these disturbances. The amplification of the picture currents (§ III.5) requires a number of valves which rapidly increases as the frequency band increases in width (Fig. 207). The phase distortion in cable transmission (§ III.6) is also a source of difficulty (Fig. 21, group-transit-time of the wide-band cable and greatest cable length which can be worked without phase distortion, as a function of line number). A list of literature references is added.

225. Electromagnetic Deflecting Systems in Television Apparatus.—B. S. Mishin. (*Izvestiya Elektroprom. Slab. Toka*, No. 7, 1938, pp. 43–48.)

The papers so far published on the design of deflecting coils in Russian technical literature deal with coils of round shape only. In the present paper methods are indicated for designing coils of elongated shape (Fig. 4). A formula (6) is derived for determining the intensity of the field due to one turn of the coil, and simplified formulae (7 and 8) for round and square coils respectively. A formula (10) is also derived for determining the total deflection of the electron beam due to a system of two coils. A numerical example is added and the accuracy of the methods proposed is confirmed by a comparison between calculated and experimental results.

226. Addition to the Paper "Post-Acceleration Cathode-Ray Oscillograph."—A. Bigalke: Schwartz. (*Zeitschr. f. tech. Phys.*, No. 9, Vol. 19, 1938, p. 284.)

In connection with Bigalke's paper (3340 of 1938) Schwartz has pointed out that in his own paper, dealt with in 3131 & 3551 of 1935, he also has considered the various proposals for increasing spot-brightness by post-deflection acceleration of the electron beam. He came to the conclusion, in connection with the development of television tubes, that the best plan was to obtain a uniform acceleration extended over the whole bulb of the tube, using for this purpose a high-ohmic resistance, carrying a current, on the tube wall; in practice, a resistance layer in spiral form with several turns was employed. Bigalke notes that the increase in brightness, in the range measured by Schwartz, agrees very well with the lower branch of Bigalke's curve; the loss of deflection-sensitivity is however increased, because the post-accelerating field extends as far as the plates. The arrangement chosen by Bigalke is therefore superior in this respect, particularly for oscillographic purposes, where great deflection-sensitivity is required; it is also more suitable for mass production.

227. The Thermal Diffusion of the Colour Centres in KCl-Crystals for Various Concentrations, *also* The Nature of the U-Centres in Alkali Halide Crystals, *and* The Yield of Quanta in the Formation of Colour Centres in NaCl- and KCl-Crystals.—Stasiw: Hilsch & Pohl: Schaitberger. (*Göttinger Nachrichten*, Math.-Phys. Class, New Series, Vol. 2, Nos. 11, 12, & 15, 1937, pp. 131–137: pp. 139–143: pp. 181–186.)

228. The Nature of the Excitation Centres in Alkali Halide Crystals [Centres with Absorption Bands displaced towards Red compared with Unexcited Centres are connected with Proper Voltages of Various Magnitudes due to Foreign Atoms or Plastic Deformations of Crystal Material].—H. Wolff. (*Zeitschr. f. Physik*, No. 7/8, Vol. 110, 1938, pp. 512–528.)

229. On the Electrical Breakdown of the Alkali Halides [Theory].—R. J. Seeger & E. Teller. (*Phys. Review*, 1st Oct. 1938, Series 2, Vol. 54, No. 7, pp. 515–519.) Agreement is found with von Hippel's experiments (1186 of 1938).

230. On the Absorption of Light by Crystals [Theory: Estimates of Temperature Dependence of Relative Probability of Conversion of Light Energy into Heat, Fluorescent Radiation, and Production of Photoelectric Current within Crystal].—N. F. Mott. (*Proc. Roy. Soc.*, Series A, 6th Sept. 1938, Vol. 167, No. 930, pp. 384–391.)

231. Irregularities in Telephone and Television Coaxial Cables.—L. Brillouin. (*Elec. Communication*, Oct. 1938, Vol. 17, No. 2, pp. 164–187.) Translated, "with slight modifications," from the paper dealt with in 2900 of 1938.

232. Notes on the Effects of Irregularities in Coaxial Cables on Television Transmission [Brillouin's Generalisations: Experiments on the "Drawing-Out" Effect: Relation between Theory and Actual Transmission Possibilities of Correction].—J. Saphores & P. Gloess. (*Elec. Communication*, Oct. 1938, Vol. 17, No. 2, pp. 188–193.) For Brillouin's work *see* 231, above.

233. The Connection between the Degree of Depolarisation of Light scattered at the Molecules of a Liquid and the Kerr Constant.—H. A. Stuart & W. Buchheim. (*Zeitschr. f. Physik*, No. 1/2, Vol. 111, 1938, pp. 36–45.)

234. High-Gain Television Amplifiers [Highest Gain obtained with Tuned-Anode-Type Couplings: etc.].—W. T. Cocking. (*Wireless World*, 24th Nov. 1938, Vol. 43, pp. 459–460.)

235. A Laboratory Television Receiver: III and IV.—D. G. Fink. (*Electronics*, Sept. & Oct. 1938, Vol. 11, Nos. 9 & 10, pp. 22–25 & 16–19.)

236. Television at the 15th Great German Broadcasting Exhibition, Berlin, 1938.—K. Lipfert. (*Funktech. Monatshefte*, Sept. 1938, No. 9, Supp. pp. 65–72.)

237. Equipment for the Radio Transmission of Sound Films.—B. I. Vilenkin, S. P. Obukhov, & A. S. Polyanski. (*Izvestiya Elektroprom. Slab. Toka*, No. 7, 1938, pp. 48–51.) Developed in the U.S.S.R. for the transmission of 20 000 elements and 24 frames per second. Mechanical scanning by rotating optical systems is used.

238. The Moscow Television Transmitter.—I. S. Djighit [Dzhigit]. (*Izvestiya Elektroprom. Slab. Toka*, No. 6, 1938, pp. 22–33.)

239. A Pioneer in Television [the Work of Emil Mechau].—F. Schröter. (*Telefunken Hausmitteilungen* [originally *Telefunken-Zeitung*], Sept. 1938, Vol. 19, No. 79, pp. 36–39.)

MEASUREMENTS AND STANDARDS

240. The Cathode-Ray Tube as a Voltage-Measuring Apparatus for Ultra-Short Waves.—H. E. Hollmann. (*E.N.T.*, Aug. 1938, Vol. 15, No. 8, pp. 241–246.)

"These investigations show that it is fundamentally possible accurately to calculate the ultradynamic sensitivity of every cathode-ray tube from its dimensions, working conditions, and effective field (determined statically), so that an empirical calibration of the tube at the frequency used may be avoided." The electrode system of the tubes investigated is shown in Fig. 1; their statical sensitivity is calculated in § 1, the ultradynamic sensitivity of tube 1 (large field form) in § 2 and of tube 2 (small field form) in § 3 (measurements and values calculated on the basis of parabolic distorting fields, Figs. 2, 3 respectively). The investigation makes use of the writer's inversion method (Abstracts, 1932, pp. 652–653: *see* also 1933, p. 634, and 274, below).

241. Investigations on [Crystal] Detectors in the Region of Very Short [Micro-] Waves.—J. Rottgardt. (*Zeitschr. f. tech. Phys.*, No. 9, Vol. 19, 1938, pp. 262–264.)

Author's summary:—A number of detector combinations are investigated for sensitivity in the decimetre and centimetre wave regions, and the silicon-tungsten pair is found to be particularly suitable for the range 50 cm to 1.4 cm. Resistance measurements on detectors of this type show a connection between their sensitivity and the difference between the currents flowing in the "pass" and "blocking" directions under the action of an applied d.c. voltage [Table 4].

242. A New Type of Wavemeter for Ultra-Short Waves.—Y. Miyamura. (*Nippon Elec. Comm. Eng.*, Sept. 1938, No. 12, pp. 340–342.) A summary was dealt with in 3336 of 1938.

243. H.F. Current Measurements with Photo-elements.—A. Kuntze. (*Hochf:tech. u. Elek:akus.*, Sept. 1938, Vol. 52, No. 3, pp. 85–88.)

Author's summary:—Two new circuits are described which employ photocurrent measuring apparatus using (1) bias and compensation (§ II) and (2) single-stage d.c. amplifier (§ III). The advantage of these circuits is the extension to small currents of the current range which can be measured photoelectrically with a radiator [metal wire or foil in evacuated glass tube]. This outweighs the disadvantages arising with these circuits from the necessity of keeping constant the auxiliary voltages and room temperature, and from a certain lag in indication. Measurements (§ IV) show that, up to frequencies of the order of 20 Mc/s, no errors arise due to capacity leaks; there are only the indicating errors of the photocurrent measuring apparatus, due to the skin effect.

244. Portable Field-Intensity Meter [Self-Contained, weighing 28 Pounds: Frequencies 180–7000 kc/s].—J. V. Cosman. (*Communications*, Sept. 1938, Vol. 18, No. 9, pp. 22–23.)

245. Some Experiments on the Amplification of Thermocouple Electromotive Forces [Forces below 10^{-9} Volt readily indicated on Portable Microammeter: Valve Amplifier with Commutators for Inverting and Synchronously Rectifying the Amplified Alternating Potentials: Over-All Useful Amplification over 50 000].—R. Gunn. (*Review Scient. Instr.*, Sept. 1938, Vol. 9, No. 9, pp. 267–269.)

246. A Push-Pull-Stabilised Triode Voltmeter [without Special Selection of Valves: Electrical Characteristics adjusted to Equality by Shunt Resistors: Principle applicable to Other Circuits requiring Matched Pair of Valves].—C. Williamson & J. Nagy. (*Review Scient. Instr.*, Sept. 1938, Vol. 9, No. 9, pp. 270–272.)

247. Electronic Voltmeter using Feedback [with List of Applications].—S. Ballantine. (*Electronics*, Sept. 1938, Vol. 11, No. 9, pp. 33–35.)

248. A Feedback D-C Meter [originally for Weak-Current Measurements in Iconoscopes, Electron-Multipliers, etc: Full-Scale Reading 0.02 μA: measures Resistances around 200 000 Megohms].—J. M. Brumbaugh & A. W. Vance. (*Electronics*, Sept. 1938, Vol. 11, No. 9, pp. 16–17 and 52.) An RCA instrument.

249. A Mutual Conductance Meter.—C. B. Aiken & J. F. Bell. (*Communications*, Sept. 1938, Vol. 18, No. 9, pp. 19 and 24, 25, and 50.)

250. An Original Method of Comparison of Capacities at Radio Frequencies [using Fixed instead of Variable Standard Capacity: No Switching Difficulties: Simple Screening: Large Range: Leakage without Effect: Choice of Suitable Variable Resistance].—W. Vaughan. (*Phil. Mag.*, Oct. 1938, Series 7, Vol. 26, No. 176, pp. 521–557.)

251. Maxwell's Bridge for comparing Self-Inductance with Capacitance at Carrier Frequencies, and Its Applications [to Measurement of Extremely Small Capacitances and the Time Constants of Resistors].—T. Ogawa, S. Yamanaka, & H. Sato. (*Nippon Elec. Comm. Eng.*, Sept. 1938, No. 12, pp. 385–389.)

252. Measurement of the Dielectric Constant of Cellulose [Method for Fibrous Material which cannot be made to Fill Completely the Condenser Space].—De Luca, Campbell, & Maass. (*Canadian Journ. of Res.*, Aug. 1938, Vol. 16, No. 8, Sec. B, pp. 273–288.)

253. Determination of the Natural Wavelengths of Inductively Excited Iron-Cored Coils [Calculations for Single-Layer Cylindrical Coil: Agreement with Measurement].—A. Mühlinghaus. (*Arch. f. Elektrot.*, 10th Sept. 1938, Vol. 32, No. 9, pp. 555–580.)

254. Tuning Coils in Production [Radio Manufacturers' Methods of checking Coil Characteristics].—(*Wireless World*, 29th Sept. 1938, Vol. 43, pp. 287–288.)

255. An Electronic Null Detector for Impedance Bridges [Circuit employing Type 913 One-Inch Cathode-Ray Tube: Difficulty with Harmonics avoided by Scott's Degenerative Amplifier].—H. W. Lamson. (*Review Scient. Instr.*, Sept. 1938, Vol. 9, No. 9, pp. 272–275.) For Scott's circuit *see* 1802 of 1938.

256. The Zero-Point Stability of Electrometer Valve Apparatus [Correct Working Point found by Matching Valves by Varying Space-Charge-Grid Resistance: Low Filament Current Desirable], *and* Determination of the Zero Effects with Counter Tubes.—F. Müller & W. Dürichen: H. Osterwisch. (*Physik. Zeitschr.*, 15th Sept. 1938, Vol. 39, No. 17/18, pp. 657–661: pp. 661–665.)

257. A New H.F. "Klirr" Factor Meter [for Frequencies up to 2.4 Mc/s].—G. Sudeck. (*E.N.T.*, July 1938, Vol. 15, No. 7, pp. 205–209.)

The fundamental circuit of this instrument is shown in Fig. 2, the complete circuit in Fig. 5. The fundamental frequency in the voltage under investigation is completely compensated by replacing the mutual inductance in the circuit of Fig. 1 (which corresponds to the Campbell-Larsen frequency-meter circuit) by a self-inductance. The theory of the circuit is given in § 3, its vector diagram in Fig. 3; eqns. 1, 2 give the conditions for compensating the fundamental-frequency voltage. The equivalent circuit for the harmonics far removed from resonance is shown in Fig. 4; it gives constant attenuation for all harmonics from the second upwards. A wide-band amplifier with an indicating instrument is connected to the output by a screened cable. The indicator has two scales directly calibrated in percentages for the "klirr" factor; an output potentiometer has stages to correspond. The adjustments for measuring "klirr" factors between 0.05 and 30 per cent. are described. "The apparatus is suitable for measuring voltages which have one pole earthed, and has an almost purely real input impedance of 70 ohms." Fig. 7 illustrates the measurement of the frequency/attenuation curve (Fig. 8.)

258. A New Type of Direct-Reading Radio-Frequency Monitor.—Matsumura & Kanzaki. (*See* 318.)

259. Direct-Reading Frequency Meter [for Low Frequencies].—M. Kobayasi & H. Uchida. (*Nippon Elec. Comm. Eng.*, Sept. 1938, No. 12, pp. 396–397: summary only.) *See* 3257 of 1938.

260. EQUIVALENT CIRCUITS OF THE FOUR-ELECTRODE QUARTZ RESONATOR.—E. V. Zelyakh & Ya. I. Velikin. (*Izvestiya Elektroprom. Slab. Toka*, No. 3, 1938, pp. 46–50.)

By using the methods proposed by Vigoureux (1929 Abstracts, p. 109, and "Quartz Resonators & Oscillators," London, 1931) for obtaining equivalent circuits of two-electrode quartz resonators, an equivalent circuit for a four-electrode resonator is derived in which two two-electrode resonators are used (Fig. 3b); an alternative circuit containing only one two-electrode resonator is also derived (Fig. 3d). A method of connecting a four-electrode resonator (Fig. 7a), which to the knowledge of the author has not yet been described in technical literature, is considered, and an equivalent circuit derived (Fig. 7c). The results obtained in this discussion were verified experimentally on two four-electrode resonators with resonant frequencies of 61 566 and 63 346 c/s respectively, and applied to the design of a crystal wave filter (Fig. 11). A procedure to be adopted when designing four-electrode resonators is also set out.

261. A QUARTZ CRYSTAL OSCILLATOR EMPLOYING THE BEAM-POWER TUBE [Type 6L6: Smaller Load on Quartz than with Ordinary Pentodes: Advantage of Earthing the Steel Shell: etc.]—K. Sakamoto. (*Nippon Elec. Comm. Eng.*, Sept. 1938, No. 12, pp. 392–393: summary only.)

262. CRYSTALS [Properties and Applications of Quartz Crystals, with Practical Information on Oscillator Stabilisation].—H. B. Dent. (*Wireless World*, 13th Oct. 1938, Vol. 43, pp. 329–330.)

263. THE BRIDGE-STABILISED OSCILLATOR [with Records for 100 kc/s Model: Application as "Crystal Chronometer" for Gravity-Measuring Equipment: etc.]—L. A. Meacham. (*Proc. Inst. Rad. Eng.*, Oct. 1938, Vol. 26, No. 10, pp. 1278–1294: *Bell S. Tech. Journ.*, Oct. 1938, Vol. 17, No. 4, pp. 574–591.) A summary was dealt with in 3717 of 1938.

264. GRID BIAS FOR CRYSTAL OSCILLATORS.—Bell. (*See* 102.)

265. THE ANOMALOUS CHARGING CURRENT IN ROCHELLE-SALT CRYSTALS [follows a Power Law after a Certain Time: Ohm's Law valid a Short Time after Voltage Application: Initial Currents depend on Thickness of Preparation investigated].—F. Seidl. (*Physik. Zeitschr.*, 15th Oct. 1938, Vol. 39, No. 20, pp. 714–716.)

266. THE PIEZOELECTRIC BEHAVIOUR OF CRYSTALS, WITH SPECIAL REFERENCE TO ROCHELLE SALT.—Ernsthausen. (*See* 186.)

267. REMARK ON THE PAPER BY H. GOCKEL & M. SCHULER: "ON A NEW SELF-DRIVEN SCHULER CLOCK AND THE ACCURACY OF TWO SCHULER PENDULUMS MAY–SEPT. 1937" [Corrected Comparison of Logarithmic Decrements of Quartz Crystals and Schuler Pendulum: Crystals have Lower Decrement].—A. Scheibe. (*Zeitschr. f. Physik*, No. 9/10, Vol. 110, 1938, p. 660.) *See* 4070 of 1938; also 268, below.

268. MOVEMENT DISCONTINUITIES OF CLOCKS IN GREENWICH AND GÖTTINGEN.—R. d'E. Atkinson. (*Zeitschr. f. Physik*, No. 1/2, Vol. 111, 1938, pp. 133–136.) Correction of statements as to method of issuing time signals from Greenwich, made in paper referred to in 4070 of 1938 (Gockel & Schuler). *See* also 267.

269. PRODUCTION OF ACCURATE ONE-SECOND TIME INTERVALS [recently added to Bureau of Standards Broadcasts from WWV: Short-Time Variations in Output of Controlled Multivibrators, Their Nature and Elimination: Measuring Technique: Other Applications].—W. D. George. (*Journ. of Res. of Nat. Bur. of Stds.*, Sept. 1938, Vol. 21, No. 3, pp. 367–373.)

270. PRODUCTION AND FREQUENCY-MEASUREMENT OF CURRENTS HAVING FREQUENCIES OF 10 TO 100 CYCLES PER SECOND.—Clark & Katz. (*See* 108.)

271. THE TRENDS OF INSTRUMENT DESIGN.—C. C. Mason. (*Journ. Scient. Instr.*, Oct. 1938, Vol. 15, No. 10, pp. 323–333.) British Association paper.

272. "DIE MESSINSTRUMENTE-INDUSTRIE DEUTSCHLANDS" [Germany's Measuring-Instrument Industry: Book Review].—(*Zeitschr. f. tech. Phys.*, No. 9, Vol. 19, 1938, p. 285.)

273. MODERN REQUIREMENTS IN RADIO TECHNIQUE FOR MEASURING APPARATUS, AND THE MANUFACTURE OF THIS APPARATUS IN THE U.S.S.R.—A. A. Fedorov. (*Izvestiya Elektroprom. Slab. Toka*, No. 7, 1938, pp. 51–53.)

SUBSIDIARY APPARATUS AND MATERIALS

274. THE "INVERSION SPECTRUM" OF A CATHODE-RAY TUBE [Deflection Sensitivity as Function of Wavelength or Anode Potential at Very High Frequencies].—Hollmann. (*Zeitschr. f. tech. Phys.*, No. 9, Vol. 19, 1938, pp. 259–262.)

Author's summary:—The static deflection spectrum and the ultradynamic "inversion spectrum" represent the deflection of an electron ray in a transverse field as a function of the ray velocity (or of the wavelength of the electrons as determined by this velocity) and by the wavelength of the voltage applied to the deflecting plates.

It may be recorded experimentally with the help of a "white" electron beam produced by the "wobbling" of the anode voltage over a wide range [*e.g.* by superposing an alternating voltage from the mains on the steady anode voltage, the proportion being so chosen that the lowest instantaneous voltage is enough to give a clear spot image, while the highest is not enough to over-load the tube]. This mixed beam splits up into a spectrum after its emergence from the transverse field. The shape of an experimentally obtained "inversion" spectrum is compared with that calculated on the basis of an extended theory which deals not only with the ray deflection [$L. \tan\alpha$ in the simple "inversion" law of eqn. 1] but also with the displacement on leaving the transverse field [y_a in eqn. 2 giving the total deflection: *see* also 1353 of 1938]. Finally it is pointed out that the "inversion-spectrograph" here described is also suitable for the investigation of the anomalous dispersion of an ultra-high-frequency longitudinal or transverse field [since the generalised "inversion" theory—2498 & 2914 of 1937, and Recknagel, 2257 of 1938—shows that the processes in longitudinal control are fundamentally the same as in transverse control: work in this direction is proceeding].

275. THE CATHODE-RAY TUBE AS A VOLTAGE-MEASURING APPARATUS FOR ULTRA-SHORT WAVES.—Hollmann. (*See* 240.)

276. OSCILLATION PRODUCTION BY AN ELECTRON BEAM IN THE FIELD OF A PLATE CONDENSER, WITH CONSIDERATION OF THE EFFECT OF THE STRAY FIELDS.—Hollmann & Thoma. (*See* 86.)

277. THE PROBLEM OF SYMMETRISATION OF BRAUN [Cathode-Ray] TUBES WITH ELECTROSTATIC DEFLECTION.—Pieplow & Steudel. (*Arch. f. Elektrot.*, 14th Oct. 1938, Vol. 32, No. 10, pp. 627–640.)

From the authors' summary:—The image errors which arise with asymmetrical electrostatic deflection in Braun tubes with two crossed deflecting condensers are systematically investigated. It is found that practically the only cause of the phenomenon known as the "trapezoidal" error . . . is the transverse fields in the direction of deflection of the plates near to the anode, produced by asymmetry in the plates near the fluorescent screen. Longitudinal fields produce a kind of image displacement. . . . These errors occur both with gas-filled and with highly-evacuated tubes. . . . A "trapezoidal" error does not occur when only the plates near the anode are run asymmetrically. . . . The most practical solution of the problem appears to be to give up the idea of producing symmetry in the tube itself and to transform an asymmetrical voltage into a symmetrical one by appropriate technique in the external circuits. The fundamental circuit solutions for this are given [Figs. 22–24].

278. ADDITION TO THE PAPER "POST-ACCELERATION CATHODE-RAY OSCILLOGRAPH."—Bigalke: Schwartz. (*See* 226.)

279. NEW CONSTRUCTIVE DEVELOPMENT OF HIGH CAPACITY CATHODE-RAY OSCILLOGRAPHS [High-Voltage Type and High-Sensitivity Type].—Buchkremer. (*E.T.Z.*, 29th Sept. 1938, Vol. 59, No. 39, pp. 1035–1038.)

The former type has a recording speed of 3×10^7 m/s for internal recording, 5×10^6 m/s for external. The latter type (*see* Thielen, 2021 of 1938) has a figure of 1×10^7 m/s for internal recording, and a sensitivity of 3 volts per mm.

280. THE RECORDING OF VDE STANDARD SURGES [0.5/50] WITH ORDINARY COMMERCIAL CATHODE-RAY OSCILLOGRAPHS: SPECIAL CIRCUITS GIVING SUCCESSFUL RESULTS.—Schneider. (*E.T.Z.*, 6th Oct. 1938, Vol. 59, No. 40, pp. 1061–1063.)

281. THE USE OF THE HIGH-VACUUM CATHODE-RAY TUBE FOR RECORDING HIGH-SPEED TRANSIENT PHENOMENA.—McGillewie. (*Elec. Communication*, Oct. 1938, Vol. 17, No. 2, pp. 124–132.)

282. ON THE ELECTROGRAPHIC RECORDING OF FAST ELECTRICAL PHENOMENA.—Selényi. (*Journ. of Applied Phys.*, Oct. 1938, Vol. 9, No. 10, pp. 637–641.) For reference to more detailed accounts *see* 669 & 3494 of 1937; *also* 3275 of 1938.

283. THEORY OF ELECTRON MOVEMENT IN THE DEFLECTING CONDENSER [of an Electron-Optical System: Large Deflecting Voltages: Prism Analogy: Deviation a Linear Function of Deflecting Voltage to First Approximation: Extra Deflections and Focusing Phenomena deduced as Small "Errors" by Disturbance Calculations: Constructions for Image].—Recknagel. (*Zeitschr. f. Physik*, No. 1/2, Vol. 111, 1938, pp. 61–78.)

284. THE SPHERICAL ABERRATION OF MAGNETIC LENSES [Experimental Determination of Spherical, Longitudinal, and Transverse Deviations: Refracting Power, Focal Length, Electron Velocity, Position of Principal Planes, etc.].—Becker & Wallraff. (*Arch. f. Elektrot.*, 14th Oct. 1938, Vol. 32, No. 10, pp. 664–675.)

285. BASIC PRINCIPLES AND DEVELOPMENT OF THE "SUPER-MICROSCOPE."—Müller. (*E.T.Z.*, 3rd Nov. 1938, Vol. 59, No. 44, pp. 1189–1194: with 16 literature references.) For other papers on electron microscopes *see* 4544 of 1938.

286. SIMPLE ELECTRON MICROSCOPES [General Account].—Johnson. (*Journ. of Applied Phys.*, Aug. 1938, Vol. 9, No. 8, pp. 508–516.)

287. FIELD DISTRIBUTION AND GRAPHICAL RAY TRACING IN ELECTRON-OPTICAL SYSTEMS [Electrolytic Trough Method: Electron Trajectories: Graphical Construction using Axial "Geometric Plot"].—Jacob. (*Phil. Mag.*, Oct. 1938, Series 7, Vol. 26, No. 176, pp. 570–601.)

288. THE POLYELECTROPHYSIOGRAPH [and a Discussion of the Persistence of Various Fluorescent Screens].—Huddleston & Whitehead. (*Review Scient. Instr.*, Oct. 1938, Vol. 9, No. 10, pp. 315–319.)

289. PHYSICS AND APPLICATIONS OF LUMINESCENT MATERIALS IN OPTICAL TECHNIQUE [Summarising Account].—Frerichs. (*Naturwiss.*, 21st Oct. 1938, Vol. 26, No. 42, pp. 681–687.)

290. LUMINESCENCE [Notes on Recent Work].—Randall. (*Nature*, 29th Oct. 1938, Vol. 142, pp. 779–781: notes on Faraday Society discussions.)

291. ON THE ELECTRICAL BREAKDOWN OF THE ALKALI HALIDES.—Seeger & Teller. (*See* 229.) For other papers on the alkali halides *see* 227 & 228, above.

292. MEASUREMENTS ON THE SECONDARY ELECTRONS EMITTED FROM "RECOIL NETS."—Sandhagen. (*See* 218.)

293. THE PRODUCTION OF H.F. "KIPP" OSCILLATIONS WITH GASEOUS-DISCHARGE TUBES.—Pieplow. (*See* 109.)

294. IMPULSE-GENERATING APPARATUS [Two Relaxation-Oscillator Circuits in Series: Two Separate Resistances allow Frequency and Length of Impulses to be Varied: Various Applications].—Hertwig: AEG. (*E.T.Z.*, 15th Sept. 1938, Vol. 59, No. 37, pp. 981–984.)

295. THE INFLUENCE OF THE INDUCTANCE AND THE SPARK RESISTANCE OF A PULSE DISCHARGE CIRCUIT ON THE MAXIMUM STEEPNESS OF THE VOLTAGE RISE.—Beindorf. (*See* 84.)

296. TIME DELAYS DUE TO SMOOTHING CIRCUITS [in Automatic Control Devices, etc.].—Ostendorf. (*See* 67.)

297. REFLECTION AND TRANSPARENCY OF THIN METALLIC FILMS [Calculations: New Formula for Non-Parallel Form of Transparent Film Base].—Koller. (*Zeitschr. f. Physik*, No. 11/12, Vol. 110, 1938, pp. 661–675.)

298. THE REMOVAL OF WALL DEPOSITS BY HIGH FREQUENCY DISCHARGES [3–300 Mc/s].—Hay. (*Canadian Journ. of Res.*, Oct. 1938, Vol. 16, No. 10, Sec. A, pp. 191–205.)

299. ELECTRON TEMPERATURE AND LIGHT EXCITATION IN GAS DISCHARGES EXCITED BY SHORT AND ULTRA-SHORT WAVES [Calculations of Excitation Functions and Electron Velocity Distributions explain Different Results of Optical and Electrical Methods: Measurements of Intensity Ratios of Spectral Lines and Electron Temperatures].—Nöller. (*Zeitschr. f. Physik*, No. 5/6, Vol. 110, 1938, pp. 320–329.)

300. AN IONISING RADIATION OF A SPARK DISCHARGE.—Raether. (*See* 15.)

301. STRIKING-VOLTAGE CURVES FOR THE RARE GASES AT LOW PRESSURES [and the Suitability of Krypton and Xenon for Electronic Valves, at Today's Reduced Prices].—Klemperer. (*Zeitschr. f. tech. Phys.*, No. 9, Vol. 19, 1938, p. 270.)

302. INVESTIGATIONS ON CRYSTAL DETECTORS IN THE MICRO-WAVE REGION.—Rottgardt. (*See* 241.)

303. PHYSICAL PROPERTIES AND TECHNICAL APPLICATIONS OF SEMICONDUCTING RESISTANCES.—Weise. (*E.T.Z.*, 13th Oct. 1938, Vol. 59, No. 41, pp. 1085–1089.)

"Today, semiconducting resistances are widely used in engineering. Nevertheless there still remain certain points which are not clear as to their properties and possible applications. It is the purpose of the present paper to remove these uncertainties." For previous work *see* 677 of 1938.

304. THEORY AND DESIGN OF "PROGRESSIVE UNIVERSAL" COILS.—Joyner & Landon. (*See* 129.)

305. THE RÔLE OF SCREENED TRANSFORMERS IN TELECOMMUNICATION INSTALLATIONS [to eliminate the Effect of the Inter-Winding Capacity: Quantitative Investigation].—Nowicki. (*Wiadomósci i Prace, Państwowego Instytutu Telekomunikacyjnego*, Warsaw, No. 5/6, Vol. 8, 1937, pp. 94–102: short French summary p. 11.)

306. THE MAGNETIC PERMEABILITY OF NICKEL FOR HERTZIAN OSCILLATIONS.—Lindman. (*See* 2.)

307. THE PRODUCTION OF VARIOUS MAGNETIC PRODUCTS STARTING FROM FeOOH.—Forrer. (*Comptes Rendus*, 17th Oct. 1938, Vol. 207, No. 16, pp. 670–671.)

308. LOSSES IN CIRCULAR-PLATE CONDENSERS AT HIGH FREQUENCIES AND HIGH VOLTAGE [Measurements with Air, Ebonite, Amber, Mica, Frequentit, & Other Dielectrics, at 10^6–10^7 c/s and up to 2000 Volts].—Zechnall. (*E.T.Z.*, 15th Sept. 1938, Vol. 59, No. 37, pp. 997–998: summary only.) *See* 2065 of 1938.

309. THE INFLUENCE OF MOISTURE UPON THE D.C. CONDUCTIVITY OF IMPREGNATED PAPER [Results bearing on Electrical Breakdown].—McLean & Kohman. (*Journ. Franklin Inst.*, Aug. 1938, Vol. 226, No. 2, pp. 203–220.)

310. THE PHYSICS OF THE ORGANIC INSULATOR [Dielectric Properties of Organic Insulating Materials on Debye Dipole Theory, with Application to Choice, Proper Use, and Development of New Materials].—Müller. (*E.T.Z.*, 27th Oct. & 3rd Nov. 1938, Vol. 59, Nos. 43 & 44, pp. 1155–1158 & 1176–1182.)

311. MEASUREMENT OF THE DIELECTRIC CONSTANT OF CELLULOSE.—De Luca & others. (*See* 252.)

STATIONS, DESIGN AND OPERATION

312. ASYMMETRIC-SIDEBAND BROADCASTING [including Analysis of Distortion due to Asymmetry, leading to Design of Special Network: Calculation of Reduced "Sideband Splash": Comparison of Eckersley System and Koomans System: etc.].—Eckersley. (*Proc. Inst. Rad. Eng.*, Sept. 1938, Vol. 26, No. 9, pp. 1041–1092.) For the Koomans system *see* 313, below.

313. DISCUSSION ON "SINGLE SIDEBAND TELEPHONY APPLIED TO THE RADIO LINK BETWEEN THE NETHERLANDS AND THE NETHERLANDS EAST INDIES."—Koomans. (*Proc. Inst. Rad. Eng.*, Oct. 1938, Vol. 26, No. 10, pp. 1299–1301.) *See* 2118 of 1938.

314. CARRIER-FREQUENCY CABLE TRANSMISSION OF BROADCAST PROGRAMMES.—Kluge. (*Hochf:tech. u. Elek:akus.*, Sept. 1938, Vol. 52, No. 3, pp. 80–82.)

A description of a transportable mains-driven carrier-current apparatus, transmitter and receiver, developed to enable broadcast programmes to be transmitted over existing unloaded lines originally designed for a.f. transmission, which have in general a narrow frequency pass band and suffer much interference from neighbouring lines. The fundamental construction is shown in Fig. 1; the carrier (frequency 37 kc/s) and both sidebands are transmitted. Tests of the apparatus are described.

315. MOBILE SHORT-WAVE TRANSMITTERS FOR BROADCAST COMMENTARIES [49–53 m, 0.4 W Aerial Power, Pack Set with 1 km Range: 85–115 m, 10 W, Transportable Set for Motor-Cars, etc., 10 km Range].—Hofmann. (*Telefunken Hausmitteilungen* [originally *Telefunken-Zeitung*], Sept. 1938, Vol. 19, No. 79, pp. 60–65.)

316. LINES FOR OUTSIDE BROADCASTS.—Woods. (*World-Radio*, 7th, 14th, and 21st Oct. 1938, Vol. 27, pp. 14–15, 14–15, and 12–13.)

317. H.T., D.C. QUICK-ACTING AUTOMATIC CIRCUIT BREAKERS FOR RADIO TRANSMITTING STATIONS.—Spirov. (*Izvestiya Elektroprom. Slab. Toka*, No. 6, 1928, pp. 16–22.)

While a considerable amount of research work has been carried out on automatic circuit breakers for power stations, comparatively little information is available on circuit breakers suitable for use in radio transmitting stations, *i.e.* designed for operation at voltages of the order of 12 000 volts and current ranging from 1 to 100 amperes. In the present paper the operation of an automatic circuit breaker when a short circuit develops in the power-supply system is discussed, and a description is given of a range of automatic circuit breakers, of the usual electro-magnetic type with an over-load coil and a magnetic arc blower (Fig. 4), developed in the U.S.S.R. A report is also presented on experiments with these circuit breakers, and a number of oscillograms are shown. It is claimed that these circuit breakers have proved very reliable in action and that their total operating time does not exceed 0.03–0.06 sec.

318. A NEW TYPE OF DIRECT-READING RADIO-FREQUENCY MONITOR [using Cyclically Varied Gap between Electrode and Quartz Surface, with C-R-Tube or Neon-Tube Indication].—Matsumura & Kanzaki. (*Nippon Elec. Comm. Eng.*, Sept. 1938, No. 12, pp. 377–384.) The quartz plate of low temperature coefficient developed by the authors (1022 of 1935) was employed.

319. BROADCASTING HOUSE, GLASGOW.—(*World-Radio*, 11th, 18th, 25th Nov. and 2nd Dec. 1938, Vol. 27, pp. 14–16, 14–16, 16–17, and 16–17.)

320. 50 kW SHORT-WAVE BROADCASTING TRANSMITTER.—Nakagami, Tanaka, & others. (*Nippon Elec. Comm. Eng.*, Sept. 1938, No. 12, pp. 343–363.) *See* also 4623 of 1938.

321. THE GERMAN-AUSTRIAN BROADCASTING SYSTEM.—Schwaiger. (*Telefunken Hausmitteilungen* [originally *Telefunken-Zeitung*], Sept. 1938, Vol. 19, No. 79, pp. 5–19.)

322. CAIRO WORLD COMMUNICATIONS CONFERENCE.—Hornung. (*Telefunken Hausmitteilungen* [originally *Telefunken-Zeitung*], Sept. 1938, Vol. 19, No. 79, pp. 78–96.)

323. "WORLD-RADIO" SHORT-WAVE AND TIME-ZONE MAP OF THE WORLD.—(*World-Radio*, 25th Nov. 1938, Vol. 27, pp. 24–25.)

324. ON THE EXPERIMENT BY THE SINGLE-SIDEBAND MULTIPLEX RADIO SYSTEM BETWEEN TOKYO AND KAGOSHIMA.—Matsumae & others. (*Nippon Elec. Comm. Eng.*, Sept. 1938, No. 12, pp. 370–376.) A summary was referred to in 3413 of 1938.

325. "HUMBER RADIO" [G.P.O. Coastal Station].—Ainslie. (*Wireless World*, 13th Oct. 1938, Vol. 43, pp. 327–328.)

326. THE ELECTRICAL INSTALLATIONS IN AIRCRAFT IN FRANCE.—Hugel. (*E.T.Z.*, 13th Oct. 1938, Vol. 59, No. 41, pp. 1099–1100: summary of French paper.)

GENERAL PHYSICAL ARTICLES

327. DEVELOPMENT AND PROGRESS IN THE SUBJECT OF DETERMINATION OF MAGNITUDE AND CHARGE OF SINGLE PARTICLES (THE QUESTION OF THE ELEMENTARY QUANTUM OF ELECTRICITY): I—PRESENT STATE OF DEVELOPMENT: II—NEW RESULTS [Existence of Charges smaller than the Electron: Direct Microscopical Determination of Magnitude].—Ehrenhaft. (*Physik. Zeitschr.*, 1st Oct. 1938, Vol. 39, No. 19, pp. 673–687.)

328. DETERMINATION OF THE ELECTRON CHARGE AND THE VISCOSITY OF AIR [New Value of Viscosity gives Electron Charge agreeing with X-Ray Value].—Banerjea & Plattanaik. (*Zeitschr. f. Physik*, No. 11/12, Vol. 110, 1938, pp. 676–687.)

329. THE STATIC INTERACTION OF CHARGED PARTICLES [Calculations on Born-Infeld Theory].—Thomas. (*Phys. Review*, 1st Sept. 1938, Series 2, Vol. 54, No. 5, pp. 367–370.)

330. THE ELECTROMAGNETIC ENERGY OF A POINT CHARGE [Definition in Finite Manner: Equations of Motion, etc.].—Pryce. (*Proc. Roy. Soc.*, Series A, 6th Sept. 1938, Vol. 167, No. 930, p. S 99: abstract only.)

331. CARRIER MOBILITY SPECTRA OF LIQUIDS ELECTRIFIED BY BUBBLING, *and* INTERPRETATION OF CARRIER MOBILITY SPECTRA OF LIQUIDS ELECTRIFIED BY BUBBLING AND SPRAYING.—Chapman. (*Phys. Review*, 1st Oct. 1938, Series 2, Vol. 54, No. 7, pp. 520–527: pp. 528–533.)

332. ON THE POSSIBILITY OF A NEUTRINO THEORY OF LIGHT.—Sokolow. (*Physica*, Oct. 1938, Vol. 5, No. 9, pp. 797–810: in German.)

333. THE VELOCITY OF LIGHT EXPRESSED BY MEANS OF THE GRAVITATIONAL AND ELECTRICAL CONSTANTS.—Laboccetta. (*La Ricerca Scient.*, 15th/30th Sept. 1938, Series 2, 9th Year, Vol. 2, No. 5/6, pp. 296–298.)

334. PHOTOELECTRIC ABSORPTION OF RADIATION IN GASES.—Ditchburn. (*Nature*, 22nd Oct. 1938, Vol. 142, p. 756.)

MISCELLANEOUS

335. OPERATIONAL FORMS AND CONTOUR INTEGRALS FOR STRUVE AND OTHER FUNCTIONS, *and* OPERATIONAL FORM OF $f(t)$ FOR A FINITE INTERVAL, WITH APPLICATION TO IMPULSES.—McLachlan. (*Phil. Mag.*, Oct. & Nov. 1938, Series 7, Vol. 26, Nos. 176 & 177, pp. 457–473 & 695–704.)

336. SOME CRITICAL CONSIDERATIONS ON THE INTEGRAL EQUATION OF THE SKIN EFFECT.—Lettowsky. (*Ann. der Physik*, Series 5, No. 4, Vol. 33, 1938, pp. 300–314.)

337. INTEGRAL REPRESENTATIONS FOR PRODUCTS OF WHITTAKER FUNCTIONS [derived by Operational Methods].—Erdélyi. (*Phil. Mag.*, Nov. 1938, Series 7, Vol. 26, Supp. No. 178, pp. 871–877.)

338. "PARTIELLE DIFFERENTIALGLEICHUNGEN . . ." [and Their Application to Physical Problems: Book Review].—Riemann. (*Zeitschr. f. tech. Phys.*, No. 10, Vol. 19, 1938, pp. 324–325.)

339. AN ELECTRICAL ALGEBRAIC EQUATION SOLVER.—Herr & Graham. (*Review Scient. Instr.*, Oct. 1938, Vol. 9, No. 10, pp. 310–315.)

340. THE COMPARISON OF SERIES OF MEASURES ON DIFFERENT HYPOTHESES CONCERNING THE STANDARD ERRORS.—Jeffreys. (*Proc. Roy. Soc.*, Series A, 6th Sept. 1938, Vol. 167, No. 930, pp. 367–384.)

341. THE POSTERIOR PROBABILITY DISTRIBUTIONS OF THE ORDINARY AND INTRACLASS CORRELATION COEFFICIENTS.—Jeffreys. (*Proc. Roy. Soc.*, Series A, 23rd Sept. 1938, Vol. 167, No. 931, pp. 464–483.)

342. "STATISTICAL PHYSICS" [Book Review].—Landau & Lifshitz. (*Review Scient. Instr.*, Oct. 1938, Vol. 9, No. 10, p. 290.)

343. "EINFÜHRUNG IN DIE TECHNISCHE SCHWINGUNGSLEHRE" [Theory of Oscillations: Book Review].—Klotter. (*E.T.Z.*, 15th Sept. 1938, Vol. 59, No. 37, p. 1003.) The present part deals with simple vibrators.

344. RELAXATION METHODS APPLIED TO ENGINEERING: IV—PROBLEMS RELATING TO ELASTIC STABILITY AND VIBRATIONS.—Bradfield, Christopherson, & Southwell. (*Proc. Roy. Soc.*, Series A, 6th Sept. 1938, Vol. 167, No. 930, p. S 110: abstract only.)

345. A VECTOR SLIDE RULE.—Wicht. (*E.T.Z.*, 13th Oct. 1938, Vol. 59, No. 41, pp. 1093–1095.)

346. THE USE OF THE ELECTRICAL CALIBRATING GAUGE FOR MEASUREMENT AND CONTROL [of Mass-Production Machines: Equipment embodying the AEG "Eltas" Gauge].—Hermann. (*Elektrot. u. Masch:bau*, 11th Sept. 1938, Vol. 56, No. 37, pp. 484–485.)

347. THE AUTOMATIC MEASUREMENT OF SMALL MECHANICAL SHIFTS BY THE INDUCTION METHOD.—Zacktreger. (*Automatics & Telemechanics* [in Russian], No. 2, 1938, pp. 7–22.)

348. THE PRACTICAL MEASUREMENT OF WALL THICKNESS [of Steel Tubes and Containers] BY X-RAYS AND A COUNTER TUBE.—Trost. (*E.T.Z.*, 13th Oct. 1938, Vol. 59, No. 41, pp. 1098–1099: long summary.)

349. INVESTIGATIONS FOR THE CONSTRUCTION OF SUITABLE VIBRATION METERS FOR MOTOR CARS AND AIRCRAFT [Discussion of the Four Main Requirements and Survey of Various Systems, leading to the Advantages of the Carrier-Frequency Method and Description of an Equipment on This Principle].—Meister. (*Akust. Zeitschr.*, Sept. 1938, Vol. 3, No. 5, pp. 271–283.)

350. A MOVING-COIL VIBROMETER.—Eccles. (*Engineering*, 26th Aug. 1938, Vol. 146, pp. 263–264: British Association paper.)

351. MEASUREMENT OF THE STARTING MOMENT OF ASYNCHRONOUS MOTORS BY A NEW ELECTROSTATIC METHOD.—Kluge & Linckh. (*E.T.Z.*, 22nd Sept. 1938, Vol. 59, No. 38, p. 1021: summary only.)

352. ON THE MEASUREMENT OF THE HARDNESS OF SYNTHETIC-RESIN MOULDING MATERIALS.—Erk & Holzmüller. (*E.T.Z.*, 13th Oct. 1938, Vol. 59, No. 41, p. 1098: summary only.)

353. AN ELECTROSTATIC METHOD OF MEASURING ELASTIC CONSTANTS.—Bancroft & Jacobs. (*Review Scient. Instr.*, Sept. 1938, Vol. 9, No. 9, pp. 279–281.)

354. THE ELECTROSTATIC SEPARATION OF FINE-POWDER MIXTURES.—Johnson. (*E.T.Z.*, 6th Oct. 1938, Vol. 59, No. 40, p. 1081: summary only.)

355. SURFACE HARDENING [of Metal Parts] BY HIGH-FREQUENCY CURRENTS [2–200 kc/s, occasionally Lower (to 50 c/s) or Higher (Short-Wave): Russian Work].—Wologdin [Vologdin]. (*E.T.Z.*, 22nd Sept. 1938, Vol. 59, No. 38, pp. 1023–1024: summary only.)

356. AN AUTOMATIC REGULATOR FOR STEAM BOILERS [Electronic Technique gives Continuous and Exact Control.]—Goldfarb. (*Automatics & Telemechanics* [in Russian], No. 2, 1938, pp. 69–86.)

357. ELABORATE TEMPERATURE - MONITORING EQUIPMENT INSTALLED IN NEW ALLOY FURNACE [Temperatures obtained up to 1000° F. and controlled within 10° or less].—Westinghouse Company. (*Electronics*, Aug. 1938, Vol. 11, No. 8, pp. 33–34.)

358. ELECTRONIC TIMER ANNOUNCED FOR PHOTOGRAPHIC PURPOSES.—(*Electronics*, Aug. 1938, Vol. 11, No. 8, p. 33.)

359. THE SIEMENS MOISTURE-METER FOR TIMBER.—Pflier. (*Zeitschr. V.D.I.*, 27th Aug. 1938, Vol. 82, No. 35, p. 1032: summary only.)

360. THE MOISTURE ALARM: A NEW COMMERCIAL INSTRUMENT FOR AUTOMATICALLY SORTING TIMBER ACCORDING TO ITS MOISTURE CONTENT.—Thomas & Greenhill. (*Journ. of Council for Sci. & Indust. Res., Australia*, Aug. 1938, Vol. 11, No. 3, pp. 258–260 and Plates.) Further development of the instrument referred to in 774 of 1938.

361. DETERMINATION OF LOW HUMIDITY WITH THE DEW-POINT POTENTIOMETER.—Frank. (*Gen. Elec. Review*, Oct. 1938, Vol. 41, No. 10, pp. 435–437.) *See* also 2638 of 1938.

362. LATEST NEWS IN THE RADIO-CONTROLLED [Model] AIRCRAFT FIELD.—De Soto. (*QST*, Sept. 1938, Vol. 22, No. 9, pp. 38–40.)

363. A RADIO CONTROL SYSTEM FOR MODEL AIRCRAFT.—Weiss. (*The Aero Modeller*, Aug. 1938, Vol. 3, No. 33, pp. 447–451.)

364. AN ORIENTATING PROTRACTOR FOR AERIAL-SURVEY PHOTOGRAPHY WITH THE D.F. AUTO PILOT.—Willis. (*Marconi Review*, Oct./Dec. 1938, No. 71, pp. 16–19.) For the "Wireless Pilot" here referred to *see* 1272 of 1938.

365. VISION IN NATURE AND VISION AIDED BY SCIENCE [with Passages on the Electron Microscope, Photoelectric Surfaces, Television].—Rayleigh. (*Nature*, 20th Aug. 1938, Vol. 142, pp. 327–336: British Association presidential address.)

366. NON-RADIO APPLICATION OF RADIO TUBES.—Starrett. (*Proc. Inst. Rad. Eng.*, July 1938, Vol. 26, No. 7, p. 808: summary only.)

367. AN INDEXED BIBLIOGRAPHY OF ELECTRON TUBES AND THEIR APPLICATIONS.—McArthur. (*Gen. Elec. Review*, Oct. 1938, Vol. 41, No. 10, pp. 455–460.)

368. INDUSTRIAL TUBE TERMINOLOGY [Table giving Names and Definitions].—Gen. Elec. Company & Westinghouse. (*Electronics*, Sept. 1938, Vol. 11, No. 9, p. 29.)

369. ON THE THEORY AND DESIGN OF TELEMETERING SYSTEMS.—Zukkerman. (*Izvestiya Elektroprom. Slab. Toka*, No. 7, 1938, pp. 53–56.)

370. CARRIER CURRENT ON POWER SYSTEMS [Telephony, Telemetering, Pilot Relaying, Supervisory Control].—Richardson. (*Communications*, July 1938, Vol. 18, No. 7, pp. 19–22 and 24.)

371. GENERAL MUNICIPAL SERVICE TELE-CONTROL.—Lakhtin. (*Automatics & Telemechanics* [in Russian], No. 6, 1937, pp. 77–103.)

372. MODERN HIGH-FREQUENCY TRANSMISSION OVER HIGH-TENSION LINES.—Dressler. (*Elektrot. u. Masch:bau*, 17th July 1938, Vol. 56, No. 29, pp. 371–376.)

373. TEST ON INDUCTIVE INTERFERENCE [between H.T. Power Lines and Communication Lines] WITH EXPERIMENTAL LINES.—Satoh & Nishiyama. (*Mem. of Ryojun Coll. of Eng.*, No. 3, Vol. 11, 1938, pp. 79–149 and Plates: in English.)

374. RESONANT SHUNTS: THEIR USE FOR ELIMINATION OF ARC RECTIFIER INTERFERENCE [with Telephone Circuits] ON THE ELECTRIFIED SOUTH AFRICAN RAILWAYS.—Funke. (*Electrician*, 22nd July 1938, Vol. 121, pp. 91–94: long summary only.)

375. ČERENKOV RADIATION [produced by Electrons traversing Material Medium with Velocity greater than Light: Direction of Emission: Quantitative Measurements of Intensity: Agreement with Theory].—Collins & Reiling. (*Phys. Review*, 1st Oct. 1938, Series 2, Vol. 54, No. 7, pp. 499–503.)

376. THE USE OF THE ELECTRON PROBE FOR MICRO-MANIPULATIONS [in Research on Cell Development, etc.].—von Ardenne. (*Naturwiss.*, 26th Aug. 1938, Vol. 26, No. 34, p. 562.) For the electron probe *see* 4076 of 1938.

377. THE POLYELECTROPHYSIOGRAPH: AN INSTRUMENT FOR TEACHING AND RESEARCH IN BIOLOGICAL SCIENCES [and a Discussion of the Persistence of Various Fluorescent Screens].—Huddleston & Whitehead. (*Review Scient. Instr.*, Oct. 1938, Vol. 9, No. 10, pp. 315–319.)

378. THE BIOLOGICAL EFFECTS OF LOW-VELOCITY CATHODE RAYS [with Description of Tube, Electron Gun, Raying Box, Killing Curves of Spores, Stimulation by Low Dosage, etc.].—Haskins. (*Journ. of Applied Physics*, Sept. 1938, Vol. 9, No. 9, pp. 553–561.)

379. BIOLOGICAL EFFECT OF THE [Neutron] RADIATION OF A CYCLOTRON.—Nakaidzumi & Murati. (*E.T.Z.*, 6th Oct. 1938, Vol. 59, No. 40, p. 1082: summary only.)

380. THE CYCLOTRON AND ITS APPLICATIONS [particularly Biological].—Chadwick. (*Nature*, 8th Oct. 1938, Vol. 142, pp. 630–634: Royal Institution Discourse.)

381. THE EXAMINATION OF THE MACROSTRUCTURE OF MATERIALS AND PRODUCTS WITH THE HELP OF X-RAYS: V.—de Graaf. (*Philips Tech. Review*, June 1938, Vol. 3, No. 6, pp. 186–188.)

382. X-RAY TUBE FOR CRYSTAL ANALYSIS AND STRESS MEASUREMENTS [for Routine Technique and Research Laboratory].—de Graaf & Oosterkamp. (*Journ. Scient. Instr.*, Sept. 1938, Vol. 15, No. 9, pp. 293–303.)

383. SPECTROCHEMICAL ANALYSIS IN COMMUNICATION RESEARCH.—Clarke & Ruehle. (*Bell S. Tech. Journ.*, July 1938, Vol. 17, No. 3, pp. 381–392.)

384. SPECTRUM ANALYSIS: RADIO WAVE ABSORPTION AND THE STUDY OF BINARY SYSTEMS [using Short, Ultra-Short, and Micro-Waves].—Cavallaro. (*Bollettino del Centro Volpi*, English Edition, April/May/June 1938, Year 1, No. 2, p. 75 d: summary only.)

385. RELATION BETWEEN HYDRATION AND DIELECTRIC CONSTANT [at High and Ultra-High Frequencies] OF COLLOIDAL HYDROPHILES.—Overbeek. (*Bollettino del Centro Volpi*, English Edition, April/May/June 1938, Year 1, No. 2, p. 113 d: summary only.)

386. GROUND INVESTIGATION [for Presence of Oil] USING ELECTROMAGNETIC WAVES [and the Short-Wave Absorption Spectra of Carbon Dioxide emitted by Oil].—Standard Oil Development Co. (*Hochf:tech. u. Elek:akus.*, Sept. 1938, Vol. 52, No. 3, p. 112: French Patent 823 297 of 26.6.36.)

387. RADIO RECEPTION TESTS IN SOME MINES IN AUSTRIA [Some 1938 Results].—Fritsch. (*See* 39.)

388. THE NATIONAL OFFICE OF SCIENTIFIC AND INDUSTRIAL RESEARCH AND INVENTIONS: ITS CREATION, ITS RESULTS, AND ITS SUPPRESSION [by Decree of 24th May 1938].—(*Recherches et Inventions*, July/Oct. 1938, No. 276, pp. 103–203.)

389. THE CLASSIFICATION OF INVENTIVE IDEAS.—Wyman. (*Scientific Monthly*, Sept. 1938, Vol. 47, No. 3, pp. 211–219.) From the U.S. Patent Office.

390. JUDICIARY AXIOMS: OLD PRINCIPLES, RECENT APPLICATIONS [in Patent Law, etc.].—Fernand-Jacq. (*Rev. Gén. de l'Élec.*, 30th July 1938, Vol. 44, No. 5, pp. 155–158.)

391. TECHNICAL EDUCATIONAL REQUIREMENTS OF THE MODERN RADIO INDUSTRY: PART III—PREPARATION FOR TECHNICAL TRAINING.—Whitteker. (*RCA Review*, July 1938, Vol. 3, No. 1, pp. 78–81.)

392. THE RÔLE OF THE ENGINEERING LIBRARY.—Naeter: Craver. (*Elec. Engineering*, Sept. 1938, Vol. 57, No. 9, p. 392.) A letter on Craver's article (3823 of 1938).

393. JOURNALS FOR ELECTRICAL ENGINEERS.—Roehmann: Dalziel. (*Elec. Engineering*, Sept. 1938, Vol. 57, No. 9, p. 392.) Criticism of Dalziel's method of analysis (3079 of 1938) and a suggested alternative. *See* also *ibid.*, Aug. 1938, No. 8, pp. 359–360 (Hoadley).

394. "VDI-JAHRBUCH 1938" [Book Review]. (*Akust. Zeitschr.*, Sept. 1938, Vol. 3, No. 5, p. 317.) The review deals only with the section on Acoustics.

395. VDE MEETING IN COLOGNE [with Notes on Papers on Telegraphy, Telephony, Broadcasting Technique, Valves, Aerials, etc.]—(*E.N.T.*, July 1938, Vol. 15, No. 7, pp. 234–236.)

396. NEW SERIES OF THE "LITERATURKARTEI ELEKTROTECHNIK."—VDE. (*E.T.Z.*, 13th Oct. 1938, Vol. 59, No. 41, p. 1105.) For an earlier reference *see* 3924 of 1937.

397. SIMPLE AND IMPORTANT PHOTOGRAPHIC METHOD OF COPYING AT NOMINAL COST.—Boydston. (*Review Scient. Instr.*, Oct. 1938, Vol. 9, No. 10, p. 328.)

398. RADIO PUBLICATIONS OF THE NATIONAL BUREAU OF STANDARDS: LIST OF PUBLICATIONS SINCE 1923.—(*Letter Circular LC* 40, Dept. of Commerce, Washington: 20th Aug. 1938: 25 pp, mimeographed.) Including addresses of the publishers of the journals in which the papers have appeared.

399. COMMUNICATIONS ON THE TECHNIQUE OF NEWS DISTRIBUTION [Short Notices of Papers on Cable Transmission Systems, Telephony, Ancillary Cables in Broadcast Transmissions, H.F. Wire Broadcasting, Wide-Band Cables, Television, etc.]—Feldtkeller. (*Naturwiss.*, 2nd Sept. 1938, Vol. 26, No. 35, pp. 581–584: notes from the *Jahrbuch des elektrischen Fernmeldewesens*, 1937.)

400. C.C.I.F. MEETING OF TECHNICAL COMMISSIONS, OSLO, 20TH JUNE – 2ND JULY, 1938.—McCurdy. (*Elec. Communication*, Oct. 1938, Vol. 17, No. 2, pp. 101–106.)

401. REVIEW OF 1937: RADIOCOMMUNICATIONS.—(*Ann. des Postes, T. et T.*, July 1938, Vol. 27, No. 7, pp. 617–652.)

402. REFLECTIONS ON THE EUROPEAN TELECOMMUNICATION NETWORK.—Valensi. (*Ann. des Postes, T. et T.*, Aug. 1938, Vol. 27, No. 8, pp. 663–705.) Translation of the Italian paper referred to in 3444 of 1938.

403. "DICTIONARY OF ELECTRICAL TERMS: 3RD EDITION" [Book Review].—Roget. (*Electrician*, 23rd Sept. 1938, Vol. 121, p. 342.)

404. "INTERNATIONAL ELECTROTECHNICAL DICTIONARY" [Book Notice and Instructions for Ordering].—(*E.T.Z.*, 8th Sept. 1938, Vol. 59, No. 36, p. 979.)

405. "VOCABULAIRE ÉLECTROTECHNIQUE INTERNATIONAL" [Book Review].—French Electrotechnical Committee. (*Rev. Gén. de l'Élec.*, 17th Sept. 1938, Vol. 44, No. 11, p. 326.)

406. FRENCH IMPORTS AND EXPORTS IN 1937 [Electrical].—Reyval. (*Rev. Gén. de l'Élec.*, 2nd July 1938, Vol. 44, No. 1, pp. 21–27.)

407. GERMAN ELECTRICAL FOREIGN TRADE DATA, JANUARY/JUNE 1938.—(*E.T.Z.*, 4th Aug. 1938, Vol. 59, No. 31, pp. 841–842.)

408. ELECTRICAL IMPORTS OF ROUMANIA, JUGOSLAVIA, AND BULGARIA.—(*E.T.Z.*, 13th Oct. 1938, Vol. 59, No. 41, pp. 1103–1104.)

409. OLYMPIA SHOW REPORT, *and* OLYMPIA SHOW REVIEW.—(*Wireless World*, 25th Aug. & 1st Sept. 1938, Vol. 43, pp. 172–183: pp. 207–217.)

410. RADIO EXHIBITION, OLYMPIA [General Notes: Push-Button Tuning: Television Receivers].—Smith-Rose. (*Nature*, 3rd Sept. 1938, Vol. 142, pp. 445–446.)

411. THE BERLIN SHOW AND RADIOLYMPIA: AN ENGLISH VISITOR'S IMPRESSIONS OF THE TWO EXHIBITIONS.—Barnett. (*World-Radio*, 2nd Sept. 1938, Vol. 27, p. 7.)

Some Recent Patents

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

ACOUSTICS AND AUDIO-FREQUENCY CIRCUITS AND APPARATUS

492 098.—Sound-radiating unit for public-address systems in which several speaker-units are arranged in ring-formation on a common standard or support.

Telefunken Co. Convention date (Germany) 10th March, 1936.

492 984.—Automatic gain control circuit for expanding or contracting the volume of sounds.

Standard Telephones and Cables (assignees of Le Matériel Téléphonique Soc. Anon.). Convention date (France) 1st July, 1936.

493 136.—Push-pull amplifier operated with constant grid-bias and maximum anode dissipation, but with greater variation on the positive than on the negative "swing."

Telefunken Co. Convention date (Germany) 28th February, 1936.

AERIALS AND AERIAL SYSTEMS

490 383.—Short-wave transmitting aerial comprising an array of concentric loops each "loaded" or broken-up by series condensers.

Marconi's W.T. Co. (assignees of P. S. Carter). Convention date (U.S.A.) 15th February, 1936.

491 220.—Aerial and down-lead combination which can be used either as a T-type aerial for long-wave reception, or as a dipole for short-wave signals.

E. V. Amy and J. G. Aceves. Application date 26th February, 1937.

491 485.—Mast type of transmitting aerial energised with out-of-phase currents to reduce high-angle radiation.

Marconi's W.T. Co. (assignees of W. D. Duttera). Convention date (U.S.A.) 16th April, 1937.

491 794.—Artificial load resistances for testing the performance of short-wave aerials, particularly those used for transmitting television signals.

J. L. Pawsey and E. C. Cork. Application date 6th March, 1937.

491 999.—Means for decoupling a transmitting aerial from a closely-adjacent receiving aerial in an arrangement used for measuring the altitude of aircraft.

Siemens Apparate und Machinen G.M.B.H. Convention date (Germany) 27th July, 1936.

DIRECTIONAL WIRELESS

490 940.—Finding the direction and/or polarisation of incoming waves by differently modulating the signal voltages picked by two separate aerials, and applying them to the deflecting plates of a cathode-ray tube.

Standard Telephones and Cables and C. W. Earp. Application date 23rd February, 1937.

491 127.—Direction-finder in which two or more horizontal frame-aerials are arranged to be rotated around a common centre in order to eliminate "night-effect."

Telefunken Co. Convention date (Germany) 29th October, 1936.

491 762.—Cathode-ray indicator for a direction-finder of the kind in which a rotating frame aerial is used to produce a heart-shaped response.

Standard Telephones and Cables (assignees of Le Matériel Téléphonique Soc. Anon.). Convention date (France) 17th December, 1936.

491 963.—Directional beacon transmitting a beam with a "zero" modulation characteristic which rotates at constant angular velocity.

Soc. Anon. des Ondes Dirigees. Convention date (France) 14th February, 1936.

492 011.—Direction-finder of the kind in which the pick-up from two crossed frame-aerials is applied through a low-frequency reversing switch to the plates of a cathode-ray indicator.

Soc. Francaise Radio-Electrique (addition to 470 060). Convention date (France) 30th December, 1936.

492 323.—Method of winding the radiogoniometer coils of a direction-finder so as to ensure a sinusoidal field, free from "octantal error."

Standard Telephones and Cables; I. R. J. James; and C. F. A. Wagstaffe. Application date 19th March, 1937.

493 574.—Direction-finding system in which the desired bearing is indicated as a difference in phase between the received signal and a locally-generated current.

Jaeger-Aviation. Convention date (Belgium) 29th July, 1936.

493 683.—Keying systems for a radio beacon which transmits a guiding-line or navigational course formed by overlapping beams.

C. Lorenz Akt. Convention date (Germany) 11th March, 1937.

RECEIVING CIRCUITS AND APPARATUS

(See also under Television)

490 597.—Automatic tuning control system in which the selectivity of the "pull-in" circuits can be varied in order to cut-out interference.

R. I. Kinross. Application date 13th February, 1937.

490 598.—Motor-car radio set in which the output volume is automatically controlled by the speed of the car.

E. J. C. S. St. J. Chesney. Application date 13th February, 1937.

490 625.—Automatic tuning control system for a superhet set, with means for reducing the effect of undesired resistance components in the local-oscillator valve.

Philco Radio and Television Corporation. Convention date (U.S.A.) 31st July, 1936.

491 183.—Wireless receiver with variable-selectivity control depending upon the heating of a non-linear resistance, such as the filament of a small electric flash-lamp.

Philips' Lamp Co. Convention date (Germany) 3rd December, 1936.

491 222.—Construction and mounting of rotary variable-inductance units, suitable for tuning an all-wave wireless set without condensers.

L. M. Meyer. Application date 26th February, 1937.

491 354.—Method of mounting, as a unit, inductances and condensers, forming a filter circuit for a wireless receiver.

C. Lorenz Akt. Convention date (Germany) 3rd *November*, 1936.

491 446.—Slow-motion gearing for driving the tuning condenser of a wireless receiver.

The General Electric Co. and R. W. Speirs. Application date 1st February, 1937.

491 463.—Control knob for tuning a wireless receiver, which can be used, when desired, to " mute " the loud speaker.

The General Electric Co. and W. H. Peters. Application date 22nd April, 1937.

491 531.—Tuning indicator for a wireless set in which the names of the stations are grouped either alphabetically or in order of wavelength.

Kolster-Brandes and K. G. Smith. Application date 5th March, 1937.

491 532.—Variable-selectivity control for a wireless set, in which the required adjustment is effected by rotating a rod of magnetic material or a disc of copper.

Kolster-Brandes and K. G. Smith. Application date 5th March, 1937.

491 685.—Construction and electrode-assembly of a multi-stage valve for handling very short waves.

Standard Telephones and Cables (assignees of J. P. Laico). Convention date (U.S.A.) 7th October, 1936.

491 693.—Band-pass coupling for a wireless receiver, in which a variable-selectivity response is given symmetrically about the mean resonant frequency.

Hazeltine Corp. (assignees of J. F. Farrington). Convention date (U.S.A.) 21st January, 1937.

491 768.—" Mixing " valve for a superhet circuit in which interaction between the various electrodes is prevented by splitting-up the electron stream into different paths.

N. V. Philips' Lamp Co. Convention date (Holland) 12th February, 1937.

491 860.—Visual tuning indicator of the cathode-ray type in which a " trademark " remains constantly visible whether the disc is illuminated or not.

Ferranti and A. L. Chilcot. Application date 10th March, 1937.

491 903.—Suppressor circuit for eliminating definite interfering frequencies in a wireless receiver.

G. Schaub Apparate Bau G.B.H. Convention date (Germany) 9th July, 1936.

491 937.—Recording and pick-up device for volume contraction and expansion in telephony and broadcasting.

L. Gabrilovitch. Convention date (France) 10th March, 1936.

492 064.—Preventing reaction due to the inductive effect of the lead-in wires in screen-grid valves for handling very high frequencies.

N. V. Philips' Lamp Co. Convention date (Germany) 15th May, 1936.

492 146.—Aerial coupling, for a motor-car set, which serves to eliminate interference from the ignition system.

N. V. Philips' Lamp Co. Convention date (Holland) 9th March, 1937.

492 263.—Combination of " delayed A.V.C." and a visual indicator to allow accurate tuning of signals below normal or " threshold " strength.

The Telefunken Co. Convention date (Germany) 12th March, 1936.

492 548.—Tuning knob for a wireless set in which a slow-motion " thumbwheel " is set in the centre of the fast-motion disc and at right-angles to it.

The Plessy Co.; P. H. Morrison; and P. J. Packman. Application date 25th June, 1937.

492 983.—High-gain amplifier in which the control-grid is closely wound and each coil is insulated from the others.

H. A. Malpas. Application date 26th May, 1937.

493 565.—Controlling a " muting " switch from the tuning knob of a wireless receiver.

The General Electric Co. and L. J. Stafford. Application date 5th May, 1937.

493 788.—Automatic tuning control with a simplified arrangement of the two off-tune or discriminator circuits.

E. K. Cole and H. C. Rowe, Jr. Application date 26th April, 1937.

TELEVISION CIRCUITS AND APPARATUS

For Transmission and Reception

490 760.—Television receiver in which means are provided for preventing undesired action of the picture signals on the grid of the saw-toothed oscillation-generator.

Telefunken Co. Convention date (Germany) 20th February, 1936.

490 845.—Means for preventing " tilt " effect in a cathode-ray television transmitter of the mosaic-screen type.

W. S. Percival; C. O. Browne; L. R. J. Johnson; and F. Blythen. Application date 20th January, 1937.

490 924.—Electron-optical system for projecting the image of a picture to be televised on to a mosaic screen, which is then scanned by a ray of light instead of by the usual electron stream.

Radio-Akt. D. S. Loewe. Convention dates (Germany) 22nd November and 2nd December, 1935.

490 981.—Light-valve or modulator for television, in which the passage of light is controlled by the "expansion" or heating action of an electron stream on a "screen" of bi-metallic strips mounted in a cathode-ray tube.

Zeiss Ikon Akt. Convention date (Germany) 18th January, 1937.

491 020.—Electron-camera type of discharge-tube for use in television, in which a series of secondary-emission electrodes are combined with the usual scanning system.

Fernseh Akt. Convention date (Germany) 24th February, 1936.

491 292.—Construction and treatment of the photo-sensitive "mosaic" screen used in a cathode-ray television transmitter.

Marconi's W.T. Co. (assignees of W. Hickok). Convention date (U.S.A.) 30th March, 1937.

491 389.—High-gain amplifier for handling a wide band of frequencies, particularly in television.

Scophony and J. H. Jeffree. Application date 11th March, 1937.

491 413.—Electrode assembly to facilitate focusing and to improve the picture contrast in a cathode-ray television transmitter of the Iconoscope type.

Marconi's W.T. Co. (assignees of W. H. Hickok). Convention date (U.S.A.) 31st December, 1936.

491 422.—Method of depositing a thin film of insulation on a metal surface, particularly in preparing the mosaic-cell electrodes used in television transmitters.

Marconi's W.T. Co. (assignees of E. R. Piore). Convention date (U.S.A.) 27th February, 1937.

491 425.—Cathode-ray television transmitter of the Iconoscope type incorporating an electron-multiplier in the same glass bulb.

Marconi's W.T. Co. (assignees of L. E. Flory and G. A. Morton). Convention date (U.S.A.) 28th January, 1937.

491 443.—Single-tube television transmitter in which the electrons liberated by scanning a mosaic screen are subsequently multiplied by secondary emission.

Radio-Akt. D. S. Loewe. Convention date (Germany) 11th September, 1936.

491 448.—Image-amplifier, or television transmitter, comprising a photo-sensitive screen which receives an optical image and is, at the same time, transparent to electrons.

Marconi's W.T. Co. Convention date (U.S.A.) 29th February, 1936.

491 450.—Generating synchronising impulses for television by applying a sinusoidal input to two valves working in phase-opposition.

Radio-Akt. D. S. Loewe. Convention dates (Germany) 3rd and 12th March, 1936.

491 468.—Paraphase arrangement, utilising the Miller effect, for amplifying the saw-toothed scanning-oscillations used in television.

C. L. Hirshman and Metropolitan-Vickers Electrical Co. Application date 21st June, 1937.

491 502.—Television system in which the relative amplitudes of the video and audio signals are controlled automatically according as a close-up or distant view is being transmitted.

Kolster-Brandes and C. N. Smyth. Application date 2nd March, 1937.

491 611.—Television receiver in which a modulating crystal is driven from the I.F. stages of the amplifier.

Scophony ; J. Sieger ; and S. H. M. Doddington. Application date 30th April, 1937.

491 728.—Circuit for separating the frame and line synchronising impulses in a television receiver.

E. L. C. White. Application date 10th March, 1937.

491 736.—Television time-base circuit of the non-self-running type, i.e. where the incoming synchronising impulses provide the energy for the saw-toothed oscillations.

E. J. Alway. Application date 18th March, 1937.

491 748.—Method of preparing and depositing a layer of fluorescent material on the screen of a cathode-ray tube, particularly for television.

The General Electric Co. ; L. C. Jesty ; and J. Sharpe. Application date 19th July, 1937.

491 803.—High-powered push-pull amplifier particularly suitable for handling television signals.

Standard Telephones and Cables and C. E. Strong. Application date 8th March, 1937.

491 873.—Tune-base circuit particularly designed to discriminate between the synchronising impulses of alternate frames in television signals with "interlaced" scanning.

The British Thomson-Houston Co. and D. S. Watson. Application date 11th March, 1937.

491 886.—Screens for masking the sharply-curved edges of the fluorescent screen in a cathode ray television receiver.

Baird Television and A. H. Gilbert. Application date 12th March, 1937.

491 887.—Television transmitter in which a sensitive screen of the "mosaic" type is discharged by a scanning-beam of light instead of by an electron stream.

Baird Television and V. A. Jones. Application date 12th March, 1937.

491 934.—Relaxation oscillator particularly suitable for the time-base unit of a television receiver.

C. L. Faudel and E. L. C. White. Application date 12th March, 1937.

492 036.—Light-sensitive electrodes designed to respond to light incident on the rear surface of the sensitised coating, particularly in television transmitters.

H. G. Lubszynski and L. Klatzow. Application date 10th March, 1937.

492 132.—Scanning system particularly adapted for television receivers in which the picture is reproduced by the incandescence of a highly-refractory screen.

N. V. Philips' Lamp Co. Convention date (Holland) 9th November, 1936.

492 167.—Electron-optical system for magnifying the image produced by the electron stream in a cathode-ray type of discharge tube.

H. G. Lubszynski and H. Miller. Application date 10th March, 1937.

492 168.—Eliminating picture "flicker" caused by supply-voltage variations due to the output from the sound-reproducing stage of a television set.

Radio-Akt. D. S. Loewe. Convention date (Germany) 16th March, 1936.

492 276.—Television scanning circuit in which the anode voltage of the cathode-ray tube is used to charge the time-base or relaxation condenser.

Radio-Akt. D. S. Loewe. Convention date (Germany) 21st March, 1936.

TRANSMISSION CIRCUITS AND APPARATUS

(*See also under Television*)

490 990.—Modulating ultra-high-frequency waves by varying the internal resistance of an electric-discharge tube associated with the carrier-wave generator.

C. Lorenz. Convention date (Germany) 23rd December, 1936.

491 093.—Modulating system involving a differential attenuation of the two side-bands of the carrier wave, so that a part of one side-band can be eliminated without producing distortion.

P. P. Eckersley and R. E. H. Carpenter. Application date 1st March, 1937.

491 444.—Ultra-short wave transmitter utilising a high-powered magnetron oscillator.

The British Thomson-Houston Co. Convention date (U.S.A.) 29th January, 1936.

491 445.—Ultra-short-wave oscillator, of the Barkhausen-Kurz type, in which the spacing between the electrodes is controlled by varying the cathode heating current.

The British Thomson-Houston Co. Convention date (U.S.A.) 29th January, 1936.

491 663.—Back-coupled valve circuit for generating oscillations of constant frequency irrespective of small fluctuations in the voltage supply.

Marconi's W.T. Co. and D. A. Bell. Application date 6th March, 1937.

491 805.—Method of modulation in which the carrier-wave is suppressed during non-signalling periods, and the percentage modulation is kept constant for all amplitudes of the signalling current.

Fernseh Akt. Convention date (Germany) 6th March, 1936.

492 006.—High-frequency signalling over wires.

C. Lorenz Akt. Convention date (Germany) 20th November, 1936.

493 674.—Arrangement of wide-band and narrow-band message frequencies in a multiplex carrier-wave signalling-system.

C. Lorenz Akt. Convention date (Germany) 21st December, 1936.

CONSTRUCTION OF ELECTRONIC DISCHARGE DEVICES

491 063.—An amplifier with a secondary-emission cathode designed to produce a high output voltage.

N. V. Philips' Lamp Co. Convention date (Germany) 21st April, 1937.

491 287.—Secondary-emission electrode, showing the Zworykin anomalous effect, and comprising a layer of an alkaline-earth borate.

Marconi's W.T. Co. (assignees of E. R. Piore). Convention date (U.S.A.) 30th January, 1937.

491 773.—Method of stabilising the output current from an electron-multiplier by an automatic control of the focusing field.

Standard Telephones and Cables (assignees of A. M. Skellett). Convention date (U.S.A.) 31st July, 1936.

491 874.—Recessed cathode for a cathode-ray tube, fitted with a retaining-wire for the emissive material.

Radio-Akt. D. S. Loewe. Convention date (Germany) 12th March, 1936.

491 994.—Multi-grid valve in which electrons turned back or "reversed" by a retarding electrode are prevented from striking against the control grid.

M-O. Valve Co.; W. H. Aldous; and G. W. Warren. Application dates 2nd July, 1937, and 5th May, 1938.

492 055.—Arrangement and construction of the multi-electrode system of a secondary-emission amplifier or electron-multiplier.

The General Electric Co.; W. H. Aldous; and L. R. G. Treloar. Application date 6th April, 1937.

492 250.—Means for minimising the deterioration of secondary emission from the target electrodes of an electron multiplier.

N. V. Philips' Lamp Co. Convention date (Holland) 30th March, 1937.

493 140.—Electron - multiplier designed and arranged to act as an oscillation generator of constant frequency.

Farnsworth Television Inc. Convention date (U.S.A.) 9th March, 1936.

SUBSIDIARY APPARATUS AND MATERIALS

491 196.—Coupling or terminal arrangement for converting electromagnetic into electrostatic waves in a high-frequency transmission-line of the so-called dielectric-guide.

Standard Telephones and Cables. Convention date (U.S.A.) 30th March, 1937.

491 277.—Method of cutting a piezo-electric crystal to oscillate at one frequency only in the X-mode, with a zero temperature-coefficient.

Marconi's W.T. Co. (assignees of S. A. Bokovoy). Convention date (U.S.A.) 30th September, 1936.

491 326.—Method of forming and depositing the sensitive alkali-metal coating on the cathode of a photo-electric cell.

Ferranti and J. A. Darbyshire. Application date 19th March, 1937.

491 382.—Oscillation-generator unit, particularly for testing purposes, in which the anode supply is taken from A.C. mains and means are provided for reducing modulation of the output oscillations by the A.C. frequency.

H. A. M. Clark. Application date 1st March, 1937.

491 407.—Cutting a piezo-electric crystal so that it has a zero or other predetermined temperature coefficient of frequency, when oscillating in the "shear" mode of vibration.

Standard Telephones and Cables (assignees of W. P. Mason). Convention date (U.S.A.) 25th November, 1936.