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Editorial

The Admiralty Handbook of Wireless Telegraphy

THE enormous increase in the number of those undergoing instruction in radio-communications has certainly raised wireless books to the status of best sellers, and the Admiralty Handbook of Wireless Telegraphy is, no doubt, no exception. It is, in many ways, an excellent text-book, and even in its present form, though shorn of much of its marginal grandeur, a real bargain. It was first published in 1938, when it superseded an earlier work with the same title published in 1931. It is very much to be regretted, however, particularly in an " official " handbook, that the opportunity was not taken to bring the nomenclature into line with the internationally agreed standards. Some people may at one time have used the name " oersted " for the unit of magnetic reluctance, and it may still be so used, although we doubt it, in the British Navy, but in 1930 it was internationally agreed at the Stockholm Congress that the name "oersted" should be given to the unit of magnetic force or field strength. The name " gauss," which the Handbook applies to the unit of magnetic force, is the internationally agreed name for the unit of magnetic induction or flux density. It is not surprising, however, to find traces of the pre-1930 muddle still persisting. Many of the units underwent changes of name at successive International Congresses, due to some extent to international rivalry. In 1881 the British Association Committee reported that the current produced by a " Volt " acting through an " Ohm " is called a " Weber," but at the first International Congress held in Paris in the same year, " Weber " was replaced by the name of a French scientist, Ampère. The 1889 Paris Congress called the unit of inductance a " quadrant," but at the fourth Congress, held at Chicago in 1893, this was replaced by the name of an American scientist, Henry. Then, on the first occasion that the International Congress was held in Scandinavia, the confusion which had arisen owing to the use of the term " gauss " for the units of both H and B was removed by giving the name of a Danish scientist, Oersted, to the former unit. All of which, as we remarked on another occasion, tends to show that in the naming of units, as in other fields of international rivalry, the home team have a certain advantage.

It must be admitted, however, that very few electrical engineers use either " oersted " or " gauss " ; both H and B are almost always expressed in lines per square centimetre, and in ordinary conversation even this is often taken for granted.

From the earliest days of wireless telegraphy the Admiralty adopted their own unit of capacitance, the " jar," equal to 1,000 e.s. units. Its present status is somewhat uncertain, to judge from the following four consecutive lines in the Handbook (Vol. I, 168) : " The jar is now obsolete as the Service unit, having been replaced by the Farad and its submultiples. Example 18. Find the quantity of electricity in a condenser of 500 jars capacity when charged to a P.D. of 10,000 volts."

In Vol. II, B. 20, it is stated that the steepness of the curve showing the emission in amperes per square centimetre from a tungsten filament plotted to a base of absolute temperature "indicates the rapid increase in temperature of the filament with heating current," which has nothing to do with the case.

In describing the horn safety gap, consisting of two bent copper wires, it is stated that "the arc will rise, *on account of its own heat*, sliding along the wires." It may be apocryphal but we have been told that Professor Ayrton's reply to this argument was simply to turn the apparatus upside down ; one could hardly then put the blame on gravity. Undoubtedly, however, the upward current of hot air will have some effect.

The Handbook is remarkably free from typographical errors, even a name like Kirchhoff is always spelt correctly in the text—but unfortunately always incorrectly in the index. It is only when we come to such outlandish and little-known names as J. J. Thomson that the Admiralty Handbook fails completely—the prophet in his own country.

On the last page, among the journals recommended to any officer or rating, is *Wireless Engineering*, published by Iliffe and Sons, monthly at 2s. 6d., but it was obviously meant well. G. W. O. H.

INDEX to ABSTRACTS

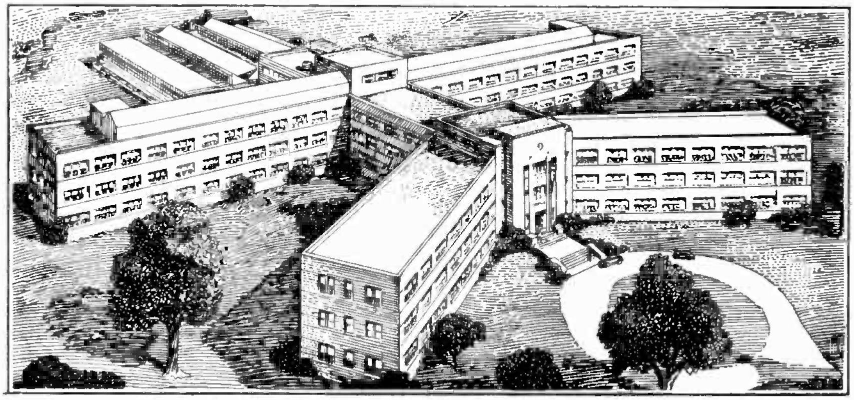
Must be ordered in advance

FOR several years past *The Wireless Engineer* has published, with the December issue, a subject index to the Abstracts and References section.

The inclusion of this Index as a part of this issue is discontinued this year, and instead, this Index, incorporating also an Index to Authors, will be published separately, early in 1942.

This issue, therefore, instead of being largely devoted to this Index, is a normal one including the Abstracts and References section which has formerly been omitted to make place for the Index.

A charge of 2s. 6d. will be made for the separate Index, and it will be necessary that those requiring copies should make early application for them to the Publishers, as otherwise it will not be possible to guarantee that copies will be available.



Architect's drawing of the new buildings which are being erected on a 250-acre site at Princeton, New Jersey, U.S.A., for R.C.A. Laboratories. In these buildings will be brought together research laboratories and staffs which have hitherto been employed by different sections of the Radio Corporation of America group of companies.

The Relaxation Amplifier*

By Martin Wald, Dr. Ing.

THE relaxation amplifier to be described in this article has been developed by the writer from the well-known relaxation oscillator. The relaxation amplifier can be used with advantage in all cases where a straight line relation between the output and input voltages is not required, for instance for telegraphic purposes. A practical application for C.W. telegraphic receivers will be described, in which the relaxation amplifier supplies also the necessary sound modulation.

As is known, relaxation oscillators are used for producing the time base voltages required, for example, in oscillographs and television receivers. The simplest and best known device of this kind is the two-valve multivibrator of Abraham and Bloch, the circuit diagram of which is shown in Fig. 1.

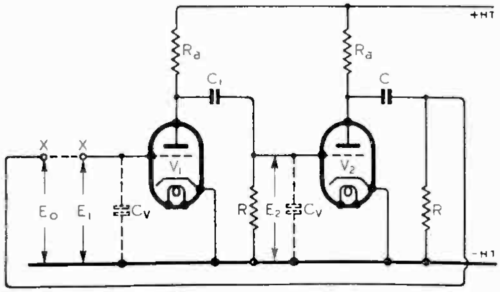


Fig. 1.—*Multi-vibrator circuit of Abraham and Bloch.*

The valve V_1 is resistance-coupled to the grid of V_2, the large condenser C_1 being provided to block off the H.T. voltage. The anode of the valve V_2 is connected to the grid of V_1 through the condenser C. The anode resistances R_a are non-reactive, and the condensers shown in dotted lines represent the valve capacitances. We have a strongly back-coupled system, which can be in stable balance only when the feedback factor k is smaller than 1 for all frequencies from zero up to infinity. The feed-back factor k can be defined as follows. We assume the feed-back lead of the arrangement to be broken at XX and a sinusoidal input voltage E_1 applied to the grid of the valve V_1 giving at the output a voltage E_0 which we assume to be also a sine wave. The ratio E_0/E_1 gives the feed-back factor k. For very low frequencies k will be smaller than 1 on account of the high impedance of condenser C. The same result will be obtained for very high frequencies on account of the valve capacitances C_v. For a middle frequency range, however, the amplification of the two valves would make k much greater than 1; therefore for stable balance one of the valves, V_1 or V_2 must be blocked by an excessive negative grid voltage. This gives two possible balances:

1. E_1 strongly negative whilst E_2 is positive,

2. E_2 strongly negative whilst E_1 is positive,

where E_1 and E_2 denote the grid voltages of the valves V_1 and V_2 respectively. Neither of these stable balances can last long on account of the condenser C which will be charged or discharged by the current flowing through the grid leak resistance R. The voltage built up across the condenser C will have the tendency to make R currentless and therefore to return the grid voltage E_1 to zero. When the charging or discharging of C has progressed so far that the blocked valve V_1 or V_2 begins again to work, the feed-back factor k becomes greater than 1 and each grid voltage will change exponentially to the other value of stable balance. Thus an oscillation will occur between the two conditions of stable balance, the frequency of which will be determined chiefly by the time constant CR available for charging and discharging the condenser C. This mode of operation of the circuit arrangement according to Fig. 1 will be made clearer by considering the wave-form of the voltages and currents occurring at different points. For simplicity's sake we suppose the pentodes V_1 and V_2 to have an idealised characteristic as shown in Fig. 2. The working point P with the bias voltage

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* Accepted by the Editor, August, 1941.

$-\frac{a}{2}$ lies in the middle of the straight part of the characteristic. A negative grid voltage $-a$ blocks off the anode current. In the positive direction the grid voltage is supposed to be practically limited at zero on account of the strong grid current occurring with any small positive grid voltage. Further we suppose the following relations to be fulfilled for the time constants in question :

$$\frac{C_v}{S} \ll R_a C_v \ll RC \quad .. \quad .. \quad .. \quad (1)$$

where S is the transconductance of either valve and R_a, R, C are anode load resistance, grid resistance, and feed-back capacitance as seen in Fig. 1. The whole process can thus be divided into four successive phases.

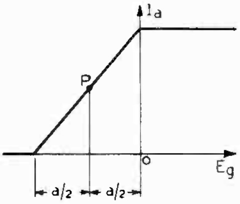

Fig. 2.—*Idealised valve characteristic.*

At first the valve capacitances C_v will charge or discharge very rapidly with the time constant C_v/S until V_1 or V_2 will be blocked. Afterwards follows the second phase of further charging the valve capacitances C_v from the H.T. supply with the much larger time constant R_aC_v. The third phase consists of charging the feed-back condenser C through the anode load resistance R_a giving an exponential waveform with the time constant R_aC. During the fourth phase, the condenser C will charge through the grid resistance R with the largest time constant RC. For closer consideration we start from the non-oscillating condition at the working point P in Fig. 2, with the valves in unstable equilibrium. At the time $t = 0$ we imagine a small voltage p suddenly impressed on the grid of V_1. During the first phase we need consider only the valve capacitances, whilst R_a and C are regarded as infinite. We thus obtain the differential equations :

$$\Delta I_{a2} = S \,.\, \Delta E_2 = -C_v \frac{d\Delta E_1}{dt} \quad .. \quad (2)$$

$$\Delta I_{a1} = S \,.\, \Delta E_1 = -C_v \frac{d\Delta E_2}{dt} \quad .. \quad (3)$$

where ΔE_1 and ΔE_2 are the increases of the grid voltage with respect to their normal value represented by the working point P in Fig. 2. Eliminating ΔE_1 we obtain from 2 and 3 :

$$\Delta E_2 = \frac{C_v^2}{S^2} \cdot \frac{d^2\Delta E_2}{dt^2} \quad .. \quad .. \quad (4)$$

The general solution of this equation is

$$\Delta E_2 = A_1 e^{\alpha t} + A_2 e^{-\alpha t} \quad .. \quad .. \quad (5)$$

where

$$\alpha = \frac{S}{C_v} \quad .. \quad .. \quad .. \quad .. \quad (6)$$

and the constants A_1 and A_2 will be determined by the initial conditions. When $t = 0$ we have

$$(\Delta E_2)_{t=0} = 0 \quad .. \quad .. \quad .. \quad (7)$$

and therefore :

$$A_1 = -A_2 = A \quad .. \quad .. \quad .. \quad (8)$$

Further, putting $p = \Delta E_1$ for the small impressed voltage, we have

$$-S \,.\, p = 2C_v \,.\, A \,.\, \alpha$$

$$\text{or } A = -\frac{p}{2} \quad .. \quad .. \quad .. \quad (9)$$

therefore :

$$\Delta E_2 = -\frac{p}{2}(e^{\alpha t} - e^{-\alpha t}) \quad .. \quad .. \quad (10)$$

and from (3)

$$\Delta E_1 = \frac{p}{2}(e^{\alpha t} + e^{-\alpha t}) \quad .. \quad .. \quad (11)$$

These formulae give the wave-form of the grid voltages ΔE_2 and ΔE_1 as the sum of two exponential curves. The term with negative exponent will drop rapidly to zero leaving the other term representing rapidly increasing changes of the grid voltages, ΔE_1 and ΔE_2 at every moment equal and opposite to each other. As shown in Fig. 3, the change of grid voltage ΔE_2 reaches at the point P_1 the critical value $-\frac{a}{2}$ necessary to block off the valve V_2 whilst ΔE_1 at the same time reaches $+\frac{a}{2}$ causing the maximum anode current to flow in the valve V_1. With the transconductance of V_2 also $\alpha = \frac{S}{C_v}$ becomes zero and therefore this phase will be finished. As the current in V_1 is twice its normal value, ΔE_2 will continue to go negative towards the value $-I_aR_a$ corresponding to the voltage drop across the anode load resistance. This second phase will be governed by the time constant $R_a C_v$ which is much larger than C_v/S. The resulting exponential curve (ΔE_2) is shown in Fig. 3 from P_1 to P_3. At the same time the valve V_2 being blocked the condenser C will be charged through the anode load resistance R_a and the internal grid-cathode resistance of V_1. The latter can be neglected for the positive voltage range and therefore the condenser C will charge exponentially with the time constant CR_a towards the final value $I_a R_a$ as shown in Fig. 3 (ΔE_c) from P_2 to P_3. At the point P_3 the charging of C having progressed so far that the grid potential begins to go negative, the grid current will stop and the condenser C can continue to charge only through the large grid leakage resistance R. This phase is represented by the exponential curve ΔE_c from P_3 to P_4 and is governed by the largest time constant $C(R_a + R)$. At the same time ΔE_1 and the anode current in V_1 will decrease whilst ΔE_2 will increase exponentially with the same time constant according to the relation $\Delta E_2 = - S \cdot R_a \cdot \Delta E_1$. At the point P_4 the grid voltage ΔE_2 has the critical value $-\frac{a}{2}$, the anode current in V_2 begins to flow and the transconductance of V_2 has again its normal value. Hence, a new half period of oscillation will start, beginning exponentially with the time constant C_v/S but in the opposite direction

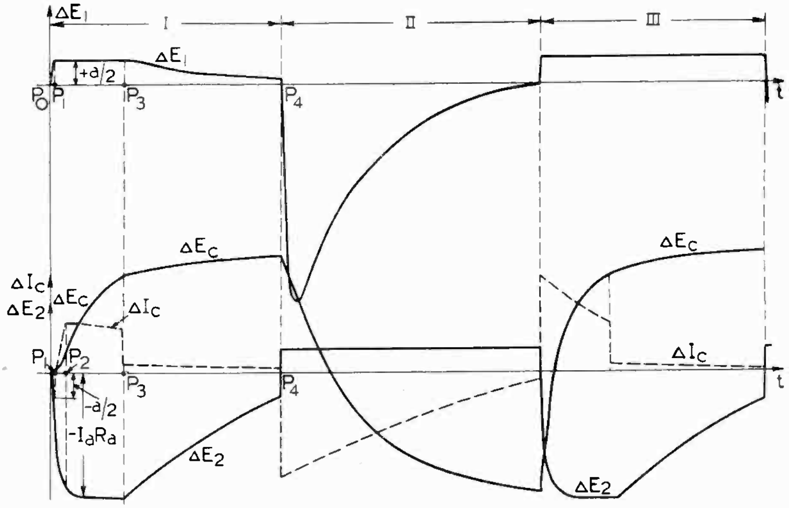

Fig. 3.—*Calculated wave-form of the relaxation oscillator.*

Fig. 3 shows three half cycles I, II, III each from P_0 up to P_4. The first half cycle I is different from the third on account of the assumption that at the time $t = 0$ the condenser C was uncharged. Beginning from the second half cycle II we have stationary working conditions, II and III representing a complete cycle which will be repeated continuously.

If we imagine a rectifier, for instance a diode, inserted in the feed-back lead, so that the feed-back current can pass only in one direction, no oscillation can occur. If, however, the rectifier had ideal characteristics, the system would theoretically become infinitely sensitive for impulses occurring in the direction in which the back-coupling is active. Indeed, any small impulse will give rise to a relaxation oscillation which, however, will be interrupted as soon as the current through the rectifier tends to change its direction, that is after a half cycle. We have here an amplifier of extreme sensitivity and we will refer to an arrangement of this kind as a "Relaxation Amplifier." Fig. 4 shows the circuit diagram. As seen we have the scheme of relaxation oscillator according to Fig. 1, but the feed-back current passes through the diode D biased by the battery voltage E_B. This negative bias voltage is so selected that at the working point the resistance of the diode D will be high compared with the grid resistance R, the feed-back factor k becoming slightly smaller than 1. The system will thus be in stable balance as long as no external impulse occurs on the grid of the valve V_1. When an external impulse occurs we must distinguish between two cases:

1. The external impulse voltage is negative.
2. The external impulse is positive.

In the first case the input voltage will be amplified by the valves V_1 and V_2, and the anode of the diode will become more negative. Hence no current will flow through it and the feed-back channel remains interrupted. After the external impulse had disappeared, the diode voltage goes back to its normal value and we have again the starting conditions. In the second case of a positive impulse, however, the anode of the diode becomes more positive and a feed-back current flows through it giving rise to a relaxation oscillation corresponding to Fig. 3 where the dotted line ΔI_c represents the current through the diode D and condenser C. At the point P_4 where the current would change sign, it will be interrupted since the diode becomes non-conductive. Any feed-back through the diode capacitance will be neutralised by the small neutrodyne condenser C_N supplying a negative feed-back. Fig. 5a shows the characteristic of an ideal rectifier as we have assumed till now. For any small negative voltage the current will be blocked, the diode representing an infinitely large resistance, whilst for any small positive voltage the diode behaves as a constant and small resistance R_D. With such an ideal rectifier the operation threshold of the relaxation amplifier would be determined by the bias voltage of the diode and could be adjusted to any desired small value. Any positive impulse exceeding the negative bias voltage would change the diode resistance from infinity to the small value R_D and a relaxation oscillation would start. In reality, however, the diode characteristic is curved as shown in Fig. 5b The diode A.C. resistance ($R_D = dE_D/dI_D$) decreases continuously as the voltage becomes more positive, and therefore a certain amount of negative bias will be necessary to make R_D large enough to stabilise the amplifier. On the other hand, when an external impulse occurs and a relaxation oscillation begins, the available diode resistance R_D decreases the rate of charging of the input capacitance $(C_g + C_v)$ and the time constant of the exponential wave-form with which the relaxation oscillation will begin depends on the amplitude of the initial impulse. It is clear that to obtain the maximum sensitivity, the working point ought to be adjusted on the most curved part of the diode characteristic (P_6 in Fig. 5b). In order to facilitate the calculation of the wave-form of the arising relaxation oscillation, we picture the whole process divided into small intervals, during which the diode resistance can be considered as constant. Further, we will assume that

$$\alpha \ll \frac{1}{R_a C_v} \qquad \qquad (12)$$

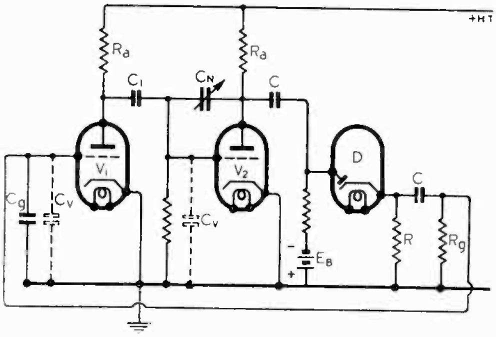

Fig. 4.—*Circuit diagram of the relaxation amplifier.*

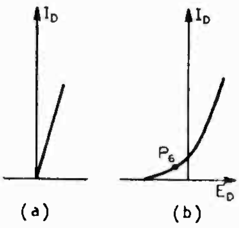

Fig. 5.—*Diode characteristics.*

This means that the exponential wave-form in question is a much slower process than the charging of the anode capacitance C_v through the resistance R_a. This requirement can be ensured by shunting the input grid by a condenser (C_g in Fig. 4) large enough compared with the valve capacitance C_v. In this case the valve capacitance C_v can be neglected and the anode load of both valves V_1 and V_2 may be considered non-reactive. Thus we obtain the equivalent scheme shown in Fig. 6. ΔE_g and ΔE_a are the input and output voltages, $g = S^2 . R_a{}^2$ the total gain of both valves. We have the relations :

$$I_D = \frac{g\Delta E_g - \Delta E_g}{R_D} = \frac{\Delta E_g}{R_g} + C_g \frac{d}{dt} \Delta E_g$$

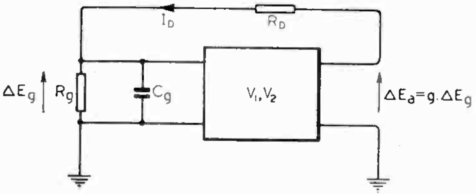

Fig. 6.

or $$\frac{d\Delta E_g}{dt} = \left(\frac{g-1}{R_D C_g} - \frac{1}{R_g C_g}\right)\Delta E_g \quad \ldots \quad (13)$$

from which

$$\Delta E_g = p \, . \, e^{\alpha t} \quad \ldots \quad \ldots \quad \ldots \quad (14)$$

and

$$\alpha = \frac{g - 1 - \dfrac{R_D}{R_g}}{R_D C_g} \quad \ldots \quad \ldots \quad (15)$$

where p is the change in the grid voltage occurring at the time $t = 0$, ΔE_g, ΔE_a, ΔE_D the voltage variations with respect to their initial values. For the diode voltage we obtain :

$$\begin{aligned}\Delta E_D = \Delta E_a - \Delta E_g &= (g-1)\Delta E_g \\ &= (g-1) \, . \, p \, . \, e^{\alpha t} \quad \ldots \quad \ldots \quad (16)\end{aligned}$$

Fig. 7 shows $\dfrac{R_{D0}}{R_D}$ as a function of ΔE_D derived from the diode characteristic in Fig. 5b. For the negative voltage range we obtain approximately an exponential curve.

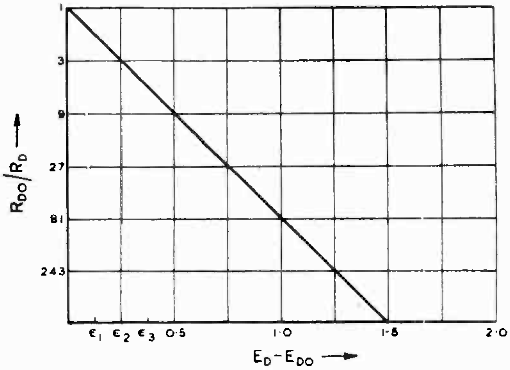

Fig. 7.

Fig. 8 shows $\alpha R_g C_g$ as a function of $\dfrac{R_{D0}}{R_D}$. For any value of R_D smaller than R_{D0} α becomes positive and a relaxation oscillation will start. Fig. 9 shows the wave-form of ΔE_g for different impulses p occurring at the time $t = 0$. For $p = P_0$ we have $R_D = R_{D0} \, . \, \alpha = 0$ and $\Delta E_g =$ constant, represented by a horizontal line. For larger impulses α becomes positive and ΔE_g will increase. For impulses smaller than p_0 and for negative ones α becomes negative and ΔE_g will drop exponentially from p_0 towards zero. The curves in Fig. 9 were obtained from Figs. 7 and 8 by dividing the diode resistance R_D into small intervals. Starting from the initial value R_{D1} we get from Fig. 8 the corresponding reciprocal time constant α_1 with which the grid voltage ΔE_g starts exponentially. When ΔE_g has progressed to the value $\dfrac{\epsilon_1}{g-1}$ (see Fig. 7) the diode resistance reaches the next interval R_{D2} which, being introduced in Fig. 8, gives a new time constant α_2 governing the following part of the exponential curve until the value $\dfrac{\epsilon_2}{g-1}$ will be reached where the time constant α changes again and so on.

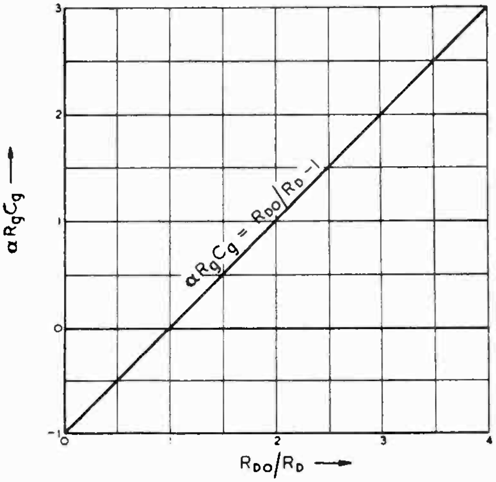

Fig. 8.

As seen from Fig. 9 the operation threshold for starting a relaxation oscillation is given by $p = p_0$. For $p > p_0$ the starting value of dE_g/dt, that is the initial slope of the time-curve in question, will depend on $p - p_0$ that is, the amount by which the impulse p exceeds the critical value p_0. A given value of ΔE_g will be more quickly reached the larger the initial impulse p. The whole process caused by an impulse p occurring at the time $t = 0$ on the input grid of the arrangement according to Fig. 4, is shown in Fig. 10. The grid voltage ΔE_1 starts exponentially according to one of the curves in Fig. 9 corresponding to the initial impulse p. The grid voltage of V_2 is given by the relation $\Delta E_2 = - S \, . \, R_a \, . \, \Delta E_1$ until the point P_1 in Fig. 10 where the valve V_2 will be blocked. The input condenser C_g will further charge from the H.T. supply through R_a, R_D and C. During this phase the charging of C can be neglected since we suppose the condenser C to be much larger than C_g. At the point P_2 the input grid potential becomes zero and the grid-cathode resistance becoming very small, the condenser C begins to charge from the H.T. supply through R_D. At the point P_3 the negative grid voltage of V_2 will drop below the value a and the valve V_2 begins again to work. The anode voltage of V_2 drops quickly to its normal value and the charge remaining on the condenser C causes the diode to go strongly negative and the feed-back lead to be interrupted until the condenser C discharges slowly through the resistances R and R_g. We suppose R_g to be small compared with R and therefore the discharging of C produces only a small negative voltage on the grid of V_1, which decreases exponentially. At the point P_4 in Fig. 10, practically the whole process is finished and the starting conditions of balance are established. The system remains in stable balance until a new external impulse occurs. The duration of the whole process will be determined chiefly by the largest time-constant C $(R + R_g)$. Now we will consider the case of an unmodulated sine wave acting on the input grid. For simplicity's sake we imagine the sine wave replaced by a stepped curve as shown in Fig. 11 which may be considered as a series of positive and negative impulses following each other. The first positive impulse will start a relaxation oscillation, as shown in Fig. 10, the wave-form of which is independent of the following impulses. After this relaxation oscillation is finished, a new oscillation will start and so on, as long as the impressed sine wave is acting. The duration of the relaxation oscillation can be adjusted by choosing the capacitance C so that an audio-frequency will result (for instance 1,000 c/s); which can be picked up across C or across the resistance E or R_g in Fig. 4.

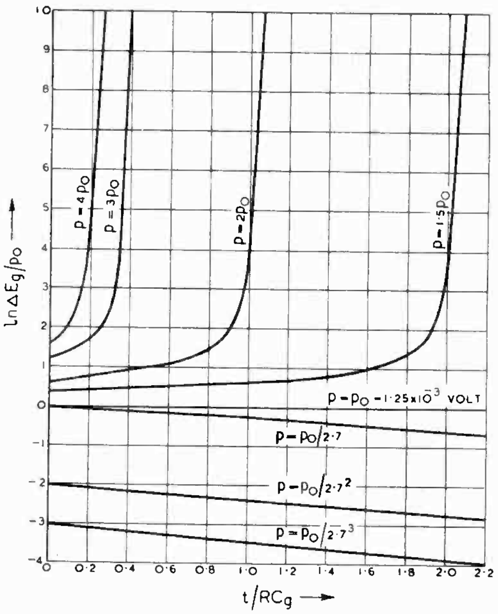

Fig. 9.

As an important application the writer suggests making use of the relaxation amplifier in telegraphic receivers. A circuit diagram for receiving C.W. telegraphy, that is, telegraphic signals without sound modulation, is shown in Fig. 12. The incoming R.F. signal feeds into the frequency changer V_1 and the changed signal of the intermediate frequency of about 130 kc/s passes the filter F_2 to the input grid of an aperiodic stage V_2 which feeds into the relaxation amplifier V_3V_4. The audio-frequency of about 1,000 c/s is picked up across a part of the resistance R, and fed into the loudspeaker valve V_5. During the R.F. signal, a sound of about 1,000 c/s will be audible from the loudspeaker L. It should be pointed out that the relaxation amplifier

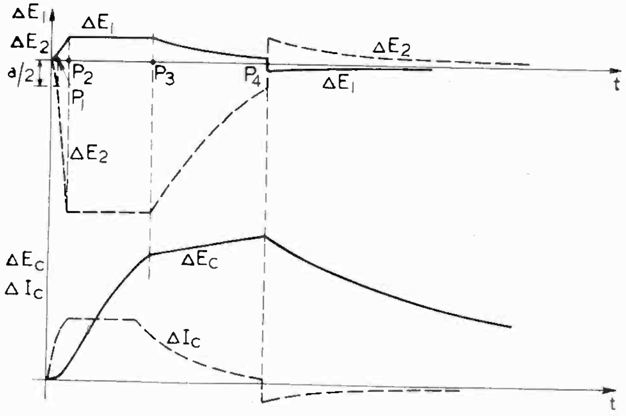

Fig. 10.—*Calculated wave-form of the relaxation amplifier.*

can be used for the same purpose in conjunction with any broadcast superheterodyne receiver. The signal can be picked up directly from the anode of the I.F. stage of the broadcast receiver and impressed on the input grid of the relaxation amplifier through a large condenser to block off the H.T. voltage. The output of the relaxation amplifier, that is the sound frequency built up across the resistance R can be impressed directly on the pick up terminals of the broadcast receiver. The usual method for the same purpose of having a beat-frequency oscillator acting on the I.F. stage of the broadcast receiver is more complicated. The relaxation amplifier used for telegraphic purposes gives the further advantage of producing a strong A.V.C. effect. This will be clear when we consider the sound-frequency output as a function of the input signal strength. As long as the input signal is smaller than the operation threshold of the relaxation amplifier no sound frequency will be realised at the output terminals of the relaxation amplifier. For any signal amplitude exceeding the threshold value the relaxation oscillation, causes the two valves to be completely opened and blocked successively and therefore produces at the output terminals the same audio-amplitude no matter how large the input signal. Large variations in the field strength of the incoming signal will therefore have no effect on the output of the relaxation amplifier.

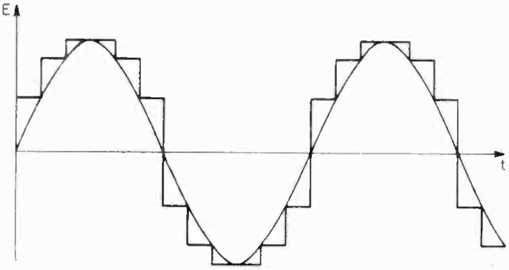

Fig. 11.

Another embodiment of the relaxation amplifier is shown in Fig. 13. The second valve in Fig. 4 serves as a phase inverting valve and is omitted in the device shown in Fig. 13. The phase inverting is accomplished by means of the transformer T. The plates of the duo-diode D_1D_2 are connected respectively to the two ends of the secondary coil of the transformer T, whilst the middle tapping point M and the diode-cathode are connected to the grid and cathode of the valve V respectively. Across the grid input of the latter a condenser C is connected. On account of the duo-diode D_1D_2 the feed-back current always makes the grid of V go negative. Therefore for positive impulses acting on the input grid we have a negative feed-back, that is, suppressing the initial impulse, whilst for negative impulses we obtain a positive feed-back, that is, supporting the

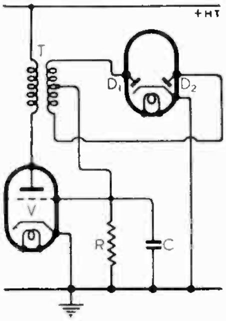

Fig. 13.—*Relaxation amplifier with transformer for phase inverting.*

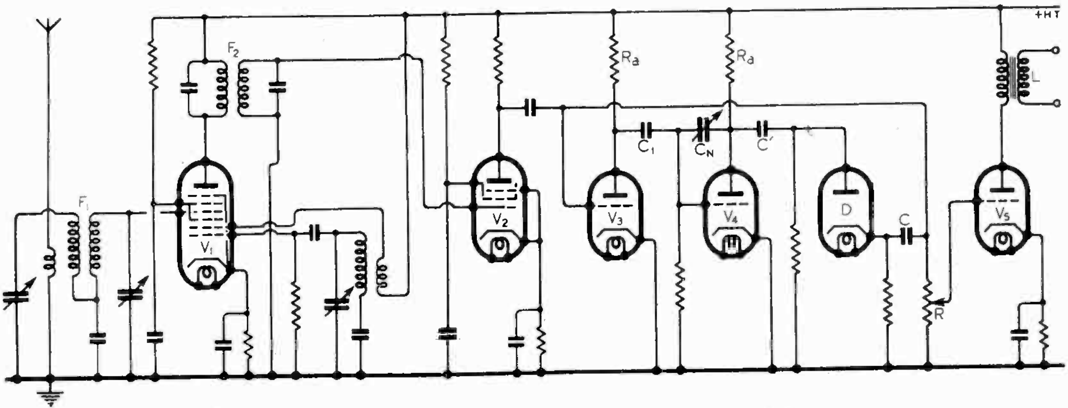

Fig. 12.—*Circuit diagram for receiving C.W. telegraphy signals.*

initial impulse. In the latter case a relaxation oscillation will start, the wave-form of which can be easily calculated. Considering the circuit diagram in Fig. 13 we have the following relations:

$$S \,.\, \Delta E_g = \Delta I_a \qquad \ldots \quad \ldots \quad \ldots \quad (17)$$

$$\frac{\Delta E_g}{R} + C\frac{d\Delta E_g}{dt} + \Delta I_D = 0 \qquad \ldots \quad (18)$$

and considering the voltages across one half of the secondary coil and diode we obtain:

$$\Delta E_g = R_D \Delta I_D + L\frac{d}{dt}\Delta I_D \pm M\frac{d}{dt}\Delta I_a \qquad \ldots \quad \ldots \quad (19)$$

where S is the slope of the valve V, ΔE_g the grid voltage, ΔI_a the current in the primary and ΔI_D that in one half of the secondary coil of the transformer T and the diode D_1 or D_2, L the inductance of each half secondary coil, M the mutual inductance between the primary and secondary coil, R_D the actual diode resistance and R the grid leakage resistance. As pointed out before, the sign of the induced voltage $M\frac{d}{dt}\Delta I_a$ depends on the sign of the initial impulse determining which of the two half coils will enter into action. Eliminating ΔI_a and ΔI_D gives further:

$$\Delta E_g\left(1 + \frac{R_D}{R}\right) + \frac{d\Delta E_g}{dt}\left(R_D C + \frac{L}{R} \mp MS\right) + \frac{d^2\Delta E_g}{dt^2}LC = 0 \qquad \ldots \quad \ldots \quad (20)$$

On putting $\Delta E_g = e^{\alpha t}$ we get from 20 the characteristic equation:

$$\alpha^2 + \alpha\left(\frac{R_D}{L} + \frac{1}{RC} \mp \frac{MS}{LC}\right) + \frac{1 + \frac{R_D}{R}}{LC} = 0 \qquad \ldots \quad \ldots \quad (21)$$

which gives for the reciprocal time constant:

$$\alpha = \frac{\pm MS}{2LC} - \frac{R_D}{2L} - \frac{1}{2RC} \pm \sqrt{\left[\frac{\pm MS}{2LC} - \frac{R_D}{2L} - \frac{1}{2RC}\right]^2 - \frac{1 + \frac{R_D}{R}}{LC}} \qquad \ldots \quad \ldots \quad (22)$$

The wave form of the grid voltage ΔE_g is given by:

$$\Delta E_g = \frac{p}{2}\left(e^{\alpha_1 t} + e^{\alpha_2 t}\right) \qquad \ldots \quad \ldots \quad (23)$$

where p is the impulse occurring at the time $t = 0$, α_1 and α_2 the two reciprocal time-constants from equation 22. Only with the upper sign of M will it be possible to obtain positive values for α when the diode resistance R_D becomes smaller than

$$R_{D_0} = \frac{MS}{C} - \frac{L}{RC}. \qquad \ldots \quad \ldots \quad (24)$$

A negative impulse $p > p_0$ will be amplified by the valve V and cause the diode D_1 to go positive so that the diode resistance R_D will become smaller than R_{D_0}. On account of the term with positive index the negative voltage of the grid will increase until the valve V

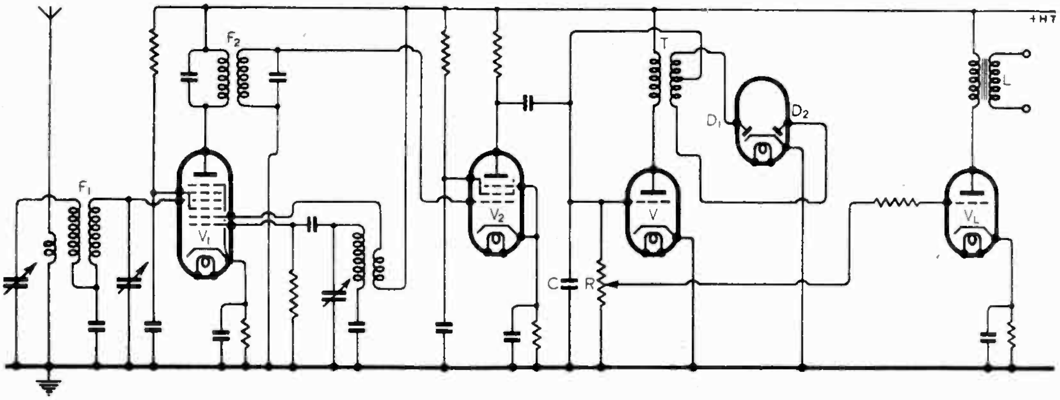

Fig. 14.—*Circuit diagram for receiving C.W. telegraphy signals incorporating the relaxation amplifier with transformer as phase inverter.*

becomes blocked. With the anode current the induced voltage in the secondary coil will also disappear and due to the charge remaining on the condenser C, the grid voltage ΔE_g biases both diodes strongly negative thus interrupting the feed-back lead. Therefore the condenser C begins to discharge exponentially through the resistance R with the time constant CR. The grid voltage and with it the diode resistance will thus return to their initial values. The system will now remain in balance unless a new negative impulse occurs. In the case of an external voltage of sine wave-form we find the resulting effect by the same considerations as before. If the time constant CR is chosen to give an audio-frequency, we obtain an audible output so long as the incoming wave is acting. Fig. 14 shows a circuit diagram for receiving C.W. telegraphic signals, incorporating this form of relaxation amplifier. The mode of operation is similar to that of the circuit diagram in Fig. 11 described above.

Standards for Magnetic Materials

THE British Standard Specification for Magnetic materials for use under combined D.C. and A.C. magnetisation (B.S.S., 933–1941), published in March, deals with the subject of incremental permeability and the accompanying iron losses when an alternating magnetisation is superposed upon a steady magnetisation, a condition often occurring in radio apparatus. Specifications are given for silicon-steel and for nickel-iron alloys in the form of strip of various thicknesses. For silicon steel it is recommended that the D.C. magnetising force shall not exceed 5.0 oersteds, suitable values being 0.2, 0.5, 2.0 and 5.0. The superposed magnetising force should have an amplitude not exceeding 0.5 of the D.C. magnetising force, suitable values being 0.01, 0.05, 0.2 and 0.5 of the D.C. value. The recommended values of the frequency are 50, 100, 300, 1000 and 3000 c/s. In the case of nickel-iron alloys the d.c. magnetising force should be less, suitable values being 0.1, 0.2, 1.0 and 2.0, but the other figures are the same. Three different test methods are described, viz. the ballistic galvanometer, the A.C. potentiometer, and the modified Owen bridge. The test samples can be rings, strips or assembled cores with interleaved joints. There is a useful appendix discussing the presentation of technical data for the design of inductors with air-gap magnetic circuits, a subject that calls for considerable care if the best results are to be obtained.

It is a pity that more care was not taken, even in the present circumstances, in the final preparation of a specification published by the British Standards Institution. On p. 19 there are variable resistances which on the next page become variable resistors; the next time they occur they have reverted to resistances, but only to change again on the next page to resistors. Condensers and capacitors play the same game throughout the specification as do also inductances and inductors. On p. 21 there is a reference to "a large capacitor" whereas, as a matter of fact, the size of the capacitor is immaterial, so long as it has a large capacitance. The complication referred to on p. 16 is not due, as stated, to a symmetrical current waveform but to an asymmetrical current waveform—a very different thing. On p. 18, line 13, "the mean value of $\check{H}$" is surely a mistake; $\check{H}$ is the minimum value.

On p. 5 there is a reference to the "applied superimposed modulated component of magnetising force." Now the applied alternating magnetising force is usually of constant amplitude and is therefore not modulated. One can perhaps regard the resultant variation of H as due to the modulation of the D.C. value by the applied A.C. component, which can then be called the modulating but certainly not the modulated component.

In the bibliography Dannat should be Dannatt and there is something wrong with the page reference to Hague's "Alternating Current Bridge Methods"; the section dealing with superposed A.C. and D.C. is on pages 497-498, not 374-377.

G. W. O. H.

Replacement Valves

An Official List

TO assist in the choice of suitable alternative valves for the many types that are now scarce, the British Radio Valve Manufacturers' Association has prepared a list of equivalent and "preferred" types.

This list, which has been issued by *The Wireless World* in booklet form, costs 1s. through newsagents or booksellers. Direct from our publishers, by post, the cost is 1s. 1d.

The Industry

AN illustrated catalogue containing an engineering description of the Type E.S.4 short-wave transmitter has been issued by Standard Telephones & Cables, Ltd. (Radio Division), Oakleigh Road, New Southgate, London, N.11.

A limited number of new technical catalogues dealing with oil and mercury high vacuum diffusion pumps have been prepared by W. Edwards & Co., Southwell Road, London, S.E.5.

Wright & Weaire, Ltd., report that Mr. R. H. Fox has resigned from the board of directors and from his executive position as works director.

Due to unexpected delays, copies of "Thermionic Valve Circuits," by Emrys Williams, advertised by Pitmans in our November issue, will not be available until early in January.

Coupling Circuits as Band Pass Filters—Part IV*

By E. K. Sandeman

(Concluded from page 454 of November Issue)

Shunt Capacitance—Mutual Coupling

THE circuit of this is shown in Fig. 1 and a solution will be devised for the case where $L_1 = L_2$. Two cases arise according to the sense of the mutual inductance M between L_1 and L_2:

Normal Circuit: M Negative.

The circuit in which the coils are connected in series opposing will be called the *Normal* circuit, since, if the capacitance of the condenser and the reactance of L_1 and L_2 were made infinite, and the coupling factor

$$k = \frac{M}{\sqrt{L_1 L_2}}$$

were made unity, the circuit would behave as if there were a straight connection between terminals 1, 1 and 2, 2.

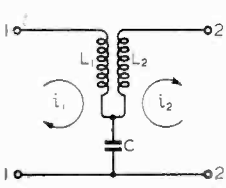

Fig. 1.

Reversed Circuit: M Positive.

The circuit in which the coils are connected in series aiding will be called the *Reversed* circuit, since, under the ideal conditions postulated for the Normal circuit, the Reversed circuit would behave as if there were a cross connection between terminals 1, 1 and 2, 2.

This network, in both the Normal and Reversed connection, may have such values assigned to its parameters as to make it constitute a low pass filter. The derivation of the design constants of the structure for this purpose is given below. Only the case for the Normal circuit is considered, since to derive the corresponding formulae for the Reversed circuit it is only necessary to reverse the signs of M and K.

Normal Circuit

Determination of short circuit impedance looking into terminals 1, 1.

Choose current conventions i_1 and i_2 as indicated in Fig. 1. Kirchhoff equations can then be set up as below when terminals 2, 2 are short circuited, and a voltage e is applied across terminals 1, 1.

$$i_1\left(L_1 j\omega + \frac{1}{Cj\omega}\right) - i_2 Mj\omega - \frac{i_2}{Cj\omega} = e \quad \ldots \quad \ldots \quad (1)$$

$$i_1 Mj\omega - i_2 L_2 j\omega - \frac{i_2}{Cj\omega} + \frac{i_1}{Cj\omega} = 0 \quad (2)$$

From (1)

$$i_2 = \frac{Mj\omega + \dfrac{1}{Cj\omega}}{L_2 j\omega + \dfrac{1}{Cj\omega}}\, i_1 = \frac{1 - MC\omega^2}{1 - L_2 C\omega^2}\, i_1 \quad \ldots \quad \ldots \quad (3)$$

Substituting (3) in (1)

$$\frac{e}{i_1} = L_1 j\omega + \frac{1}{Cj\omega} - \left(Mj\omega + \frac{1}{Cj\omega}\right)\left[\frac{1 - MC\omega^2}{1 - L_2C\omega^2}\right]$$

$$= L_1 j\omega + \frac{1}{Cj\omega} - \frac{1}{Cj\omega}\left[\frac{(1 - MC\omega^2)^2}{1 - L_2C\omega^2}\right]$$

$$= L_1 j\omega + j\,\frac{M\omega(MC\omega^2 - 2) + jL_2\omega}{1 - L_2C\omega^2} \quad \ldots \quad \ldots \quad (4)$$

$$= j\,\frac{L_1\omega - L_1L_2C\omega^3 + M\omega(MC\omega^2 - 2) + L_2\omega}{1 - L_2C\omega^2}$$

= short circuit impedance

$$= Z_1 \tanh P \quad \ldots \quad \ldots \quad \ldots \quad (5)$$

where Z_1 is the image impedance at 1, 1 and P is the propagation constant of the structure.

Open Circuit Impedance looking into 1, 1.

By inspection of Fig. 1, the open circuit impedance

$$= Z_1 \coth P = j\left(L_1\omega - \frac{1}{C\omega}\right) \quad \ldots \quad (6)$$

$$= \frac{1}{Cj\omega}(1 - L_1C\omega^2) \quad \ldots \quad \ldots \quad \ldots \quad (7)$$

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* MS. accepted by the Editor, June, 1941.

Now assume $L_1 = L_2 = L$ say, so that $Z_1 = Z_2 = Z$ say.

Then from equations (5) and (6)

$$Z^2 = \frac{L}{C} - L^2\omega^2 + \frac{M}{C}(MC\omega^2 - 2) + \frac{L}{C}$$

$$= \frac{2L - 2M}{C} - L^2\omega^2 + M^2\omega^2 \quad .. \quad (8)$$

When $\omega = \omega_c$ $Z^2 = 0$ or ∞. Since only $Z^2 = 0$ gives a finite value to ω_c when $\omega = \omega_c$, $Z = 0$. Putting $Z = 0$ and $\omega = \omega_c$ in (8)

$$\therefore (L^2 - M^2)\omega_c^2 = \frac{2L - 2M}{C}$$

$$\therefore \omega_c = \frac{\sqrt{2L - 2M}}{C(L^2 - M^2)}$$

$$= \sqrt{\frac{2}{C(L + M)}} \quad .. \quad .. \quad (9)$$

Phase Shift Characteristics of both Normal and Reversed Networks

Inspection of the network shows that at zero frequency the phase shift is zero, and that as the frequency is increased a lagging phase shift is introduced. The last point can be seen more clearly by drawing the equivalent T for the coupled inductances L_1 and L_2, using a positive value of K for the normal circuit and a negative value of K for the reversed circuit. Inside the pass band the propagation constant is imaginary, the attenuation being zero. In equation (6) it is therefore permissible to put $P = jB$ where B is the phase constant of the network.

In each network therefore

$$Z \coth jB = -Zj \cot B = j(L\omega - \frac{1}{C\omega})$$

$$\therefore B = \cot^{-1}\frac{1}{Z}\left[(\frac{1}{C\omega} - L\omega)\right] \quad .. \quad (10)$$

Inside the pass band Z is real and positive. Hence, when $\omega = 0$, $B = 0$, and when $\omega = \frac{1}{\sqrt{LC}}$, $B = 90$ deg. lag. (Lag because examination of (10) shows the phase to increase continuously in the same direction, and, as indicated above, the initial phase shift at low frequency is lagging.)

At the cut off frequency, $\omega = \sqrt{\frac{2}{C \pm M}}$, and substituting this value of ω in (10) and the value of Z from equations (8) and (8a),

$$B = \cot^{-1}\left(\frac{\frac{1}{C} - L\omega^2}{Z\omega}\right)$$

$$= \cot^{-1}\left(\frac{\frac{1}{C} - L\omega^2}{\omega\sqrt{\frac{2L \mp 2M}{C} - (L^2 - M^2)\omega^2}}\right)$$

$$= \cot^{-1}$$

$$\left(\frac{\frac{1}{C} - \frac{2L}{C(L \pm M)}}{\omega_c\sqrt{\frac{2L \mp 2M}{C} - (L^2 - M^2)\frac{2}{C(L \pm M}}}\right)$$

$$= \cot^{-1}\left(\frac{\frac{1}{C}(1 - \frac{2L}{M \pm L})}{\omega_c\sqrt{\frac{2(L \mp M)}{C} - \frac{2(L \mp M)}{C}}}\right)$$

$$= \cot^{-1}(-\infty) = 0 \text{ or } 180 \text{ deg.}$$

From the considerations given above the zero value is excluded. The network therefore introduces lag varying from zero at zero frequency to 180 deg. at the cut-off frequency.

For evaluating B numerically at all frequencies equation (12), derived below, should be used, as substitution in this is easier.

Value of Propagation Constant of Normal Circuit inside and outside the Pass Band

The relation between cosh P and coth P is given by

$$\cosh P = \frac{\text{Coth } P}{\sqrt{\coth^2 P - 1}}$$

Inserting in this the value of coth P from (6), and putting $Z_1 = Z$,

$$\cosh P = \frac{\frac{j}{Z}(L\omega - \frac{1}{C\omega})}{\sqrt{-\frac{1}{Z^2}(L\omega - \frac{1}{C\omega})^2 - 1}}$$

Now substitute in this the value of Z from (9) and (9a).

$$\therefore \cosh P = \frac{j(L\omega - \frac{1}{C\omega})}{\sqrt{\frac{-L^2\omega^2 - \frac{1}{C^2\omega^2} + \frac{2L}{C}}{-\frac{2L-2M}{C} + L^2\omega^2 - M^2\omega^2}}}$$

$$= \frac{j\left(L\omega - \frac{1}{C\omega}\right)}{j\left(M\omega - \frac{1}{C\omega}\right)} = \frac{L\omega - \frac{1}{C\omega}}{M\omega - \frac{1}{C\omega}} \quad .. \quad (11)$$

Inside the Pass Band

$$\text{Cosh } P = \cosh jB = \cos B = \frac{L\omega - \frac{1}{C\omega}}{M\omega - \frac{1}{C\omega}} \quad .. \quad .. \quad (12)$$

Outside the Pass Band

$$\cosh P = \cosh (A + jB)$$

$$= \frac{L\omega - \frac{1}{C\omega}}{M\omega - \frac{1}{C\omega}} = Q_n \text{ say} \quad .. \quad (13)$$

Inside the pass band Q_n and Q_r are less than unity, and the phase shift is given by equations (12) and (12a). Outside the pass band Q_n and Q_r may have any real value positive or negative, and the only values of B which satisfy equations (13) and (13a) are 0 and 180 deg. (since the cosh of a complex quantity is a complex quantity, while Q_n and Q_r are real). The value of B which obtains in any non-pass range is the same as the value of B at the cut off frequencies which bound the non-pass range, and is constant at that value throughout the non-pass range. In the present case the value of B in the non-pass range is the value of B at the cut off frequency as determined below. This is 180 deg.

Attenuation outside the pass range :

from (13)

$$\cosh (A + jB) = \cosh (A + j180 \text{ deg.})$$

$$= -\sinh A = \frac{L\omega - \frac{1}{C\omega}}{M\omega - \frac{1}{C\omega}}$$

$$\therefore A = \sinh^{-1} \frac{\frac{1}{C\omega} - L\omega}{M\omega - \frac{1}{C\omega}} \quad .. \quad .. \quad (14)$$

$$\therefore A = \sinh^{-1} \frac{\frac{1}{C\omega} - L\omega}{M\omega + \frac{1}{C\omega}} \quad .. \quad .. \quad (14a)$$

A note on the evaluation of A from equation (14) may be useful.

The equation to be solved is in the form $A = \sinh^{-1} Q$.

or $\sinh A = Q$ which may be written

$$\tfrac{1}{2}(e^A - e^{-A}) = Q$$

Put $e^A = r$ from which we get $r - \frac{1}{r} = 2Q$

$$\text{or } r^2 - 2Qr - 1 = 0$$

$$\therefore r = \frac{2Q \pm \sqrt{4Q^2 + 4}}{2}$$

$$= Q + \sqrt{Q^2 + 1} \quad .. \quad .. \quad (15)$$

The plus sign is taken since r must evidently be positive.

Derivation of Design Equations for Normal Circuit

When $\omega = 0$, from (8)

$$Z^2 = \frac{2L - 2M}{C} = \frac{2L(1 - k)}{C} \quad .. \quad (16)$$

Hence, if L, k and Z are chosen, C is determined from equation (16), or if any three of the four quantities are chosen, the other is determined by the same equations. ω_c is then determined by equation (9).

If Z, ω_c and k are chosen

$$\text{From (16), } L = \frac{CZ^2}{2(1 - K)} \quad .. \quad .. \quad (17)$$

Squaring (9) and substituting from (17)

$$\omega_c^2 = \frac{\frac{2CZ^2}{2(1-k)}(1 - k)}{C\frac{C^2Z^4}{4(1 - k)^2}(1 - k^2)} = \frac{4(1 - k)}{C^2Z^2(1 + k)}$$

$$\therefore C = \frac{2}{\omega_c Z}\sqrt{\frac{1 - k}{1 + k}} \quad .. \quad .. \quad (18)$$

From (17) and (18),

$$L = \frac{Z}{\omega_c(1 - k)}\sqrt{\frac{1 - k}{1 + k}}$$

$$= \frac{Z}{2\pi f_c\sqrt{1 - k^2}}$$

Summary of Design Equations

Normal Circuit	*Reversed Circuit*
$Z^2 = \frac{2L(1 - k)}{C}$	$Z^2 = \frac{2L(1 + k)}{C}$

$$L = \frac{CZ^2}{2(1-k)} \qquad L = \frac{CZ^2}{2(1+k)}$$

$$\omega_c = \sqrt{\frac{2}{C(L+M)}} \qquad \omega_c = \sqrt{\frac{2}{C(L-M)}}$$

$$= \frac{2}{CZ}\sqrt{\frac{1-k}{1+k}} \qquad = \frac{2}{CZ}\sqrt{\frac{1+k}{1-k}}$$

$$C = \frac{2}{\omega_c Z}\sqrt{\frac{1-k}{1+k}} \qquad C = \frac{2}{\omega_c Z}\sqrt{\frac{1+k}{1-k}}$$

$$L = \frac{Z}{\omega_c\sqrt{1-k^2}} \qquad L = \frac{Z}{\omega_c\sqrt{1-k^2}}$$

Series Capacitance—Mutual Coupling

The circuit of this is shown in Fig. 2. As in the case of the shunt capacity Mutual Coupling two cases arise according to the sense of the mutual inductance M between L_1 and L_2. The *Normal* circuit will be taken as the one in which a straight through connection is effectively obtained if the condenser is removed, and the inductances made infinite and the coupling factor made unity. The Reversed Circuit is that in which, under the same conditions, an effective commutation results.

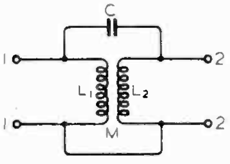

Fig. 2.

When the inductances L_1 and L_2 are equal both Normal and Reversed circuit may have such values assigned to their parameters that they constitute high pass filters.

The derivation of their parameters for this purpose is given below.

Normal Circuit

Replacing the coupled circuit in Fig. 2, constituted by L_1 and L_2 and their mutual inductances, by the equivalent T, when $L_1 = L_2 = L$, the circuit of Fig. 3 results.

Short Circuit Impedance.

By inspection, the impedance looking into either pair of terminals with the other pair short circuited.

$$= \frac{(1-k^2)Lj\omega}{1-(1-k^2)LC\omega^2} = Z\tanh P \qquad (19)$$

where P is the propagation constant of the structure and Z is the image impedance.

Open Circuit Impedance.

By inspection, the impedance looking into either pair of terminals with the other pair open circuited.

$$= \frac{[1-(1-k^2)LC\omega^2]Lj\omega}{1-2(1-k)LC\omega^2} = Z\coth P \quad \ldots \quad \ldots \quad (20)$$

From equations (19) and (20)

$$Z^2 = \frac{(k^2-1)L^2\omega^2}{1-2(1-k^2)LC\omega^2} \quad \ldots \quad \ldots \quad (21)$$

When $\omega = \omega_c$, $Z = 0$ or ∞. Since the numerator can never equal zero and the denominator can never equal infinity for finite values of frequency and components, a single cut off frequency exists, i.e., when $Z = \infty$, so that

$$1 - 2(1-k)LC\omega_c{}^2 = 0$$

$$\text{or} \quad \omega_c = \sqrt{\frac{1}{2(1-k)\,LC}} \quad \ldots \quad \ldots \quad (22)$$

Further, from equation (21), when $\omega \simeq 0$, Z^2 is negative so that Z is imaginary. Hence the section is a high pass filter.

Phase Shift Characteristic of Network

From inspection of Fig. 3 the phase shift introduced at very high frequencies tends to zero and is a leading shift. At infinite frequency the phase shift is zero.

Inside the pass band the propagation constant is imaginary, the attenuation being zero. In equation (19) it is therefore permissible to put $P = jB$, where B is the phase shift constant of the network, whence

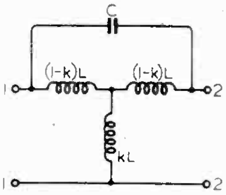

Fig. 3.

$$Z\tanh jB = Zj\tan B = \frac{(1-k^2)Lj\omega}{1-(1-k^2)LC\omega^2}$$

$$\therefore \; B = \tan^{-1}\left[\frac{(1-k^2)L\omega}{Z[1-(1-k^2)LC\omega^2]}\right] \quad (23)$$

At the cut off frequency $Z = \infty$, so that $B = 0$ or 180 deg. Inspection of equation (23) shows that the phase rotation between ω = infinity and $\omega = \omega_c$, cannot exceed 180 deg., hence, since the phase shift at ω = infinity is zero, at ω_c the phase shift is 180 deg. lead.

The network therefore introduces a leading phase shift varying from 180 deg. at the cut off frequency to zero at infinite frequency.

To evaluate the phase shift at other frequencies in the pass band, equation (23) may be used if substitution for Z is made from equation (21).

Derivation of Design Equations.

From equation (21), when $\omega = \infty$

$$Z^2 = \frac{(1 - k^2)L}{2(1 - k)C} = \tfrac{1}{2}(1 + k)\frac{L}{C} \quad \ldots \quad (24)$$

Hence if L, k and Z are chosen arbitrarily or from any specific considerations, C is determined from equation (24). Similarly if any three of the four quantities in equation (24) are chosen, the other is determined. In all cases ω_c is then determined from equation (22).

If Z, ω_c and k are chosen.

From (24) $$L = \frac{2CZ^2}{1+k} \quad \ldots \quad \ldots \quad (25)$$

Squaring (22) and substituting from (25),

$$\omega_c^{\,2} = \frac{1}{2(1 - k)\dfrac{2C^2Z^2}{1 + k}}$$

$$\therefore\ C = \frac{1}{2\omega_c Z}\sqrt{\frac{1 + k}{1 - k}} \quad \ldots \quad \ldots \quad (26)$$

From (25) and (26)

$$L = \frac{2Z^2}{1 + k}\cdot\frac{1}{2\omega_c Z}\cdot\sqrt{\frac{1 + k}{1 - k}}$$
$$= \frac{Z}{\omega_c\sqrt{1 - k^2}} \quad \ldots \quad \ldots \quad (27)$$

Reversed Circuit

The equations for this can be obtained from these for the normal circuit by replacing k by $-k$. Examination of these equations shows that the circuit is also a high pass filter, and that the phase shift varies from 180 deg. lead at the cut off frequency to zero at infinite frequency.

Summary of Design Equations

Normal Circuit	*Reversed Circuit*
$\omega_c = \sqrt{\dfrac{1}{2(1 - k)LC}}$	$\omega_c = \sqrt{\dfrac{1}{2(1 + k)LC}}$
or	or
$f_c = \dfrac{1}{2\pi\sqrt{2(1 - k)LC}}$	$f_c = \dfrac{1}{2\pi\sqrt{2(1 + k)LC}}$
$Z^2 = \tfrac{1}{2}(1 + k)\dfrac{L}{C}$	$Z^2 = \tfrac{1}{2}(1 - k)\dfrac{L}{C}$
If Z, ω_c and k are chosen :	
$C = \dfrac{1}{2\omega_c Z}\sqrt{\dfrac{1 + k}{1 - k}}$	$C = \dfrac{1}{2\omega_c Z}\sqrt{\dfrac{1 - k}{1 + k}}$
$L = \dfrac{Z}{\omega_c\sqrt{1 - k^2}}$	$L = \dfrac{Z}{\omega_c\sqrt{1 - k^2}}$

The reversed circuit therefore permits the use of smaller values of condenser, assuming the coupling factor k to remain the same.

Provided the correct value of C is used, the same performance from the point of view of cut off and impedance can be obtained from both circuits using the same inductances and coupling factor. The phase shift characteristics will however differ as can be seen by substituting equation (21) in equation (23) and comparing the resultant formula for the phase shift with the same formula with the sign of k reversed.

Correspondence

"The High Frequency Properties of Various Forms of Wire Specimens"

To the Editor, The Wireless Engineer.

SIR,—In the review, in the October issue, of my E.R.A. Report on "The High Frequency Properties of Various Forms of Wire Specimens" (Ref. M/T69) some observations were made which I venture to suggest may somewhat mislead as to the true facts of the situation. I might say at this point that the report in its original form, based on work carried out by me as a post-graduate student at the E.R.A. Laboratory, was submitted as a thesis of the University of London, before Möhring's article, though published, was available to me, whilst the work was begun previous to this publication.

In addition :

(1) The second method of measurement given in my report renders easy the substitution of different wire specimens and ensures that there is no undesirable discontinuity in the materials in which equality of current is assumed. The vacuojunction method of Möhring has not these advantages.

(2) Möhring's frequency limit appears to be about 100-150 Mc/s ; my range extended to 250 and 400 Mc/s. In interest of technique and content the difference is material.

(3) The decrease of A.C. resistance with longitudinal field at very high frequencies forms, I believe, a novel contribution as to the persistence of this effect, which is important in its theoretical interest and still more in its applications. The implications of the specific use of mumetal in this connection appear to have been overlooked.

(4) Arnold's formula was only used for interpolation and therefore the distinction between 0.25 and 0.26 in the constant term is irrelevant.

Finally, although the typographical errors are regrettable, they are outside my province and absent from my thesis.

Swanage, Dorset. G. G. SUTTON.

Wireless Patents

A Summary of Recently Accepted Specifications

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

DIRECTIONAL WIRELESS

536 485.—Direction finder in which a cathode-ray tube is used to indicate both the direction and "sense" of an incoming signal.

Marconi's W.T. Co.; C. S. Cockerell; and G. P. Parker. Application date, 25th March, 1939.

536 950.—Phase-shifting circuit for keying a radio-navigational system of the overlapping beam type.

Standard Telephones and Cables and W. L. McPherson. Application date 1st December, 1939.

537 089.—Radio-navigational system in which the D.F. and compass readings are correlated on a single cathode-ray indicator.

Marconi's W.T. Co. (assignees of D. G. C. Luck). Convention date (U.S.A.) 31st January, 1939.

537 118.—Direction-finding system in which two crossed frame aerials are alternatively coupled to a single vertical aerial to produce a "reversed cardioid" effect in the receiver.

Telefunken Co. Convention date (Germany) 6th December, 1938.

RECEIVING CIRCUITS AND APPARATUS

(*See also under Television*)

536 171.—Band-pass filter circuit including positive and negative resistances and a quarter-wave transmission-line coupling.

Marconi's W.T. Co.; N. M. Rust; J. D. Brailsford; and E. F. Goodenough. Application date 5th October, 1939.

536 412.—Tuning system with band-spreading on the short waves arranged to give equal accuracy of adjustment throughout the short-wave range.

Philips Lamps. Convention date (Germany) 13th October, 1938.

536 440.—Heterodyne wireless receiver in which a secondary-emission valve is used as a mixer, the grid-cathode circuit being tuned to the signal frequency and the secondary or target circuit to the local oscillations.

Philips Lamps. Convention date (Netherlands) 7th January, 1939.

536 450.—Automatic gain control system in which an auxiliary electrode in a valve is used to develop a voltage which is fed back negatively to control the signal output.

Marconi's W.T. Co. (assignees of T. M. Shrader). Convention date (U.S.A.) 12th November, 1938.

536 505.—Superhet receiver with permeability-tuning devices for maintaining a constant frequency difference between the signal and local-oscillator circuits.

Johnson Laboratories Inc. (assignees of D. V. Sinninger). Convention date (U.S.A.) 10th April, 1939.

TELEVISION CIRCUITS AND APPARATUS

FOR TRANSMISSION AND RECEPTION

536 436.—Saw-tooth oscillation-generator, particularly for television, comprising a pentode valve to which a cut-off bias is applied during the initial portion only of the retrace interval or back stroke.

Hazeltine Corporation (assignees of J. C. Wilson). Convention date (U.S.A.) 14th January, 1939.

536 453.—Single hard-valve circuit for generating saw-tooth oscillations of large amplitude particularly for driving the magnetic deflecting system of a cathode-ray tube.

Standard Telephones and Cables; D. S. B. Shannon; and P. K. Chatterjea. Application date 14th November, 1939.

536 588.—Means for discriminating between pulses of different durations but similar wave-form, particularly those used for scanning in television.

Standard Telephones and Cables and W. A. Beatty. Application date 17th November, 1939.

536 720.—Projection screen for television, made of transparent crystals which exhibit local opaqueness when scanned by the electron stream of a cathode-ray tube (addition to 513 776).

Scophony and A. H. Rosenthal. Application date 1st June, 1939.

536 803.—Oscillating system for scanning in television comprising a number of closely-adjacent mirrors arranged to oscillate about parallel axes.

Scophony; F. Okolicsanyi; and A. J. Gale. Application date 24th July, 1939.

537 119.—Time-base circuit for a television receiver with means for preventing distortion of the raster due to leakage inductance in the magnetic deflecting system.

Standard Telephones and Cables and W. A. Montgomery. Application date 7th December, 1939.

537 142.—Saw-tooth oscillation-generator producing impulses of rectangular wave-form, and of adjust-

able duration, particularly for transmitting television signals.

Standard Telephones and Cables ; R. M. Barnard ; and W. Kram. Application date 10th November, 1939.

TRANSMITTING CIRCUITS AND APPARATUS

(*See also under Television*)

536 963.—System of multiplex telephony in which periodical pulses are transmitted in each channel and modulation is effected by their partial or complete suppression.

Philips Lamps. Convention date (Germany) 3rd February, 1939.

537 076.—Modulating system in which the current is fed to the aerial through two or more amplifiers in different phases so as to maintain a constant output from each though the vectorial sum varies in amplitude with the applied signal.

Soc. Française Radio-Électrique. Convention dates (France) 2nd and 29th December, 1938 and 25th February, 1939.

537 091.—Multiplex telephony system in which the separate signals are transmitted simultaneously in the form of modulated impulses of the same frequency but displaced in time.

Philips Lamps. Convention date (Germany) 20th February, 1939.

CONSTRUCTION OF ELECTRONIC-DISCHARGE DEVICES

536 730.—Method of manufacturing a cathode-ray tube incorporating a fluorescent screen with secondary-emission properties.

R. H. Colborne. Application date 23rd November, 1939.

537 175.—Cathode-ray modifier or modulator in which an electrostatic field across the anode-cathode path is combined with a transverse electro-magnetic field to divert a portion of the electron stream to a collector anode.

L. J. Blumenthal and A. Perelmann. Application date 23rd October, 1939.

SUBSIDIARY APPARATUS AND MATERIALS

535 927.—Means for extending the effective volume range of a recording device of the telegraphone type.

Electrical Research Products Inc. Convention date (U.S.A.) 29th July, 1939.

535 961.—Radio altimeters, operating by the reception, after reflection from the ground, of a frequency-modulated signal.

Marconi's W.T. Co. (assignees of R. C. Sanders, Junior). Convention date (U.S.A.) 28th January, 1939.

536 042.—Signalling system in which electromagnetic waves, of a predetermined frequency, are used to produce a luminous indication.

E. Molina and D. Desmidt. Application date 4th March, 1940.

536 066.—Microphone with a highly-directional characteristic which is independent of frequency.

Marconi's W.T. Co. (assignees of H. F. Olson). Convention date (U.S.A.) 31st October, 1938.

536 100.—Method of feeding the rotary drum used for receiving facsimile signals.

Standard Telephones and Cables (communicated by G. Deakin). Application date 1st November, 1939.

536 126.—Interlock switching arrangement for a combined radio transmitter and receiver, particularly for use at aircraft stations.

Marconi's W.T. Co. and T. N. D. Phillips. Application date 27th February, 1940.

536 153.—Saw-tooth oscillation generator with automatic voltage regulation to ensure a long and linear working or scanning stroke.

Hazeltine Corporation (assignees of H. A. Wheeler). Convention date (U.S.A.) 13th February, 1939.

536 215.—Time-base circuit of the " self running " type with means to stabilise the charging time of the condenser against voltage fluctuations in the supply.

Standard Telephones and Cables ; D. S. B. Shannon ; and P. K. Chatterjea. Application date 18th August, 1939.

536 217.—Time-base circuit with means for ensuring linearity and for controlling the amplitude of the output wave without affecting its frequency.

Standard Telephones and Cables ; D. S. B. Shannon ; and P. K. Chatterjea. Application date 8th September, 1939.

536 229.—" Grounded-plate " amplifier arranged in push-pull for handling very high frequencies.

Marconi's W.T. Co. (assignees of J. W. Conklin and S. Gubin). Convention date (U.S.A.) 15th November, 1938.

536 284.—Tuned relay, responsive to a double signalling frequency, with an intervening time delay, for remote control systems.

R. M. A. Smith ; G. L. Woolnough ; D. R. Price ; and Metropolitan-Vickers Electrical Co. Application date 15th January, 1940.

536 292.—Stabilised direct-current amplifier, particularly for handling photo-electric currents without " drift " and suitable for use in facsimile signalling.

Marconi's W.T. Co. (assignees of M. Artzt). Convention date (U.S.A.) 7th October, 1938.

536 349.—Dry-contact bridge circuit for a frequency-changing circuit, or for a " third order " modulating system, particularly in connection with carrier-wave signalling.

Standard Telephones and Cables (assignees of R. O. Wise). Convention date (U.S.A.) 27th April, 1939.

536 375.—Method of cross coupling two screen-grid amplifiers, particularly for use as an interference suppressor.

Société Française Radio-Électrique. Convention date (France) 10th November, 1938.

536 538.—Thermionic amplifier circuit in which a constant gain is maintained, in spite of variations in the valve characteristics, by utilising an auxiliary and locally-derived " checking " circuit.

Radio Transmission Equipment and C. E. G. Bailey. Application date 24th November, 1939.

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

3219. OBSERVATIONS OF FREQUENCY-MODULATION PROPAGATION ON 26 MEGACYCLES [Simplified Analysis showing Distortion occurring with Two-Path Transmission consists of Introduction of New Modulation Frequency which is Frequency-Modulated and is Not Harmonically Related to Fundamental Modulation Frequency: Riverhead Observations from W9XA, Kansas City (1150 Miles)].—M. G. Crosby. (*Proc. I.R.E.*, July 1941, Vol. 29, No. 7, pp. 398–403.)

3220. FURTHER COMPARISONS OF METEOROLOGICAL SOUNDINGS BY RADIO WAVES WITH RADIOSONDE DATA [and the Effects of Water Vapour & Condensed Drops].—A. W. Friend. (*Bull. Am. Meteorol. Soc.*, Feb. 1941, Vol. 22, No. 2, pp. 53–59: Discussion pp. 59–61.)

For a previous report *see* 3728 of 1940. "By radiosonde comparisons and improved operating techniques it has been found possible to make the older equipment [7 of 1940: "older" in comparison with new apparatus not yet in regular use] yield many more data. . . . The weaker tropospheric radio-wave reflections from discontinuities in upper air regions are made observable only because of a continuous background of radio-wave pulse reflection [reflection coefficient around 10^{-6} to 10^{-7}] of sufficient magnitude to cause an observable rise in the interference background amplitude level. . . It is believed possible to detect ["in many cases before visible clouds are formed": *cf.* 964 of March] by means of radio-wave echoes the approximate heights of most cloud formations . . ." [especially of clouds formed by convection under a temperature-inversion boundary]. The wavelength used was 123 m. For another summary see *Sci. Abstracts*, Sec. B., Aug. 1941, Vol. 44, No. 524, pp. 161–162.

3221. THE EFFECT OF THE DIELECTRIC CONSTANT OF THE AIR ON THE FREQUENCY STABILITY OF OSCILLATING CIRCUITS [Investigation of Influence of Temperature, Relative Humidity, & Pressure on the Dielectric Constant].—Volpert. (*See* 3292.)

3222. MEASUREMENTS OF THE DELAY AND DIRECTION OF ARRIVAL OF ECHOES FROM NEAR-BY SHORT-WAVE TRANSMITTERS.—C. F. Edwards & K. G. Jansky. (*Proc. I.R.E.*, June 1941, Vol. 29, No. 6, pp. 322–329.) A summary was dealt with in 1292 of May.

3223. AN AUTOMATIC IONOSPHERE STATION.—F. Ya. Zaborshchikov, D. N. Krasnolobov, & A. I. Fomina. (*Elektrosvyaz* [in Russian], No. 1, 1941, pp. 18–30.)

A description of the equipment developed in Russia for automatic recording of the frequency/height characteristics of the ionosphere. Pulses of continuously varying frequency are radiated at a rate of 50 per second and the delay between the sending and receiving of the impulses is registered on a film by a cathode-ray oscillograph. The main characteristics of the equipment are as follows—(1) The frequency range is 1.5 to 15 Mc/s. (2) A complete frequency/height characteristic can be taken in 5 minutes. (3) The transmitter and receiver are synchronised by a common oscillator. (4) The output circuit of the transmitter serves also as the input circuit of the receiver. The equipment is described in detail, and several circuit diagrams are included. A station of this type has already been in regular service for six months.

3224. DISTRIBUTION OF ATMOSPHERIC OZONE [New Theory for Greater Amount of Ozone in Polar Regions & consequently in High-Level Currents of Polar Origin: Ozone Distribution as Index of Changes in Circulation].—O. R. Wulf. (*Bull. Am. Meteorol. Soc.*, Feb. 1941, Vol. 22, No. 2, p. 78: summary only.)

3225. Report of Cosmic Ray Observations made on the U.S. Antarctic Expedition in Cooperation with the Bartol Research Foundation.—S. A. Korff & E. T. Clarke. (*Journ. Franklin Inst.*, Nov. 1940, Vol. 230, No. 5, pp. 567–581.)

3226. Observational Clue to the Size of Meteors [Evidence in Favour of Relatively Large Size].—M. A. R. Khan. (*Nature*, 27th Sept. 1941, Vol. 148, p. 372.)

3227. Bright Meteor followed immediately by Auroral Display.—C. W. Gartlein. (*Sci. News Letter*, 2nd Aug. 1941, Vol. 40, No. 5, p. 72.)

3228. Cause of Night Glow of Sky is Magnetic Activity [Lick Observatory Measurements show Direct Relationship].—D. R. Barber. (*Sci. News Letter*, 2nd Aug. 1941, Vol. 40, No. 5, p. 78: *Science*, 25th July 1941, Vol. 94, Supp. p. 8.)

3229. Sunspot and Magnetic Storm of September 18th–20th.—(*Nature*, 27th Sept. 1941, Vol. 148, p. 368.)

3230. Six Periodic Fluctuations in Solar Constant [apparently Components of the 11-Year Sunspot Cycle].—Harvard University. (*Journ. Franklin Inst.*, Nov. 1940, Vol. 230, No. 5, p. 654: summary only.)

3231. Proposed Standard Solar-Radiation Curves for Engineering Use.—P. Moon. (*Journ. Franklin Inst.*, Nov. 1940, Vol. 230, No. 5, pp. 583–617.)

3232. The Solar Corona [with Special Attention to Edlén's Researches].—D. H. Menzel. (*Nature*, 13th Sept. 1941, Vol. 148, p. 312: summary only.) *See* also 2348 of September.

3233. The Abundances of Molecules in the Solar Reversing Layer.—R. H. Lyddane, F. T. Rogers, Jr., & F. E. Roach. (*Phys. Review*, 1st Aug. 1941, Vol. 60, No. 3, pp. 281–282.)

3234. Propagation of Radio Waves round the Earth [General Account].—T. L. Eckersley. (*Nature*, 27th Sept. 1941, Vol. 148, pp. 364–366.)

3235. The Effect of the Earth's Curvature on Ground-Wave Propagation.—G.W.O.H: Burrows & Gray. (*Wireless Engineer*, Oct. 1941, Vol. 18, No. 217, pp. 393–395.) Editorial on the paper dealt with in 1834 of July.

3236. Wave Propagation over Two Parallel Wires: the Proximity Effect—Inductance.—C. M. Hebbert. (*Bell S. Tech. Journ.*, July 1941, Vol. 20, No. 3, pp. 325–330.) Appendix to a paper on the "Transmission Characteristics of Toll Telephone Cables at Carrier Frequencies."

3237. Angular Distribution of Light scattered in Liquids [Centres scatter in Manner of Particles small compared with λ, with Additional Scattering independent of Direction & of Polarisation State].—L. H. Dawson & E. O. Hulburt. (*Journ. Opt. Soc. Am.*, Aug. 1941, Vol. 31, No. 8, pp. 554–558.)

3238. The Measurement of the Refracting Power of Absorbing Liquids.—H. Littmann. (*Physik. Zeitschr.*, 1st Oct. 1940, Vol. 41, No. 19, pp. 442–447.)

A previous paper (30 of January) derived theoretically and experimentally the intensity characteristic of light reflected from an absorbing medium, and showed the likelihood that the measurement of the refracting power of such a medium by means of total reflection would be subject to systematic errors. This point is investigated in the present paper by means of two methods of measuring the refracting power which are unaffected by absorption.

3239. Scattering of Light by Pigment Particles [and the Derivation of an Empirical Equation for Scattering as Function of Particle Size, over Wide Range of Sizes & Indices of Refraction].—D. H. Clewell. (*Journ. Opt. Soc. Am.*, Aug. 1941, Vol. 31, No. 8, pp. 521–527.)

3240. Penetration of Fog by Light from Sodium and Tungsten Lamps.—M. Luckiesh & L. L. Holladay. (*Journ. Opt. Soc. Am.*, Aug. 1941, Vol. 31, No. 8, pp. 528–530.)

3241. A New Experiment on the Interference of Diverging Light Rays [Limitations of Fresnel's Two-Mirror Arrangement avoided by Use of Mica Sheet, giving Patterns on Large Screen].—R. W. Pohl. (*Physik. Zeitschr.*, 15th Nov. 1940, Vol. 41, No. 21/22, pp. 498–499.)

3242. On the Phenomenon of "Fringes" in a Purely Corpuscular Theory of Light.—S. T. Serghiesco. (*Journ. Opt. Soc. Am.*, Aug. 1941, Vol. 31, No. 8, pp. 550–554.) For previous work *see* 1529 of May.

3243. The Velocity of Acoustical and Electromagnetic Waves [Refutal of Stratton's Objection to Einstein's Second Postulate (*c* Independent of Motion of Source) by Consideration of Doppler Effect, etc.].—G.W.O.H. (*Wireless Engineer*, July 1941, Vol. 18, No. 214, pp. 265–266.) Criticism of views in "Electromagnetic Theory" (1819 of July).

3244. A New Way of Measuring the Velocity of Light.—R. A. Houstoun. (*Proc. Roy. Soc. Edinburgh*, Sec. A, Part 1, Vol. 61, 1941, pp. 102–114.) *See* 42 of 1939. The quartz plate, oscillating in a 100 Mc/s field, acts as an intermittent grating to light passing through it, parallel to the optical axis.

ATMOSPHERICS AND ATMOSPHERIC ELECTRICITY

3245. Cathode-Ray-Oscillographic Investigation of a Lightning Stroke [Records of Two Strokes whose Effects are Known (" Cold " Lightning splitting Tree, No Burning : " Hot " Lightning with Fatal Effect & Burning : Influence of Duration of Main Discharge : Implications for Protective Devices].—H. Norinder. (*E.T.Z.*, 10th July 1941, Vol. 62, No. 28, pp. 617–621.)

3246. Thunderstorm Problems [Summary of Discussion].—F. J. W. Whipple. (*Nature*, 13th Sept. 1941, Vol. 148, pp. 305–307.)

3247. " Physics of the Air " [Book Review].—W. J. Humphreys. (*Proc. Phys. Soc.*, 1st Sept. 1941, Vol. 53, Part 5, No. 299, pp. 624–625.) For a paper by the same writer *see* 2915 of 1940.

3248. Formation of Cloud and Rain [Survey], *and* Sea-Salt and Condensation Nuclei.—G. C. Simpson. (*Sci. Abstracts*, Sec. A, Aug. 1941, Vol. 44, No. 524, p. 225 : p. 225.)

3249. Turbulence and the Growth of Cloud Drops.—D. Arenberg. (*Sci. Abstracts*, Sec. A, Aug. 1941, Vol. 44, No. 524, p. 225.)

3250. Grounding Electric Circuits Effectively: Part III—Ground System Requirements.—J. R. Eaton. (*Gen. Elec. Review*, Aug. 1941, Vol. 44, No. 8, pp. 451–456.)

3251. Electrets made from Dry-Mixed Components, *and* Effect of Pressure on the Surface Charge of an Electret.—W. J. Dodds & J. D. Stranathan : G. E. Sheppard & J. D. Stranathan. (*Phys. Review*, 15th Aug. 1941, Vol. 60, No. 4, p. 360 : pp. 360–361.) For previous work on electrets *see* 1961 of 1940 and back reference.

PROPERTIES OF CIRCUITS

3252. A Stabilised Frequency Divider [for Frequency-Measuring Equipment, Wire-Line Carrier Systems, etc : Relaxation Oscillator stabilised by Selective Feedback, and synchronised as Frequency Divider at High Orders of Division : High Degree of Independence of Operating Conditions : etc.].—G. Builder. (*Proc. I.R.E.*, April 1941, Vol. 29, No. 4, pp. 177–181.)

3253. Theory and Application of Resistance Tuning [Special Suitability of Transitron (Reverse-Transconductance) Oscillator (2296 of 1939) : Frequency Variations of 50 : 1 if Good Wave-Form is Not Essential : Linear R/f Relation for 1.5 : 1 Variation (with Resistance Change in Both Arms) : Applications to Laboratory Oscillator, Frequency-Modulation, & Industrial (Temperature, Pressure, Humidity, etc.) Measurements].—C. Brunetti & E. Weiss. (*Proc. I.R.E.*, June 1941, Vol. 29, No. 6, pp. 333–344.)

3254. Measurements of Shot and Thermal Noise : the Linear Rectifier as Indicator.—Bell. (*See* 3353.)

3255. Errors in the Calibrated Losses of Symmetrical Resistance Networks [with Equations & Curves for Corrections when Terminations differ from Assumed Values].—A. W. Melloh. (*Proc. I.R.E.*, July 1941, Vol. 29, No. 7, pp. 387–390.)

3256. Regulating Methods in Controllable Electrical Systems and the Criteria for Their Stability [Theoretical Investigation with Practical Conclusions : the Conflicting Demands of Precise Regulation and Short Regulating Time, in Direct & Indirect Control Methods : the Advantages of a Combined Method : etc.].—W. Artus. (*E.N.T.*, Oct. 1940, Vol. 17, No. 10, pp. 231–244.)

3257. The Crosley Contrast Expander : an Analysis of the Circuit [Bridge Circuit with Two Metal-Filament Lamps].—Amos. (*See* 3396.)

3258. The Solution of A.C. Circuit Problems [Method using Matrix Multiplication].—Pipes. (*See* 3554.)

3259. The Response of Electrical Networks to Non-Sinusoidal Periodic Waves [Direct Method of Attack yielding Accurate Equation of Final Current Shape].—N. Marchand. (*Proc. I.R.E.*, June 1941, Vol. 29, No. 6, pp. 330–333.)

3260. Natural and Resonant Frequencies of Coupled Circuits.—G.W.O.H. (*Wireless Engineer*, June 1941, Vol. 18, No. 213, pp. 221–223.)

Extension of writer's previous method (*Elec. World*, 1916) to study of resonant frequencies when one circuit only is excited : for low resistances there are 3, including the antiresonance (rejector resonance) frequency : this remains unchanged as the resistances are progressively increased, while the other two approach, coalesce, and vanish : the surviving frequency is no longer that of rejector resonance but of acceptor resonance.

3261. Coupling Circuits as Band-Pass Filters : Parts I, II, & III [Television & Other Techniques demand Precision Method of Design, provided by Straight Filter Theory : Formulae for Double - Parallel, Single - Parallel, & Series-Parallel Tuned Mutual Coupling Circuits, Tapped-Inductance Circuit, etc : Design Charts].—E. K. Sandeman. (*Wireless Engineer*, Sept., Oct., & Nov. 1941, Vol. 18, Nos. 216, 217, & 218, pp. 361–367, 406–415, & 450–454.) For the final part *see* this issue (December).

3262. Undercoupling in Tuned Coupled Circuits to realise Optimum Gain and Selectivity.—Adams. (*See* 3310.)

3263. A Coaxial Filter for Vestigial-Sideband Transmission in Television.—Salinger. (*See* 3411.)

3264. CONCENTRIC LINES AS BAND-PASS FILTERS: NEW DEVELOPMENTS.—R.C.A. Laboratories. (*E. & Television & S-W.W.*, Jan. 1941, Vol. 14, No. 155, p. 28.)

3265. A BAND FILTER WITH VERY STEEP ATTENUATION RISE AT ONE FLANK [Combination of Quartz Filter & Input Network].—H. Rupp. (*E.N.T.*, Dec. 1940, Vol. 17, No. 12, pp. 275–280.)

Primarily for the distortion-measuring equipment dealt with in 3400, below, but of interest also for high-fidelity carrier systems (for broadcast programmes, etc.). It has an attenuation rise of 6.3 nepers in an interval of 35 c/s at the lower cut-off frequency of 49.5 kc/s, and a pass-band of 20 kc/s.

3266. STRAY CAPACITANCES: THEIR INFLUENCE ON THE EFFECTIVE INDUCTANCE OF A COIL IN A METAL CONTAINER [measured by Resonance Method and Unbalanced & Balanced Transformer Bridge Methods, for Various Connections of Metal Container: Effects in Constant-*K* Band-Pass & Band-Pass Crystal Lattice Filters, and Methods of Overcoming Them].—L. I. Farren & R.S. Rivlin. (*Wireless Engineer*, Aug. 1941, Vol. 18, No. 215, pp. 313–323.) From the G.E.C. laboratories.

3267. THE BAND-PASS EFFECT [Transformation of Low-Pass & High-Pass Sections into Band-Pass "Ampli-Filters," in Certain Conditions]: ITS NATURE IN ELECTRIC WAVE-FILTERS TERMINATED IN NEGATIVE IMPEDANCE.—S. P. Chakravarti. (*Wireless Engineer*, March 1941, Vol. 18, No. 210, pp. 103–111.) Further development of the work dealt with in 1720 of 1936, 3495 of 1938, and 51 of January (for later work *see* 1032 of April).

3268. THE FOUNDATIONS OF FILTER THEORIES, AND THEIR APPLICATIONS.—H. Epheser & H. Glubrecht. (*E.N.T.*, Aug. 1940, Vol. 17, No. 8, pp. 169–192.)

It is understandable that the practical engineer may find even Piloty's comprehensive papers (2477 of 1937 and 2226 of 1938) too mathematical for him, but even the admirably practical work of Jacoby & Schmidt ("Reactance Quadripole as Filter": *Siemens-Veröff. a.d. Nachrichtentech.*, Vol. 2, 1932, p. 279 onwards) did not lead to a wide spreading of filter theory. This is probably because the technician loses interest when a treatment becomes too full and complicated and the particular application he has in his mind is obscured. The writers have set out to produce a complete and unified presentation of the fundamentals which shall be comprehensible without previous acquaintance with the subject and which shall serve as an easy path to the utilisation of Cauer's important papers and books (20 references are given to these, many of which have been dealt with in past Abstracts: *see* for example 1932 Abstracts, p. 537—a paper in English which is marked as specially important; 1613 of 1935; 3915 of 1939; 2539 of 1940. For later papers, not mentioned, *see* 1627 of June and 3017 of November).

Part A of the present paper deals with the properties of the linear network and the dipole, Part B with quadripoles. Part C gives a development of filter circuits by Cauer's method (including both the Tschebyscheff and Jaumann methods of determining the parameters: *see* 1933 Abstracts, p. 443, and back references). Part D deals with the actual carrying out of the design of appropriate circuits, and with the effects of matching errors and losses: an appendix gives a proof of the reactance law.

3269. CANONICAL NETWORK CIRCUITS FOR REACTANCE QUADRIPOLES WITH PREDETERMINED CHARACTERISTICS.—H. Piloty. (*T.F.T.*, Sept., Oct., & Nov. 1940, Vol. 29, Nos. 9, 10, & 11, pp. 249–258, 279–290, & 320–325.) For earlier work *see* 959 (and 958) of 1940, and *cf.* 3272, below.

3270. ON THE THEORY OF INSERTION LOSSES.—E. V. Zelyakh. (*Elektrosvyaz* [in Russian], No. 1, 1941, pp. 62–68.) A number of practical problems concerning insertion losses in complex circuits are presented in the shape of five theorems, the proofs of which are given.

3271. STANDARDISED CURVE TABLES FOR THE CALCULATION OF THE WAVE TRANSMISSION EQUIVALENTS OF BAND-PASS FILTER SECTIONS [*m*-"T" and *m*-"Pi" Sections of Zobel Band-Pass Network: Band-Pass "X" Section of Series Oscillatory Circuits, and of Parallel].—R. Feldtkeller. (*T.F.T.*, July 1940, Vol. 29, No. 7, pp. 201–206.)

3272. THE CALCULATION OF FILTER CIRCUITS FROM THEIR OPERATIVE ATTENUATION.—R. Feldtkeller & W. Rheinhard. (*T.F.T.*, Nov. 1940, Vol. 29, No. 11, pp. 313–320.)

"For a low-pass X-circuit with two attenuation peaks in the suppression region, and for the filter circuits derived from this by equivalence considerations and simple frequency transformations the circuit elements are calculated in an elementary, partly graphical method from the requirements of the operative attenuation": the method of Piloty (959 of 1940 [*see* also 958]) is considered to be too complicated mathematically for the practical man.

3273. OPERATIVE TRANSMISSION EQUIVALENT [Betriebsmass] AND ECHO EQUIVALENT OF SYMMETRICAL LOSS-FREE QUADRIPOLES [Establishment of Relation, with Help of Reactance Angle: Graphical Representation, leading to Determination of Operative Attenuation & Echo Attenuation (due to Reaction of Quadripole on Transmitter through Its Impedance): etc.].—R. Feldtkeller. (*T.F.T.*, Nov. 1940, Vol. 29, No. 11, pp. 339–341.)

3274. BUILDING-UP PROCESSES IN OSCILLATORY CIRCUITS [Treatment applicable to Exploring-Note Sound Analysis, Amplifiers with Several Mutually Detuned Circuits, etc.].—Feldtkeller. (*See* 3417.)

3275. SOME NOTES ON LINEAR AND GRID-MODULATED RADIO-FREQUENCY AMPLIFIERS.—Terman & Buss. (*See* 3298.)

3276. High-Gain Wide-Pass-Band Amplifier Design [for Minimum Number of Valves: by Use of Couplings with Complementary Frequency-Response Curves], *and* Neutralising Wide-Band Amplifiers.—R.C.A. Laboratories. (*E. & Television & S-W.W.*, Jan. 1941, Vol. 14, No. 155, pp. 12–14: Feb. 1941, No. 156, pp. 84 and 86.)

3277. Eliminating Peaks in Amplifier Response Curves.—R.C.A. Laboratories. (*See* 3418.)

3278. Valve Admittance Correction Circuits [for Neutralisation of Negative Input Conductances arising at Ultra-High Frequencies].—R.C.A. Laboratories. (*E. & Television & S-W.W.*, May 1941, Vol. 14, No. 159, p. 208.)

3279. Reducing Phase Shift in Negative-Feedback Amplifiers [by Sandwiched Tertiary Winding for Feedback Voltage, giving Tight Coupling & Reduced Leakage Inductance].—R.C.A. Laboratories. (*E. & Television & S-W.W.*, Feb. 1941, Vol. 14, No. 156, p. 75.)

3280. Equivalent Circuits of the Feedback Amplifier ["Constant Voltage" & "Constant Current" Equivalent Circuits of Simple Amplifier, of Proved Utility, re-drawn for Feedback Amplifier by Artifice of replacing Forward & Feedback Paths by Equivalent Forward Path utilising a Hypothetical Valve: Application to Cathode-Coupled Amplifier].—A. Fairweather. (*Wireless Engineer*, April 1941, Vol. 18, No. 211, pp. 151–153.)

3281. The Theory of Self-Balancing Phase-Inversion Circuits.—A. A. Rizkin. (*Elektrosvyaz* [in Russian], No. 1, 1941, pp. 39–46.)

Phase-inversion circuits used for the transition from single-valve to push-pull operation are discussed, and the defects of the self-balancing circuit described by Lorenzen (Fig. 1: *see* 1431 of 1939) are pointed out. A symmetrical self-balancing circuit (Fig. 2) which is free from these defects is proposed by the author. The main feature of this circuit is the introduction of a negative feedback to the main branch of the push-pull circuit. The operation and design of this, and of the more general circuit with independent feedback to both valves (Fig. 4), are discussed. A symmetrical self-balancing circuit in which the source of excitation can be earthed is also considered. The discussion is illustrated by numerical examples, and in conclusion a few critical remarks are made on the circuit (Fig. 7) proposed by Terman & others (64 of 1940), which came to the author's knowledge after this paper had been completed.

3282. A New Type of Direct-Current Amplifier [for Measuring & Control Purposes].—Eberhardt, Nüsslein, & Rupp. (*See* 3588.)

3283. Non-Linear Distortion in Amplifier Valves and Low-Frequency Transformers.—Kettel. (*See* 3357.)

3284. Load Currents in Transformers with Several Secondary Windings [as in Mains Units for Wireless Apparatus: Dependence of Current in One Winding on Load on Another (Development of Formulae): Determination of Constants by Open-Circuit & Short-Circuit Measurements: Example].—H. H. Wolff. (*E.N.T.*, Sept. 1940, Vol. 17, No. 9, pp. 209–213.)

3285. The Design of the Universal Winding [for Max. Inductance in Min. Volume].—Hershey. (*See* 3460.)

3286. Reducing Loss in H.F. Couplings [*e.g.* between Balanced Two-Wire Line and Earthed, Unbalanced Concentric-Line Resonator].—R.C.A. Laboratories. (*E. & Television & S-W.W.*, Jan. 1941, Vol. 14, No. 155, pp. 31–32.)

3287. The Calculation of Capacitances for Cables of Simple Cross Section [Comparison of Methods used by Breisig, Kaden (Electrical Images: 68 of 1936 and 1879 of 1937), Kaden (Potential of Line Multiple Sources), & Meinke (3081 of 1940)].—F. Sommer. (*E.N.T.*, Dec. 1940, Vol. 17, No. 12, pp. 281–294.) For previous work *see* 4070 of 1939.

3288. Circuit-Designation Method [New System of Circuit-Wiring Representation showing Paths of Various Types of Current].—O. H. Caldwell. (*Proc. I.R.E.*, May 1941, Vol. 29, No. 5, pp. 289–290.)

TRANSMISSION

3289. The Generation of High Powers on Short Waves [10 m: 220 W Output for 850 W Input] with Quenched Spark Gaps.—W. Schönfeld. (*E.T.Z.*, 26th June 1941, Vol. 62, No. 26, p. 598: summary of 1938 Dresden Dissertation.)

A ten-gap discharger is used: it has in parallel with it an auxiliary *LC* circuit (450 kc/s in the best conditions), every half-wave of which shock-excites the short-wave circuit afresh. Conditions for the best results are given.

3290. Beam Power Tetrodes as Negative-Resistance Oscillators.—H. L. Krauss. (*Proc. I.R.E.*, March 1941, Vol. 29, No. 3, p. 141: summary only.)

3291. The Pierce Piezoelectric Oscillator: Analysis for the Design of Crystal- and Line-Controlled Apparatus.—Jefferson. (*See* 3439.)

3292. The Effect of the Dielectric Constant of the Air on the Frequency Stability of Oscillating Circuits.—A. R. Volpert. (*Elektrosvyaz* [in Russian], No. 1, 1941, pp. 31–38.)

It is pointed out that the frequency stability of an oscillating circuit is affected by the humidity of the air no less than by temperature, the humidity acting (a) directly by changing the dielectric constant ϵ of the air, and (b) indirectly by affecting the properties of the insulating materials. Changes occurring under heading (a) only are dealt with in the present paper.

Formula 8 is derived for determining $\epsilon - 1$ of humid air. In this formula p is the total pressure of the air and water vapour (in mm Hg), T the absolute temperature, and $k = e/p$, where $e = p_2$, the water-vapour pressure. A family of curves $\epsilon - 1$ calculated from (8) for different temperatures and relative humidities g is shown in Fig. 1. In Fig. 2 experimental curves are plotted showing the variation of t (in degrees C), g, and q (absolute humidity) with time in a thermostatic oven, and also a calculated curve $\epsilon - 1$. A modified formula (13) is then derived in which k is replaced by $gE/100\,p$ (from eqn. 10): this gives $\epsilon - 1$ in terms of T, g, p, and E (saturated vapour pressure at a given temperature). Using this formula, the effects of t, g and p on ϵ are investigated separately by determining the corresponding coefficients of ϵ, *i.e.* relative increases in ϵ for a unit change in each of the above factors. Formulae 14, 15, and 16 for calculating these coefficients are derived, and curves are plotted in Figs. 3, 5, and 6 showing their variation with t.

Curves showing the variation of the temperature coefficient at various constant temperatures when g is varied are also plotted (Fig. 4). The effect of altitude on ϵ is also investigated, and it is shown that for a change of $\pm$ 100 m ϵ is changed by $\mp 9 \times 10^{-6}$.

The curves prove that humidity may affect considerably the frequency of an oscillating circuit, and it is therefore suggested that deliquescent materials, such as calcium chloride, should be used in thermostatic ovens.

3293. Effect of Temperature on Frequency of 6J5 Oscillator [for Television & F.M.].—(*See* 3303.)

3294. Drift Analysis of the Crosby Frequency-Modulated Transmitter Circuit [Crosby A.F.C. Circuit, with Proper Attention to Design and Choice of Frequency Multiplications, provides Stability of Same Order as Crystal: etc.].—E. S. Winlund. (*Proc. I.R.E.*, July 1941, Vol. 29, No. 7, pp. 390–398.)

3295. A Note on Amplitude, Phase, and Frequency Modulation [Mathematical Analysis & Vector Diagrams].—H. D. Bickley. (*P.O. Elec. Eng. Journ.*, April 1941, Vol. 34, Part I, pp. 42–45.)

3296. Theory and Application of Resistance Tuning [Special Suitability of Transitron Oscillator: Applications to Laboratory Oscillator, Frequency-Modulation, etc.].—Brunetti & Weiss. (*See* 3253.)

3297. The Solution of Unsymmetrical-Sideband Problems with the Aid of the "Zero-Frequency Carrier" [with Combined Amplitude & Angle Modulation, a Concept derived from Consideration of the "Vector Envelope": Solution yields directly the Modulation Envelope of Output Signal].—H. A. Wheeler. (*Proc. I.R.E.*, Aug. 1941, Vol. 29, No. 8, pp. 446–458.)

3298. Some Notes on Linear and Grid-Modulated Radio-Frequency Amplifiers.—F. E. Terman & R. R. Buss. (*Proc. I.R.E.*, March 1941, Vol. 29, No. 3, pp. 104–107.) A summary was dealt with in 3794 of 1940.

3299. The Measurement of Modulation Depth [Method comparing Modulation Amplitude with Mean Carrier Amplitude, Electrically, before applying Result to Indicating Circuit: applied in Peak Programme Meter for B.B.C. Monitoring].—H. D. McD. Ellis. (*Wireless Engineer*, March 1941, Vol. 18, No. 210, pp. 99–102.)

3300. The Measurement of Modulation in Carrier Amplifiers.—J. P. Kinzer. (*Bell Lab. Record*, Aug. 1941, Vol. 19, No. 12, pp. 374–378.)

Particularly for the modulation product $2P - Q$, which is usually in phase for all the amplifiers in tandem, so that the total power is proportional to the square of the number of amplifiers.

3301. Half-Wave Modulation [Intelligibility of Speech Not Seriously Depreciated by Transmission of One Half Only of Wave-Form: for Given Communication Requirement, limited in Range by Effect of Noise on Intelligibility, Design of Transmitter to transmit Half the Speech Wave gives 44% Saving in Power, 17% in Peak Emission, & Omission of Much Apparatus].—C. E. G. Bailey. (*Wireless Engineer*, July 1941, Vol. 18, No. 214, pp. 279–282.)

RECEPTION

3302. Diode as Rectifier and Frequency-Changer [Usefulness of Diode as Frequency-Changer when Transit-Time Effects would be Troublesome in Multi-Electrode Valves: etc.].—Bell. (*See* 3343.)

3303. Effect of Temperature on Frequency of 6J5 Oscillator [Compensation of Frequency Drift during Warming-Up Period: for Television & F.M.].—(*Sci. Abstracts*, Sec. B, Aug. 1941, Vol. 44, No. 524, p. 163.) From *Radiotronics, Bull. No.* 110.

3304. Temperature and Frequency-Drift [Observations on a Television Receiver].—R.C.A. Laboratories. (*E. & Television & S-W.W.*, April 1941, Vol. 14, No. 158, pp. 182–183.)

3305. Vibrator Units with Ultra-High-Frequency Receivers [Suitability of "Vibrapacks"].—S. L. Robinson. (*E. & Television & S-W.W.*, Feb. 1941, Vol. 14, No. 156, p. 96.)

3306. Improvements in B-Battery Portability [Package Size per Unit of Capacity reduced by about 50%: Design of "Minimax" Types].—H. F. French: Ever-Ready Company. (*Proc. I.R.E.*, June 1941, Vol. 29, No. 6, pp. 299–303.) *See* also 1062 of April.

3307. Safety Requirements for Mains-Operated Wireless Apparatus [Notice of Specification B.S. 415–1941].—British Standards Institution. (*Wireless Engineer*, May 1941, Vol. 18, No. 212, p. 197.)

3308. Receiver Aerial Coupling Circuits.—Sturley. (*See* 3334.)

3309. Measurement of Loop-Antenna Receivers.—Swinyard. (*See* 3450.)

3310. Undercoupling in Tuned Coupled Circuits to realise Optimum Gain and Selectivity [Mathematical Analysis to obtain Optimum Coupling in Practical Design of I.F. Transformers for Superheterodyne Receivers: Existence of a Non-Critical Optimum Coupling below the Critical Value].—J. J. Adams. (*Proc. I.R.E.*, May 1941, Vol. 29, No. 5, pp. 277–279.)

3311. D.C. Amplified A.V.C. Circuit Time Constants [Examination of Statement (Kellogg & Phelps, 2100 of 1937) that Total Time Constant of Two *RC* Circuits separated by a Valve is Sum of Individual Time Constants: Influence of Comparative Values of These: Practical Errors due to Variations of Valve Slope Resistance & Amplification Factor: a More Correct Formula].—K. R. Sturley & F. Duerden. (*Wireless Engineer*, Sept. 1941, Vol. 18, No. 216, pp. 353–360.)

3312. Some Novel Automatic-Frequency-Control Circuits [especially the Use of Thyrite Resistances], *and* Improved Discriminator Circuit for Automatic Frequency Control.—Anon: R.C.A. (*E. & Television & S-W.W.*, Feb. 1941, Vol. 14, No. 156, pp. 82 and 84: March 1941, No. 157, p. 141.)

3313. Further Notes on Ganging Superheterodyne Receivers [Derivation of Formulae for Direct Calculation of Circuit Components & Fault Factor: with Curves for Quantities involved].—M. Wald. (*Wireless Engineer*, April 1941, Vol. 18, No. 211, pp. 146–150.) Further development of the work dealt with in 1839 of 1940.

3314. The Superheterodyne Receiver as a Source of H.F. Interference.—R. Moebes. (*T.F.T.*, July 1940, Vol. 29, No. 7, pp. 196–199.)

Most modern broadcast receivers employ an i.f. between 468 and 475 kc/s (but *see* later) and the oscillator frequency is by that amount higher than the signal frequency. The amplitude of the oscillator-frequency oscillations varies according to the mixing valve used, the frequency, and the supply voltages, and ranges between 5 and 15 V_{eff}. The amplified i.f. voltage at the rectifier is generally also around 10 v. Such voltages demand a careful screening of the oscillatory circuit, particularly the coils, if a radiation of these frequencies is not to occur and cause effects in the receiver itself or in neighbouring receivers. The metal cases employed in commercial receivers are out of the question for broadcast receivers using the cabinet as their loudspeaker baffle, and in practice the ordinary receiver of this type allows the heterodyning and i.f. oscillations to be detected (by a small frame and a sensitive receiver) in its immediate neighbourhood; in certain cases, probably as the result of resonance effects, the i.f. radiation may interfere with neighbouring sets. As a rule, however, the direct radiation does not have this effect, even when, to save metal, the metal of the chassis is replaced by a synthetic material. The screening cans of the oscillator and band-filter circuits ought not, however, to be dispensed with.

But more serious than the direct radiation is the possibility of the action of the oscillator circuit on the input circuit, by which voltages of the heterodyning frequency may appear at the aerial terminals and cause interference. Such action may be direct (when the design is unfortunate and the components' screening inadequate) or through the mixing valve: for the majority of receivers still have no h.f. input stage, and even those that have an input band-filter usually convert this, on the short-wave band, into a simple circuit. The magnitude of the heterodyning voltages likely to be thus produced at the input-circuit terminals through the mixing valve is here examined theoretically and, on certain assumptions, found to be 7–10 mv on the medium band, 2–3 mv on the long waves, and as much as 75 mv on the short. The direct action of the oscillator circuit on the input circuit is likely to add still more: confirmatory tests on a number of 6- and 7-circuit receivers showed good agreement with theory on the medium and short waves (suggesting that here the indirect action is predominant) but gave values much higher than those calculated on the long waves where, presumably, the direct action is more serious: the measured voltages ranged from 20–30 mv and even, in certain cases, to 80 mv. Seven-circuit sets with band-filter input on the medium and long waves gave voltages usually under 1 mv; but on the short waves, as predicted above, they yielded values around 100 mv.

The remainder of the paper discusses the effects of these voltages in actual practice, particularly with community-aerial systems; the comparatively small number of complaints received seems to require explanation, and some suggestions are made. Among these, it is pointed out that with the usual i.f. of about 470 kc/s most of the heterodyning frequencies lie outside the broadcast band: lately, however, certain receivers have been brought out with an i.f. of about 129 kc/s, and here the danger of interference is increased in more than one way: this was confirmed by experiment. The general conclusion reached is that as the superheterodyne receiver becomes more widely used, the short-wave band becomes more popular, and community-aerial systems are extended to deal with it, this type of interference will increase in seriousness: steps should therefore be taken now to reduce its dangers.

3315. Ultra-Short-Wave Anti-Static Aerials [for Near-By Interference (*e.g.* Ignition)].—R.C.A. Laboratories. (*See* 3327.)

3316. Compulsory [Ignition] Interference Suppression [Letter urging Suitability of Present Moment for Its Introduction].—(*Wireless World*, Oct. 1941, Vol. 47, p. 268.) *Cf.* Morgan, *Elec. Review*, 24th Oct., p. 433.

3317. Interference Problems in Fluorescent Lighting [Interference (originating chiefly at Cathode) arrives by Direct Radiation from Bulb, from Power Line, and by Propagation over Common Line: Noise Frequencies: Suppression].—E. S. Mills & J. H. Campbell. (*Proc. I.R.E.*, March 1941, Vol. 29, No. 3, p. 141: summary only.)

3318. Progress in the Development of Instruments for Measuring Radio Noise [with 21 Literature References].—C. M. Burrill. (*Proc. I.R.E.*, Aug. 1941, Vol. 29, No. 8, pp. 433–442.)

Including the Burrill-Morgan logarithmic-scale peak-reading meter RCA TMV-141A, with excellent performance. It is suggested that indicators of the rapid-response/slow-recovery type should be called "quasi-peak" indicators: "a thorough and well-planned programme of research ought to be undertaken by someone," to determine the time constants for these indicators more directly and promptly so as to arrive at the best values for them. For previous work *see* 1356 of May.

3319. "Hilfsbuch für Rundfunkentstörer" [Text Book for Interference-Suppressing Technicians: Book Review].—W. Schulz. (*T.F.T.*, Aug. 1940, Vol. 29, No. 8, p. 248.) Published for the German P.O.

3320. The Use of Headphones with Communication Receivers. — (*E. & Television & S-W.W.*, March 1941, Vol. 14, No. 157, p. 105.)

3321. Servicing Equipment and Its Uses: Part IV—Special Tools and Appliances. (*Wireless World*, Oct. 1941, Vol. 47, No. 10, pp. 265–267.)

3322. A Five-Band Receiver for Automobile Service.—Little & Rettenmeyer. (*See* 3543.)

3323. Aviation Portable [" Learavian " Receiver covering Aeronautical & Medium-Wave Broadcast Frequencies, with Intercommunication 'Phone System]. — (*Wireless World*, Oct. 1941, Vol. 47, No. 10, p. 251.)

3324. Scott High-Fidelity Receivers.—E. H. Scott. (*Proc. I.R.E.*, June 1941, Vol. 29, No. 6, pp. 295–299.)

3325. European Listeners [Note on Recent U.I.R. Synoptic Chart].—(*Wireless World*, Oct. 1941, Vol. 47, No. 10, p. 258.)

AERIALS AND AERIAL SYSTEMS

3326. The Approximate Representation of the Distant Field of Linear Radiators [Résumé of General Theory: Field of a Conducting Thread: Equivalent Length of a Conducting Thread: " Effective Length " of a Driven Antenna (Approximate Formulae obtained from Leading Term in Fourier Series): Distant Field of Two Crossed Antennas (as in " Turnstile " U.H.F. Aerial): etc.].—R. King. (*Proc. I.R.E.*, Aug. 1941, Vol. 29, No. 8, pp. 458–463.)

3327. Ultra-Short-Wave Anti-Static Aerials [Signals on Horizontal Aerial vary approx. Linearly with Height above Ground: Near-By Interference (*e.g.* Ignition) practically Constant over Wide Variation of Height: System of Two Aerials, One close to Ground, Other Raised, with Outputs Opposed].—R.C.A. Laboratories. (*E. & Television & S-W.W.*, April 1941, Vol. 14, No. 158, pp. 183 and 187.)

3328. The Behaviour of Wide-Band Cables with Styroflex Insulation in the Decimetric-Wave Band.—H. Kaufmann. (*T.F.T.*, Nov. 1940, Vol. 29, No. 11, pp. 325–326.)

Up to a few Mc/s, the attenuation characteristic of such cables depends almost entirely on resistance loss, which is here proportional to the square root of the frequency: but since the leakance loss increases about in proportion to the frequency, at extremely high frequencies it must finally exceed the resistance loss. The writer calculates the attenuation characteristic for two types of ordinary Styroflex-insulated wide-band cable, for frequencies up to 2000 Mc/s, from the equations (1–3) valid for a homogeneous line provided that the loss-angle of the dielectric is small compared with unity. Eqn. 3 involves this loss angle, for the air-Styroflex combination, and in order to calculate it (by Kaden's approximation, eqn. 4) it was necessary to extend Kebbel's centimetric-wave loss-angle measurements on Trolitul (2444 of 1939) to the decimetric region: the full characteristic is given in Fig. 1. Measurements at 20 cm and 50 cm of the complete attenuation characteristic, by the resonance method already described (2681 of 1940), show that the calculating technique still gives sufficiently accurate results in the decimetric-wave region.

3329. A Flexible Low-Attenuation Transmission Line [Continuously Moulded Polystyrene Embedment in Ribbon Form].—R.C.A. Laboratories. (*E. & Television & S-W.W.*, March 1941, Vol. 14, No. 157, pp. 135–136.)

3330. The Attenuation and Impedance of Single Coaxial Cables.—Brockbank. (*See* 3419.)

3331. Some Properties of an Aerial System built of Dipoles [Four Vertical Dipoles, at Corners of a Square: Various Radiation Characteristics obtainable: Reduced Vertical & Increased Horizontal Radiation: Vertical Stacking of Such Systems].—G. Rutelli. (*Sci. Abstracts*, Sec. B, Aug. 1941, Vol. 44, No. 524, p. 164.) From *Zeitschr. f. tech. Phys.*, No. 7, Vol. 21, 1940, p. 140–148.

3332. Rhombic Transmitting Aerial: Increasing the Power Efficiency [Use for High-Power Transmission hitherto limited by Terminating-Resistance Difficulties: Derivation of Practical Formula for Efficiency, leading to Conclusion that Parallel Arrangement of Such Aerials provides Effective Means for Increased Efficiency].—L. Lewin. (*Wireless Engineer*, May 1941, Vol. 18, No. 212, pp. 180–187.)

3333. On the Impedance of Receiving Aerials.—A. Heilmann. (*T.F.T.*, Dec. 1940, Vol. 29, No. 12, pp. 357–360.)

Fränz (761 of March) has recently pointed out the error of the idea that the impedance of an aerial is different according to whether it is used as a transmitting or a receiving aerial [*cf.* also Magnus & Oberhettinger, 2121 of August]. "The following proof of the equality of receiving and transmitting impedance should appeal particularly to technicians in telephony: it is based on the law of the 'equivalent current source.' This states that in any linear network in which electromotive forces are acting at any points, the current in a resistance branch $\mathfrak{R}_n$ can be calculated as if this resistance were fed from an equivalent current source with e.m.f. $\mathfrak{E}_i$ and internal resistance $\mathfrak{R}_i$, where $\mathfrak{E}_i$ is the open-circuit voltage (across the terminals *a* and *b* left open when $\mathfrak{R}_n$ is removed) and $\mathfrak{R}_i$ is equal to the resistance of the network at the terminals *a*, *b* when all voltage sources are short-circuited." In the course of his argument the writer deals with Wilmotte's conclusions and with those of Niessen & de Vries, explaining in each case the cause of error.

3334. Receiver Aerial Coupling Circuits [Analysis of Problem of obtaining Highest Transfer Voltage Ratio with Minimum Reduction of Selectivity and Minimum Mistuning: Generalised Formulae: Experimental Verification].—K. R. Sturley. (*Wireless Engineer*, April & May 1941, Vol. 18, Nos. 211 & 212, pp. 137–146 & 190–197.)

3335. Grounding Electric Circuits Effectively: Part III—Ground System Requirements.—J. R. Eaton. (*Gen. Elec. Review*, Aug. 1941, Vol. 44, pp. 451–456.)

3336. The Mathematics of Ice Loading Effect on Design of Overhead Lines.—J. McCombe. (*Distribution of Elec.*, Oct. 1941, Vol. 14, No. 144, pp. 480–483.) *See* also *Elec. Review*, 10th Oct. 1941, pp. 371–373.

3337. Nomograms for the Solution of Spherical Triangles.—J. B. Friauf. (*Journ. Franklin Inst.*, Aug. 1941, Vol. 232, No. 2, pp. 151–174.)

VALVES AND THERMIONICS

3338. Large-Signal High-Frequency Electronics of Thermionic Vacuum Tubes [Mathematical Treatment (with Solution degenerating into Space-Charge-Limited Operation at Low Frequencies) based on Division of Multielectrode Valve into Several Diode Sections: Cases of Plane Diode with Cathode of Infinite Emission Capacity (Zero Initial Velocity), and with Periodic Injection of Electrons: Velocity-Modulated Valves & Their 58% Efficiency Limitation: Possible Improvement of Conventional Power Valves].—C. C. Wang. (*Proc. I.R.E.*, April 1941, Vol. 29, No. 4, pp. 200–214.)

3339. Velocity-Modulated Valves: Modern Trends in Tubes for U.H.F. Operation.—(*Wireless World*, Oct. 1941, Vol. 47, No. 10, pp. 248–251.)

3340. Calculating Conductance [due to Electron Beam traversing a Transverse Alternating Field: Correction], *and* The Deflecting Condenser.—S. Rodda: W. E. Benham. (*Wireless Engineer*, April 1941, Vol. 18, No. 211, p. 154: July, No. 214, pp. 277–278.) *See* 1077 of April. For Recknagel's paper *see* presumably (the reference given in the first letter is incorrect) 2257 of 1938.

3341. On the Induced Current and Energy Balance in Electronics [U.H.F. Results (particularly with Velocity Modulation) point to Necessity for Fundamental Revision of Ordinary Concept of Current: Generalised Theory: Ramo's Work (131 of 1940): Treatment including Effects of Space Charge & Changing Electrode Potentials, and Balancing of Energy Relations: Application to U.H.F. Parallel-Plane Valves & Klystron], *and* On the Energy Equation in Electronics at Ultra-High Frequencies.—C. K. Jen. (*Proc. I.R.E.*, June 1941, Vol. 29, No. 6, pp. 345–349: Aug., No. 8, pp. 464–466.) *See* also 3342, below.

3342. Field Propagation Time within a Valve System at Quasi-Optical Frequencies [above Present Ultra-High Range: Electron-Transit Time may drop to Minor Rôle, Field-Propagation Time predominating].—C. K. Jen. (In second paper dealt with in 3341, above.)

3343. Diode as Rectifier and Frequency-Changer [Usefulness of Diode as Frequency-Changer when Transit-Time Effects would be Troublesome in Multielectrode Valves: when Difference-Frequency Output must be Linearly Proportional to Smaller of Input Voltages & Independent of Other Input, etc: in Measuring Equipment & as Limiter: Theoretical Investigation of Effect of Imperfect Rectification, Signal/Noise Ratio of Frequency-Changer, etc.].—D. A. Bell. (*Wireless Engineer*, Oct. 1941, Vol. 18, No. 217, pp. 395–404.) From the Cossor laboratories.

3344. Ceramics in Valve Construction [particularly German Work on Low-Loss Ceramic Seals for U.H.F. Valves].—R. Howard. (*Electronic Engineering* [formerly *E. & Television & S-W.W.*], Aug. 1941, Vol. 14, No. 162, pp. 343–344 and 376.)

3345. A New Frequency Changer [with Electron-Multiplication: Particularly Suitable for U.H.F.].—(*E. & Television & S-W.W.*, Feb. 1941, Vol. 14, No. 156, p. 59.)

3346. Silver-Magnesium Alloy as a Secondary Electron Emitting Material [and Activation Methods: Suggested Explanation of Behaviour].—V. K. Zworykin, J. E. Ruedy, & E. W. Pike. (*Journ. Applied Phys.*, Sept. 1941, Vol. 12, No. 9, pp. 696–698.)

3347. A Study of the Secondary Emission from Cuprous Oxide, Pure or Treated with Alkali Metals.—A. I. Frimer. (*Journ.

of Tech. Phys. [in Russian], No. 5, Vol. 10, 1940, pp. 394–401.)

A report is presented on experiments with pure Cu_2O (prepared in two different ways) and Cu_2O treated with caesium, potassium, and rubidium. The apparatus used is described and a number of experimental curves are shown. The main conclusions reached are as follows :—(1) The secondary emission σ from Cu_2O is lower than from Cu (σ is 1.17 for Cu_2O and 1.35 for Cu) but it increases considerably (up to 6) when an alkali metal is deposited. (2) The absorption of gas by Cu_2O increases σ. (3) Heating of Cu_2O up to 400° C does not increase σ. (4) The energy distribution of secondary electrons from Cu_2O does not differ much from that in the case of Cu. If, however, Cu_2O is treated with an alkali metal the predominance of slow electrons becomes very prominent. A theoretical interpretation of the results is given.

3348. On the Dependence on Angle of the Secondary-Electron Emission from Insulators.—Salow. (*See* 3432.)

3349. The Dependence of the Secondary Electron Emission produced by Gamma Radiation upon the Direction of the Radiation [in Radiation Therapy].—C. W. Wilson. (*Proc. Phys. Soc.*, 1st Sept. 1941, Vol. 53, Part 5, No. 299, pp. 613–623.)

3350. Effects of Heat Treatment on Field Emission from Metals [Anomalous F.E. (due to Surface Electropositive Impurities) removed by Heating, except from Nickel: Investigation using Martin's Cylindrical Electron Projector Tube].—J. H. Daniel. (*Journ. Applied Phys.*, Aug. 1941, Vol. 12, No. 8, pp. 645–652.) *See* Martin, 3351, below.

3351. The Cylindrical Electron Projector Tube in the Study of Thermionic and Field Emission.—Martin. (*See* Daniel, 3350, above). The tube was described by Martin in his paper dealt with in 619 of 1940.

3352. Reduction of Magnesium Oxide by Tungsten in Vacuum [Method of calculating Rate: Experimental Confirmation: of Interest in connection with Oxide-Coated Cathodes and with Use of Magnesia as Insulator].—G. E. Moore. (*Bell T. System Tech. Pub.*, Monograph B-1296, 12 pp.)

3353. Measurements of Shot and Thermal Noise: the Linear Rectifier as Indicator [applicable to Noise Measurement by Substitution Methods but Not by Absolute Methods].—D. A. Bell. (*Wireless Engineer*, March 1941, Vol. 18, No. 210, pp. 95–98.) For criticism (W. H. Aldous & E. G. James) and reply *see* July & Aug. issues, Nos. 214 & 215, pp. 278 & 323.

3354. The Shot Effect in a Saturated Diode [Campbell's and Schottky's Theorems, based on Entirely Different Physical Considerations, shown by Heaviside Analysis to lead to Same Result in calculating Shot Noise in External Circuit consisting of Lumped Impedances].—N. R. Campbell & V. J. Francis. (*Phil. Mag.*, Sept. 1941, Vol. 32, No. 212, pp. 239–244.)

3355. Correction, and Extension to Cylindrical Electrode Systems (as in Large Transmitting Triodes) of "A Theory of the Practical Triode."—I. A. Harris. (*Wireless Engineer*, April 1941, Vol. 18, No. 211, pp. 153–154.) *See* 1080 of April.

3356. On the Theory of Tubes with Two Control Grids [Inadequacy of Published Data: Some Characteristics, & Practical Method of Calculating the Performance: Pentagrid Heptode as Amplifier, as Modulator, & as Heterodyne Detector].—A. H. Wing. (*Proc. I.R.E.*, March 1941, Vol. 29, No. 3, pp. 121–136.)

3357. Non-Linear Distortion in Amplifier Valves and Low-Frequency Transformers.—E. Kettel. (*E.T.Z.*, 3rd July 1941, Vol. 62, No. 27, p. 614: summary, from *Telefunken-Röhre*, No. 18, 1940, pp. 1–32.)

A quasi-linear system is defined as one which must be regarded as non-linear towards the fundamental and linear towards the harmonics. The "klirr" factor K (governing harmonic production) and modulation factor m (governing combination-tone formation) are used as measures of the distortion.

The former (root of the sum of the squares of the percentages of the various harmonics in comparison with the fundamental) and the latter (defined as $m = (S_{\max} - S_{\min})/(S_{\max} + S_{\min}) \times 100\%$) have simple relations to one another only when only the 2nd and 3rd harmonics are in evidence: for the square-law characteristic the calculated relation is $m_2 = 4K_2$. For every point on the characteristic of an amplifier value $\mu = SR_i$. The writer calculates μ and K for three cases: where $\mu =$ const., $S = f(V_g, V_a)$ ("slope" distortions): $S =$ const., $\mu = f(V_a)$, ("amplification-factor" distortions: this term includes the true "Durchgriff" distortions and the "current-division" distortions): and $S = f(V_g, V_a)$, $\mu = f(V_a)$ (as in highly modulated pentodes: both types of distortion occur). Low-frequency triodes and pentodes are considered in these calculations, and then the writer deals with the various forms of "slope" distortion (namely modulation distortion, cross-modulation, and hum-modulation) occurring in h.f. pentodes with high internal resistance and small anode-voltage modulation.

Finally, "iron" distortions are considered, arising from the non-linear relation between B and H, and thus given by the hysteresis curve. Without magnetic bias the curve is symmetrical and the distortions contain only odd (principally the 3rd) harmonics. Introduction of bias makes the curve asymmetrical and adds some even harmonics: as the bias is increased the distortions diminish. The no-load "klirr" factor and the voltage and current "klirr" factors for a load R_i are calculated, and a simple method of measuring the first is given (not in the summary). The "klirr" factor in the absence of magnetic bias, and the "iron" distortions in a push-pull output stage and in a single-valve output stage, are calculated at the end of the full paper.

3358. THE FIGURE OF MERIT OF H.F. VALVES [Suggested "F.O.M." Rating for guiding Choice of Suitable Valve for a Particular Wide-Band Amplifier Circuit: Derivation for Four Types of Circuit].—C. Lockhart. (*E. & Television & S-W.W.*, March 1941, Vol. 14, No. 157, pp. 106–110.)

3359. GAS-FILLED TRIODES AND THEIR PRACTICAL USE [in Laboratory & in Industry].—G. Windred. (*E. & Television & S-W.W.*, Jan., Feb., & March 1941, Vol. 14, Nos. 155/157.) Concluding the series dealt with in 4279 of 1940 and 861 of March.

3360. VALVE ELECTRODE ASSEMBLY: A NEW METHOD.—R.C.A. Laboratories. (*E. & Television & S-W.W.*, Jan. 1941, Vol. 14, No. 155, p. 19.)

3361. ALTERNATIVES IN VALVE REPLACEMENT.—L. A. Moxon. (*E. & Television & S-W.W.*, May 1941, Vol. 14, No. 159, pp. 201–203.)

DIRECTIONAL WIRELESS

3362. MEASUREMENTS OF THE DELAY AND DIRECTION OF ARRIVAL OF ECHOES FROM NEAR-BY SHORT-WAVE TRANSMITTERS.—Edwards & Jansky. (*See* 3222.)

3363. LONG-DISTANCE POSITION-FINDING BY D.F. [Extension of Simple Method of Calculating the Great-Circle Bearing between Two Stations, to give Latitude & Longitude of Distant Station].—F. Addey. (*P.O. Elec. Eng. Journ.*, July 1941, Vol. 34, Part 2, pp. 94–95.) *See* 3478 of 1939.

3364. NOMOGRAMS FOR THE SOLUTION OF SPHERICAL TRIANGLES.—J. B. Friauf. (*Journ. Franklin Inst.*, Aug. 1941, Vol. 232, No. 2, pp. 151–174.)

3365. AEROPLANE LOCATION RECORDER [with Large Motor-Driven Frame Aerial for Short-Wave Signals from Aeroplane: Automatic Indication].—United Air Lines. (*E. & Television & S-W.W.*, May 1941, Vol. 14, No. 159, p. 218.)

3366. ECHO SOUNDER FOR AIR DEFENCE [using 50 cm Waves: on Principle of Western Electric "Absolute Altimeter" (1892 of 1940) but with Focused Beam].—(*Journ. Roy. Aeron. Soc.*, Sept. 1941, Vol. 45, No. 369, p. 268: abstract only.) Based on U.S. Patent Office publications.

3367. "AIR NAVIGATION" [Book Review].—F. G. Brown. (*Engineering*, 26th Sept. 1941, Vol. 152, p. 244.)

ACOUSTICS AND AUDIO-FREQUENCIES

3368. THE LOUDNESS GAIN BY BINAURAL HEARING, AND ITS SIGNIFICANCE [Binaural Telephones give 1 Neper Gain (owing to "Square-Root" Sensitivity Law of Ear): Neglect hitherto due to General Erroneous Belief in "Square" Law: Application to improve Transmission Efficiency or to allow Increased Line Attenuation].—K. Braun. (*T.F.T.*, Dec. 1940, Vol. 29, No. 12, pp. 343–345.)

3369. HALF-WAVE MODULATION [Intelligibility of Speech Not Seriously Depreciated by Transmission of One Half Only of Wave-Form].—Bailey. (*See* 3301.)

3370. ON THE AUDIBILITY OF ECHO AND ITS INFLUENCE ON THE INTELLIGIBILITY OF SPEECH.—A. Rabinovich. (*Journ. of Tech. Phys.* [in Russian], No. 8, Vol. 10, 1940, pp. 605–616.)

3371. A NEW REFERENCE-ATTENUATION METER WITH OBJECTIVE EXCITATION AND INDICATION [including Use of Loudspeaker, excited by Speech Spectrum from Beat-Note Generator, as "Artificial Mouth," and Ballistic Galvanometer (with Rectifier) as "Ear"].—K. Braun. (*T.F.T.*, Aug. 1940, Vol. 29, No. 8, pp. 223–227.) Further development of the work dealt with in 54 of 1940 and 1105 of April.

3372. AUDIO-FREQUENCY MICROVOLTER [combining with an A.F. Oscillator to give Accurately known Continuously Variable Voltages 1.0 μV to 1.0 V].—General Radio. (*Review Scient. Instr.*, Aug. 1941, Vol. 12, No. 8, p. 415.)

3373. A NEW TYPE OF AUDIO-FREQUENCY OSCILLATOR [Resistance-Tuned, with Regeneration through Selective *RC* Network].—(*E. & Television & S-W.W.*, Jan. 1941, Vol. 14, No. 155, pp. 14 and 21.)

3374. SOUND-INTEGRATING MACHINE [for Rapid Plotting of Sound-Field of Ringer or Loudspeaker].—(*Bell Lab. Record*, July 1941, Vol. 19, No. 11, p. 342.)

3375. THE ELECTRICAL BREAKDOWN OF ROCHELLE SALT.—B. V. Gorelik. (*Journ. of Tech. Phys.* [in Russian], No. 5, Vol. 10, 1940, pp. 369–375.)

Experiments were conducted to investigate the reasons for the abnormally low electrical breakdown of Rochelle salt. Comparative tests with crystals of rock salt, alum, and naphthalin were also made.

3376. RECENT RESEARCH AND ITS EFFECT UPON LOUDSPEAKER DESIGN [including Box Baffles and a "Vented Acoustic Chamber": Importance of Correct Vent Area: etc.]. (*E. & Television & S-W.W.*, April 1941, Vol. 14, No. 158, pp. 174–176.)

3377. THE POST OFFICE AND PUBLIC ADDRESS [from 1928 onwards].—E. J. Casterton. (*P.O. Elec. Eng. Journ.*, April 1941, Vol. 34, Part 1, pp. 26–30.)

3378. THE CALCULATION OF CAPACITANCES FOR CABLES OF SIMPLE CROSS SECTION.—Sommer. (*See* 3287.)

3379. Sound Propagation in the Open Air, and Its Dependence on Meteorological Conditions [Theoretical Treatment of Effects of Wind & Temperature Gradients: Experimental Confirmation (Minimum Attenuation for 250–4000 c/s is 1 db/100 m): Differing Effects of Nearness to Ground on High & Low Frequencies, etc.].—H. Sieg. (*E.N.T.*, Sept. 1940, Vol. 17, No. 9, pp. 193–208.) With 30 literature references.

3380. The Propagation of Pressure Fluctuations of Large Amplitude in Air Columns [Experimental Investigation].—L. J. Kastner. (*Phil. Mag.*, Sept. 1941, Vol. 32, No. 212, pp. 206–224.)

3381. Bell Sound Detector [Use of Line Microphones (3600 of 1939) for Ground Defences].—Bell Tel. Laboratories. (*Journ. Roy. Aeron. Soc.*, Sept. 1941, Vol. 45, No. 369, p. 268: abstract only.)

3382. Aeroplane "Spotting" by Electro-Acoustical Methods.—Benjamin Electric. (*E. & Television & S-W.W.*, April 1941, Vol. 14, No. 148, pp. 153–154.) Commercial development of the system referred to in 790 of March.

3383. On the Preparation of a Thermal Light-Source which can be Modulated at Note Frequencies.—Lattman. (*See* 3608.)

3384. The Technique of the Commercial Gramophone-Disc Recording Process [including Test Methods (Advantages of Measurement of Quadratic & Cubic—Asymmetrical & Symmetrical—Distortions over Measurement of "Klirr" Factor: etc.): a Compressed Survey].—W. A. Günther. (*Bull. Assoc. suisse des Élec.*, 4th July 1941, Vol. 32, No. 13, pp. 291–296: in German.)

3385. Re-coating Recording Blanks [Description of Operation], *and* Recording Blanks.—W. H. Pierce: D. W. Aldous. (*Wireless World*, Sept. 1941, Vol. 47, No. 9, pp. 242–243: Oct. 1941, No. 10, pp. 269–270.)

3386. A Variable-Speed Turntable Unit [Friction Wheel-&-Cone Drive].—(*E. & Television & S-W.W.*, March 1941, Vol. 14, No. 157, p. 110.)

3387. Magnetic Recording and Some of Its Applications in the Broadcast Field [with 29 Literature References].—S. J. Begun. (*Proc. I.R.E.*, Aug. 1941, Vol. 29, No. 8, pp. 423–433.) A summary was referred to in 1395 of May.

3388. The Synthetic Production and Control of Acoustic Phenomena by a Magnetic Recording System [Survey of Previous Proposals for "Synthetic Reverberation": Magnetic-Tape System re-designed by Brush Company: Applications to Other Purposes (Study of Sound-Decay Curves, of Space-Phasing for Improving Naturalness of P.A. Systems, etc.)].—S. K. Wolf. (*Proc. I.R.E.*, July 1941, Vol. 29, No. 7, pp. 365–371.)

3389. The Absorption of Sound by means of a Three-Layer Resonance System.—V. Nesterov. (*Journ. of Tech. Phys.* [in Russian], No. 8, Vol. 10, 1940, pp. 617–626.)

3390. The "Acoustic Envelope": New Development to aid Voice Production [employed by Paul Robeson in touring Halls of Widely Varying Characteristics].—H. Burris-Meyer. (*Wireless World*, Sept. 1941, Vol. 47, No. 9, p. 233.) For other work by Burris-Meyer *see* 2440 of September.

3391. Synthesis of Musical Sounds by the Toothed-Wheel Generator [Discrepancies between Tone of Electrical Musical Instruments & Their Mechanical Prototypes: Investigation, with View to eliminating These, of Toothed-Wheel Generator, with Magnetic or Electrostatic Pick-Up: Effects of Variation of Gap, Tooth Form, etc.].—K. H. Kleine. (*Physik. Zeitschr.*, April 1941, Vol. 42, No. 6, pp. 111–116.)

3392. Tests at the National Institute of Electroacoustics to arrive at an Objective Estimate of the Acoustical Quality of Some Violins.—G. Pasqualini. (*La Ricerca Scient.*, Sept. 1940, Vol. 11, No. 9, pp. 622–639.) Beginning with a survey of previous work in various countries.

3393. Negative Characteristic of the Pipe Reed.—Zahradníček & Nespor. (*Physik. Zeitschr.*, Sept. 1940, Vol. 41, No. 17/18, pp. 419–421.)

3394. Motion of the Walls of a Cornet [studied with Piezoelectric Pick-Up].—H. P. Knauss. (*Phys. Review*, 1st July 1941, Vol. 60, No. 1, p. 65: summary only.)

3395. The Comma in Music [Suggestion of New Comma, between Those of Pythagoras & Didymus, as Integer (53 Commas in Octave)].—A. F. Dufton. (*Phil. Mag.*, Sept. 1941, Vol. 32, No. 212, pp. 259–261.)

"Although a gamut with 54 notes to the octave may appear to be unsuitable for a manual keyboard, the development of mechanically played music must not be ignored."

3396. The Crosley Contrast Expander: an Analysis of the Circuit [Bridge Circuit with Two Metal-Filament Lamps].—S. W. Amos. (*Wireless Engineer*, June 1941, Vol. 18, No. 213, pp. 237–239.)

The improvement in contrast is not proportional to the original contrast, but "even this kind of expander is well worth including in receivers, owing to its simplicity."

3397. Design for a Super-Quality 12-Watt Amplifier.—J. C. C. Gilbert. (*E. & Television & S-W.W.*, Feb. & March 1941, Vol. 14, Nos. 156 & 157, pp. 72–75 & 111–116.)

For a further note *see* April issue, pp. 184–185: here a defect (attenuation of the very low and very high audio-frequencies) of the Carpenter paraphase circuit employed is discussed, and a change suggested to O. H. Schmitt's circuit (2024 of 1938), the claims for which have been verified experimentally: the paper incorrectly gives the name as Schmidt.

3398. The Calculation of Frequency Response of Audio-Frequency Amplifiers [and the Influence of the Miller Effect on the Higher Frequencies].—(*E. & Television & S-W.W.*, April 1941, Vol. 14, No. 158, p. 167.)

3399. Non-Linear Distortion in Amplifier Valves and Low-Frequency Transformers.—Kettel. (*See* 3357.)

3400. A Measuring Equipment with Direct Indication for the Determination of the "Klirr" Factor and Individual Harmonics.—H. Rupp. (*E.N.T.*, Nov. 1940, Vol. 17, No. 11, pp. 247–261.)

To obtain an accurate knowledge of the transmission properties of amplifiers, lines, etc., it is necessary to know how the "klirr" factor (non-linear distortion factor: sometimes translated as "blurr" or "rasping" factor: defined by Küpfmüller as

$$k = \sqrt{(A_2{}^2 + A_3{}^2 + \ldots)/(A_1{}^2 + A_2{}^2 + \ldots)},$$

but often given as

$$k' = \sqrt{(A_2{}^2 + A^2{}_3 + \ldots)/A_1{}^2},$$

in which case $k = k'/(1 + k'^2)$: (*cf.* Kettel, 3357) varies not only with the frequency but also with the transmission level. With the usual methods of measuring this factor, such a process would take a great deal of time, since the circuit would require balancing before each reading. The method here developed allows the factor to be read directly off an indicating instrument: if desired, the "klirr"-factor characteristic could be recorded automatically. By a change of circuit the individual harmonics can be measured: in this way the detection of the part of the transmission circuit which is causing the distortion is made easy—an advantage not possessed by previous techniques. The equipments described cover a frequency range of 50 to 10 000 c/s; the smallest "klirr" factor measurable is 0.4%, the accuracy is within 6–7% of the factor value.

The principle of the "klirr" factor measurement is that the variable test frequency f_1 is passed through the circuit under investigation and leaves it as $f_1 + nf_1$: it is then acted on (in the "modulator" M in Fig. 4) by an auxiliary frequency f_2 which is automatically regulated so that the sum (or the difference) of f_1 and f_2 is constant. Beyond M there appear, therefore, the two fundamental frequencies f_1 and f_2, and in addition the frequencies $f_2 + (f_1 + nf_1)$ and $f_2 - (f_1 + nf_1)$. If f_2 is so regulated that the sum frequency $f_2 + f_1$ remains constant, and if the mixture is acted on by a high-pass filter S, only $f_2 + nf_1$ will emerge from S and reach the indicating instrument K, which will therefore measure the "klirr" frequencies of the original test frequency: the same will occur when it is the difference frequency which is kept constant, a low-pass filter being used in this case for S. The automatic adjustment of the auxiliary frequency is accomplished purely electrically by the system of multiple modulation included in the complete scheme, Fig. 5: the three generators G_1, G_2, & G_3 produce frequencies f_1, f_2, & f_3, of which the first and last are fixed while f_2 is variable over a certain range. The modulators M_1 & M_2 produce $f_1 - f_2$ and $f_2 - f_3$, respectively, which are freed from the fundamentals and other modulation frequencies by filters S_1 & S_2. The frequency $f_1 - f_2$ forms the variable test frequency, the original "f_1" dealt with above, while $f_2 - f_3$ forms the auxiliary frequency ("f_2" above) which acts on the test frequency in a third modulator M_3 after that frequency has passed through the circuit under investigation. The sum of the fundamental frequencies arriving at M_3 is thus $f_4 = f_1 - f_2 + (f_2 - f_3) = f_1 - f_3$: since f_1 and f_3 are both constant, f_4 is also constant, whatever the test frequency $f_1 - f_2$ may be, which is what was required.

The scheme shown in Fig. 6 and discussed more fully on pp. 259–260 is a simplified version of the above, requiring rather less apparatus but lacking certain advantages. In either case, the performance of the final filter (S in Fig. 4) in front of the indicating instrument is the chief factor in determining the accuracy obtainable: the lower-frequency flank of its characteristic must be very steep, and it therefore takes the form of a crystal bridge filter (*see* 3265, above). The circuit used when it is required to measure individual harmonics is shown in Fig. 8 and discussed more fully on p. 260.

3401. Solid Carbon Dioxide as an Exciter of Vibrations [and Some Applications].—Mary D. Waller. (*Nature*, 16th Aug. 1941, Vol. 148, pp. 185–187.)

3402. On Acoustically Effective Vortex Motion in Gaseous Jets.—P. Savic. (*Phil. Mag.*, Sept. 1941, Vol. 32, No. 212, pp. 245–252.)

3403. Paper on the Velocity of Acoustical Waves in Petroleum Fractions.—Matteson & Vogt. (*See* 3511.)

3404. Supersonic-Wave Absorption in Liquids, measured Optically [by Practical Application of Grobe's Method (2860 of 1938)].—A. Lindberg. (*Physik. Zeitschr.*, 15th Oct. 1940, Vol. 41, No. 20, pp. 457–467.)

3405. Supersonic-Wave Dispersion and the Velocity of Fracture [with Photographs of Glass Fractures].—A. Smekal. (*Physik. Zeitschr.*, 15th Oct. 1940, Vol. 41, No. 20 pp. 475–480.)

PHOTOTELEGRAPHY AND TELEVISION

3406. "Scrambled" Television.—Scophony. (*Wireless World*, Oct. 1941, Vol. 47, No. 10, pp. 272–273.) British Patent 530 776.

3407. Television Transmission [Experiments with 441-Line, 30-Frame Interlaced Transmission over Coaxial Cable & Other Telephone Facilities].—M. E. Strieby & C. L. Weis. (*Proc. I.R.E.*, July 1941, Vol. 29, No. 7, pp. 371–381.) A summary was dealt with in 1936 of July.

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3408. Some Observations relating to Reports of Colour Television in America, *and* J. L. Baird's New Colour Television System.—P. Nagy: J. L. Baird. (*E. & Television & S-W.W.*, Feb. 1941, Vol. 14, No. 156, pp. 60–62 and 95, 96: pp. 69–70.)

3409. Film Scanner for Use in Television Transmission Tests [Advantages of Farnsworth Image Dissector as Pick-Up: Use of Special Film "stretched" to give 60 Frames: Vertical Scanning by Continuous Motion of Film, Horizontal by Electronic Line Sweep in Dissector Tube].—A. G. Jensen. (*Proc. I.R.E.*, May 1941, Vol. 29, No. 5, pp. 243–249.)

3410. A Phase-Curve Tracer for Television [Phase Curve of Any Network shown on C.R.O. Screen, on Linear Frequency Scale from 0.1–5 Mc/s].—B. D. Loughlin. (*Proc. I.R.E.*, March 1941, Vol. 29, No. 3, pp. 107–115.) A summary was referred to in 1937 of July.

3411. A Coaxial Filter for Vestigial-Sideband Transmission in Television.—H. Salinger. (*Proc. I.R.E.*, March 1941, Vol. 29, No. 3, pp. 115–120.) A summary was dealt with in 1846 of July. *Cf.* Brown, 3088 of November.

3412. Brightness Distortion in Television.—D. G. Fink. (*Proc. I.R.E.*, June 1941, Vol. 29, No. 6, pp. 310–321.) A summary was dealt with in 1430 of May.

3413. Versatile Multi-Channel Television Control Equipment.—D. E. Norgaard & J. L. Jones. (*Proc. I.R.E.*, May 1941, Vol. 29, No. 5, pp. 250–265.) A summary was referred to in 1938 of July.

3414. New Designs of Television Control-Room Equipment.—J. D. Schantz. (*Proc. I.R.E.*, June 1941, Vol. 29, No. 6, pp. 303–309.) From the Farnsworth Corporation.

3415. Photoelectric Conductivity of Zinc-Sulphide/Copper Phosphors under the Action of Alpha Rays.—F. R. Lappe. (*Ann. der Physik*, 14th June 1941, Vol. 39, No. 8, pp. 604–618.)

The writer begins by stressing the importance of investigating the mechanism of phosphors by electrical methods (*cf.* Ruffler, 2517 of September). These are often easier, quicker, and more sensitive than optical methods, and conclusions as to optical behaviour can be drawn from them. Thus Goos, by experiments with ZnSCu phosphors disintegrated by alpha rays, found among other things that this disintegration produced a linear increase in the extinction effect, already particularly pronounced in this particular phosphor (2714 of 1940 and back reference): he used, instead of optical measurement, the change of dielectric constant in a h.f. oscillatory circuit as a measure of the effect of illumination.

It has been suggested that the "secondary current," *i.e.* the conductivity under an applied voltage, on illumination, would show a similar variation, and the present work examines this suggestion. The phosphor was spread in a very fine layer on a metal plate in a "conductivity cell" so that its electrical behaviour could be followed, both before and after the action of alpha rays, under the influence of the exciting light and of the red and infra-red light for producing the extinction effect (Fig. 1). The highly insulating phosphor under test shows a conveniently measurable "secondary current" on illumination only if the film is so thin that the incident light can excite it all through: Lenard gives a thickness of 0.014 mm at most for full excitation, and the film here used was of about that thickness, giving secondary currents about 1000 times as great as the "dark" current, with comparatively low voltages.

Among the results obtained, and summarised on pp. 617–618, are the following:—the extinction effect in a continuously "blue"-excited phosphor (curve a, Fig. 3), measured as a "secondary-current" decrease, shows a marked inertia, as does the rise which occurs at the end of the extinction ("Rot aus"). If, on the other hand, the "blue" excitation is cut off, the current falls in the normal decay mode (curve b): the introduction of the extinguishing radiation ("Rot belichtet") causes an immediate but small rise in the current, followed by a more rapid decay. The small rise indicates the occurrence of a slight luminosity produced by the long-wave radiation, side by side with the extinction effect. Curve c represents the case when the red radiation is applied directly the blue is cut off: the current sinks much more quickly, practically reaching its "dark" value within 6 minutes, compared with over 10 minutes. The first apparent action of alpha rays is to behave as a short-wave exciting radiation, but simultaneously the destruction of the active centres has set in. The extinction effect as shown by the "secondary current" increases linearly with the destruction process, so that Goos's results are confirmed by this new method. A considerable variation of the "secondary current" with gas pressure was found, both dark and illuminated currents increasing rapidly with decreasing pressure: the extinction effect decreased, not so markedly, with decreasing pressure.

3416. The Response of Electrical Networks to Non-Sinusoidal Periodic Waves.—Marchand. (*See* 3259.)

3417. Building-Up Processes in Oscillatory Circuits [Treatment based on Equivalent Circuit containing only Distortion-Free Lines: Stationary Oscillations: Building-Up Process outside Resonance: with Continually Varying Frequency (*e.g.* in Exploring-Note Sound Analysis): Technique applicable to Amplifiers with Several Mutually Detuned Circuits, etc.].—R. Feldtkeller. (*T.F.T.*, Dec. 1940, Vol. 29, No. 12, pp. 353–356.) For different treatments *cf.* Wheeler, 3642 of 1939, and Strecker, 447 of February.

3418. Eliminating Peaks in Amplifier Response Curves [at High-Frequency End of Video-Amplifier Range, due to Reactive Elements in Anode Circuit of One Valve].—R.C.A. Laboratories. (*E. & Television & S-W.W.*, May 1941, Vol. 14, No. 159, pp. 215 and 217.)

3419. The Attenuation and Impedance of Single Coaxial Cables [with Air-Space and Solid Polythene Dielectrics: Benefits obtainable from Standardisation of Characteristic Impedance: 75 Ohms as Suitable Value].—R. A. Brockbank. (*P.O. Elec. Eng. Journ.*, July 1941, Vol. 34, Part 2, pp. 66–71.)

3420. The Behaviour of Wide-Band Cables with Styroflex Insulation in the Decimetric-Wave Band.—Kaufmann. (*See* 3328.)

3421. A Flexible Low-Attenuation Transmission Line [Continuously Moulded Polystyrene Embedment in Ribbon Form].—R.C.A. Laboratories. (*E. & Television & S-W.W.*, March 1941, Vol. 14, No. 157, pp. 135–136.)

3422. Kerr Effect and Molecular State in Highly Compressed Gases and Liquids.—E. Kuss & H. A. Stuart. (*Physik. Zeitschr.*, April 1941, Vol. 42, No. 6, pp. 95–105.)

3423. Half-Tone Reproduction in Picture-Transmission Apparatus using Gas-Filled Lamps for Positive Recording.—E. L. Orlovski. (*Journ. of Tech. Phys.* [in Russian], No. 4, Vol. 10, 1940, pp. 274–294.)

A detailed discussion is given of the mathematical relationship between the optical density D'_r of the picture element to be transmitted and the optical density D_r of the corresponding recorded element when positive recording of the received picture is employed. It is shown that considerable distortion of half-tones occurs in picture transmission by apparatus of Soviet manufacture. Accordingly, the optimum operating conditions of the positive rectifier in the recording apparatus are established and a correcting circuit (lower half of Fig. 18) is proposed. Experiments with this circuit have shown that a great improvement is obtained thereby. Theoretical considerations are also put forward indicating that the photocurrent amplifier at the transmitting or receiving station can be so designed as to ensure distortionless transmission of half-tones. Another advantage of such amplifiers would be a rise in the permissible interference level.

3424. Fundamentals of Phototelegraphy Technique: Parts I and II.—H. Bitter. (*T.F.T.*, Aug. & Sept. 1940, Vol. 29, Nos. 8 & 9, pp. 215–223 & 270–276.) The third and final part was dealt with in 1444 of May.

3425. The Handling of Telegrams in Facsimile.—R. J. Wise & I. S. Coggeshall. (*Proc. I.R.E.*, May 1941, Vol. 29, No. 5, pp. 237–242.) A summary was dealt with in 1947 of July.

3426. The RCA-931 Multiplier Phototube.—(*Review Scient. Instr.*, Aug. 1941, Vol. 12, No. 8, p. 416.)

3427. A Review of the Development of Sensitive Phototubes [with over 80 Literature References].—A. M. Glover. (*Proc. I.R.E.*, Aug. 1941, Vol. 29, No. 8, pp. 413–423.)

3428. On the Theory of the Photoeffect in Semiconductors [where Sommerfeld's Free-Electron Theory is No Longer Adequate].—V. F. Weisskopf & L. W. Apker. (*Phys. Review*, 15th July 1941, Vol. 60, No. 2, p. 170: summary only.)

3429. The Crystal Photoeffect in *d*-Tartaric Acid [Examination of Brady-Moore Current-Reversal Phenomenon].—C. K. Lui. (*Phys. Review*, 15th July 1941, Vol. 60, No. 2, pp. 160–161: summary only.)

3430. A Note on the Demonstration of the Photoeffect with a Glow-Discharge Lamp [and Some Applications].—Metzger. (*See* 3604.)

3431. A Study of the Secondary Emission from Cuprous Oxide, Pure or treated with Alkali Metals.—Frimer. (*See* 3347.)

3432. On the Dependence on Angle of the Secondary-Electron Emission from Insulators.—H. Salow. (*Physik. Zeitschr.*, 1st Oct. 1940, Vol. 41, No. 19, pp. 434–442.)

For previous work, in connection with television pick-up tubes, *see* 1995 & 4025 of 1939 and 1881 of 1940. The present paper deals with measurements on mica, glass, and zinc sulphide. The characteristic of the s.e. coefficient between incident angles 0° to 70° and potentials 100 to 4000 v is a smooth curve following the same law as that for the angle-dependence of s.e. from metals. On the assumption of the validity of the Widdington-Thomson law for the energy dissipation of the primary electrons, and assuming a secondary-electron absorption proportional to the path, a formula is derived which represents the important features of the experimental results as regards potential and angle dependence. The sudden change in the s.e. from insulators at definite angular values, assumed to exist by Wehnelt and his school, is traced to the special measuring technique employed: the "jump" effect occurring in the collector current in this technique happens when the s.e. coefficient of the insulator reaches unity, and must not be regarded as a sudden change in the secondary emission.

3433. The Drift of the Selenium Barrier-Layer Photocell [Survey of Conflicting Reports: Measurements on Photronic, German, & Other Types].—R. A. Houstoun. (*Phil. Mag.*, June 1941, Vol. 31, No. 209, pp. 498–506.)

3434. A Bibliography relating to Barrier-Layer Photoelectric Cells.—(*Science Library Bibliogr. Series*, No. 558, 1941, 3 pp.)

MEASUREMENTS AND STANDARDS

3435. A New Method for Measuring the Dielectric Constants and Loss Factors of Insulating Materials in the Centimetric Wave Band.—F. Borgnis. (*Naturwiss.*, 22nd Aug. 1941, Vol. 29, No. 34, pp. 516–517.)

The ordinary h.f. methods become so difficult at these micro-wave frequencies that optical methods have been tried (Bäz, 3695 of 1939: Kebbel, 2444 of 1939). Recently the distribution of the electric field of standing waves produced in a hollow tube of rectangular section, with a plate of the material at its closed end, has been employed for the purpose (Roberts & von Hippel, 3508 of 1940: Fejér & Scherrer, 3436, below). The present letter describes a method using a cylindrical cavity resonator of radius R, the test specimens taking the form of cylindrical rods of radius ρ, easy to prepare and economical in material: the electromagnetic relations in the resonator are exactly defined, are unaffected by edge effects and external disturbances, and permit an accurate theoretical treatment to be applied.

The cavity is excited in its electrical fundamental (Borgnis, 905 of 1940 [for later work *see* 61 of January and cross references]). The electric field strength has only one component E_z parallel to the cylinder axis, the magnetic field strength has a circular component H_ϕ. The resonance wave, whatever the height of the cylinder, is given by $\lambda = 2.61\,R$. If the rod of material is introduced centrally in the cavity, the essential character of the field remains unchanged: the presence of the rod modifies only the radial course of the electric and magnetic fields. The resonance wavelength λ is increased by $\Delta\lambda$, and for thin rods $\epsilon - 1 = 0.538\,(R/\rho)^2 \,.\, \Delta\lambda/\lambda$, from which ϵ is obtained easily. The loss factor is measured by plotting the resonance curves of the resonator without and with the rod: if d and d' are the corresponding half-value breadths, then $\tan\delta = (0.269/\epsilon)(R/\rho)^2(d' - d)$. Average values for ϵ on a 14 cm wavelength, for Trolitul, Calit, and amber, were 2.32, 5.30, and 2.30 respectively, while the corresponding values for $\tan\delta \times 10^4$ were 5.7, 19, and 70. Control tests showed complete agreement between theory and experiment. The limit of error varies with different materials: it may rise to about 10%.

3436. Paper on the Measurement of Dielectric Constant and Loss Factor for Centimetric Waves, by Interferometric Method.—G. Fejér & P. Scherrer. (*Helvetica Phys. Acta*, Vol. 14, 1941, p. 141 onwards.) Referred to by Borgnis, 3435, above.

3437. The Oscillating High-Frequency Ammeter [for Ultra-High Frequencies: Editorial on American Development, 3724 of 1938 and 819 of March].—G.W.O.H.: Michel & Meahl. (*Wireless Engineer*, March 1941, Vol. 18, No. 210, pp. 93–94.)

3438. The Effect of the Dielectric Constant of the Air on the Frequency Stability of Oscillating Circuits.—Volpert. (*See* 3292.)

3439. The Pierce Piezoelectric Oscillator: Analysis for the Design of Crystal- and Line-Controlled Apparatus [Fresh Analysis to help in Design of Oscillator with Frequency Variable over Maximum Range compatible with Control by Single Crystal, and with Constant Amplitude: Extension to Line-Stabilised U.H.F. Oscillators].—H. Jefferson. (*Wireless Engineer*, June 1941, Vol. 18, No. 213, pp. 232–237.) From the Marconi laboratories.

3440. Contour-Mode Vibrations in *Y*-Cut Quartz-Crystal Plates [Theory & Experiment: Conclusion that Principal Contour-Mode Responses are due to Coupling between Shear and Second Flexure & Its Harmonics: Extensional & First Flexural Modes occur only with Special Electrode Arrangements].—G. Builder & J. E. Benson. (*Proc. I.R.E.*, April 1941, Vol. 29, No. 4, pp. 182–185.)

3441. Oscilloscope Patterns of Damped Vibrations of Quartz Plates, and *Q* Measurements with Damped Vibrations [including a Method using a "Momentary Contactor," sometimes employed in Determination of Alternator Wave-Form].—H. A. Brown. (*Proc. I.R.E.*, April 1941, Vol. 29, No. 4, pp. 195–199.) A summary was referred to in 3519 of 1940.

3442. Piezoelectric Crystals [Correspondence on Notation of Quartz Crystals].—R. L. Smith-Rose: Mason & Willard. (*Proc. I.R.E.*, July 1941, Vol. 29, No. 7, p. 405.) *See* 501 of February.

3443. Refraction Patterns of the Surfaces of Opaque and Translucent Solids [Extension of Method (previously applied to Quartz) by Use of 'Diakon' Casts].—R. S. Rivlin & W. A. Wooster. (*Nature*, 27th Sept. 1941, Vol. 148, p. 372.) *See* 2774 of October.

3444. A Quartz-Crystal Cutting and Lapping Machine [Simplified Design, retaining Essentials for Accurate & Controlled Cutting], *and* The Preparation of Piezoelectric Quartz Plates.—F. Butler. (*E. & Television & S-W.W.*, May 1941, Vol. 14, No. 159, pp. 204–207 and 211: *Electronic Engineering* [new form of above], June 1941, Vol. 14, No. 160, pp. 252–254 and 281.)

3445. Some Analyses of Wave Shapes used in Harmonic Producers [in the Heterodyne Method of Frequency Comparison: Fourier Analyses of Sinusoidal, Rectangular, & Trapezoidal Pulses, and of Multivibrator Waves: Method of Modulation with Submultiple to increase Harmonic Content].—F. R. Stansel. (*Bell S. Tech. Journ.*, July 1941, Vol. 20, No. 3, pp. 331–339.)

3446. A Stabilised Frequency Divider [for Frequency-Measuring Equipment, etc.].—Builder. (*See* 3252.)

3447. SOME OBSERVATIONS ON AN A.C. RESONANT PENDULUM [Pendulum Bob of Iron swinging into Air-Core Coil tuned by Condenser to 60 c/s : Measurements on Current & Voltage, to determine Nature of Driving Force].—D. K. Weimer. (*Phys. Review*, 1st July 1941, Vol. 60, No. 1, p. 65 : summary only.)

3448. WIRE-BROADCASTING MEASURING TECHNIQUE [developed by German P.O. & Industry].—Eisele. (*See* 3544.)

3449. SIGNAL GENERATORS ON THE H.F. MODULATION PRINCIPLE [particularly for Testing the Sensitivity & Selectivity of Receivers].—H. Nitsche. (*E.N.T.*, Nov. 1940, Vol. 17, No. 11, pp. 262–268.)

From the Rohde & Schwarz laboratories. If a h.f. generator for sensitivity measurements generates a h.f. voltage around 50–100 v and this has to be reducible by a voltage-dividing device to perhaps 1 μV, screening attenuation necessary to keep interfering voltages down to 10% of the reduced test voltage must be of the order of 10^9. This by no means easy problem has been solved satisfactorily for frequencies up to 300 Mc/s and over, but many attempts have been made to circumvent the necessity for such careful screening. A reduction of the full generator voltage, by the use of space-charge-grid valves or special regulating circuits, has the defect that if this is done, the reaction of the voltage divider on the frequency cannot be nullified, as is usually the case, by the use of very loose couplings. The employment of harmonics, with amplitudes about 1–2% of the fundamental, is another possible way of reducing the screening by about two orders of magnitude, but the obtaining of a harmonic voltage which will keep a constant ratio to the fundamental over a range of frequencies (a condition necessary for a direct calibration) is a difficult task. The use of sideband frequencies ("h.f. modulation principle") offers definite advantages : a h.f. carrier (*e.g.*, $f = 50$ Mc/s) is modulated by a h.f. voltage of lower frequency (*e.g.*, $f_1 = 500$ kc/s), to yield a sideband frequency of $f \pm f_1$ which can be given a note modulation by modulating f_1, so that the modulation percentage remains constant. Then the production of small voltages $\mathfrak{U}_{f+f1}$ is not dependent on the screening of the short-wave oscillator, since larger voltages of the required frequency do not occur if the weakening takes place on the modulating voltage $\mathfrak{U}_{f1}$. Moreover, very small changes in the frequency of $f \pm f_1$ can be performed simply, by varying the comparatively low modulating frequency : a 10^{-3} change of f_1 (*i.e.* a change of 500 c/s in the case taken above) would give a detuning $\Delta f/f = 10^{-5}$ in the sideband frequency $f + f_1 = 50.5$ Mc/s.

An equipment developed on these principles was constructed and showed a number of interesting properties : the writer, however, emphasises that it was required for a distinctly special purpose (not specified) and that it is not recommended for general purposes or as a basis for mass production : it involves a large outlay and (in spite of careful design with an eye to simplicity in working) a complicated procedure. On the other hand, if the principle is used only for the advantage which it offers in the matter of very fine frequency adjustment for the measurement of band-widths (the defects of the usual methods, electrical and mechanical, of obtaining such an adjustment are discussed in section II on p. 265), the equipment can be made very much simpler and more convenient, and forms a useful auxiliary to an ordinary signal generator.

3450. MEASUREMENT OF LOOP-ANTENNA RECEIVERS [and the Introduction of the Measuring Signal by a Transmitting Loop : Designs of Latter, including Shielding : Derivation of Formulae concerned : etc.].—W. O. Swinyard. (*Proc. I.R.E.*, July 1941, Vol. 29, No. 7, pp. 382–387.)

3451. PROGRESS IN THE DEVELOPMENT OF INSTRUMENTS FOR MEASURING RADIO NOISE.—Burrill. (*See* 3318.)

3452. THE MEASUREMENT OF MODULATION DEPTH [Method used in Peak Programme Meter for B.B.C. Monitoring].—Ellis. (*See* 3299.)

3453. A MEASURING EQUIPMENT WITH DIRECT INDICATION FOR THE DETERMINATION OF THE "KLIRR" FACTOR AND INDIVIDUAL HARMONICS.—Rupp. (*See* 3400.)

3454. A "TROUGH" VOLTMETER FOR MEASURING THE MINIMUM VALUE OF A UNIDIRECTIONAL UNDULATING VOLTAGE.—F. C. Williams & A. Fairweather. (In paper dealt with in 3478, below.)

3455. DESIGN FOR MAGIC-EYE VALVE VOLTMETER.—J. C. G. Gilbert. (*E. & Television & S-W.W.*, May 1941, Vol. 14, No. 159, pp. 212–214.)

3456. AN IMPULSE GENERATOR [for Impulse Transmission Testing & Other Purposes : giving Continuous Series of Impulses or Cyclic Repetition].—B. M. Hadfield & W. W. Chandler. (*P.O. Elec. Eng. Journ.*, April 1941, Vol. 34, Part 1, pp. 31–35.) The impulsing speed can be varied without affecting the percentage break, and *vice versa*.

3457. THE USE OF REPEATERS AS IMPEDANCE METERS [in Small Repeater Stations lacking Other Instruments : Repeater Itself used as Bridge].—K. Oettl. (*T.F.T.*, July 1940, Vol. 29, No. 7, pp. 192–196.)

3458. STRAY CAPACITANCES : INFLUENCE ON EFFECTIVE INDUCTANCE OF COIL IN METAL CONTAINER [measured by Resonance Method and Transformer Bridge Methods].—Farren & Rivlin. (*See* 3266.)

3459. THE BRIDGED-*T* METHOD OF MEASURING THE CONSTANTS OF A COIL [Extension of Editorial on Honnell's Method (3111 of 1940) to Inductance & Effective Resistance].—G.W.O.H. (*Wireless Engineer*, April 1941, Vol. 18, No. 211, pp. 135–136.)

3460. THE DESIGN OF THE UNIVERSAL WINDING [for Max. Inductance in Min. Volume : Gear-Ratio Formula and Tables & Curves for Its Application].—L. M. Hershey. (*Proc. I.R.E.*, Aug. 1941, Vol. 29, No. 8, pp. 442–446.)

3461. A.C. Impedance of Chokes and Transformers: a Measuring Instrument for Production Checks [Objections to Established Methods (Volt-Ammeter, Comparison): Development of Practical Instrument largely overcoming These, based on Comparison by Valve-Voltmeter Method].—T. J. Rehfisch & H. T. Bissmire. (*Wireless Engineer*, July 1941, Vol. 18, No. 214, pp. 266–270.) From the Murphy laboratories.

3462. Measurement of Iron Cores at Radio Frequencies [Method of measuring Effective Permeability & Loss Factor: Derivation of Expressions for predicting Coil Characteristics from These Constants: Examples (Variation of Q with Frequency & with Coil Diameter, Core/Coil Capacitance Effects, etc.): Corrections for Internal Resistance: etc.].—D. E. Foster & A. E. Newlon. (*Proc. I.R.E.*, May 1941, Vol. 29, No. 5, pp. 266–276.)

3463. Testing Small Samples of Transformer Iron.—G.W.O.H: Lamson. (*Wireless Engineer*, Aug. 1941, Vol. 18, No. 215, pp. 307–309.) Editorial on the method dealt with in 2180 of August.

3464. Mechanical Rectifiers and Their Use in Measuring Technique.—W. A. E. Peters. (*E.T.Z.*, 3rd July 1941, Vol. 62, No. 27, pp. 606–610.)

Disadvantages of simple dry-plate rectifiers (variations with current, voltage, and temperature: ageing: unsuitability for small voltages and therefore for null methods): two can be used in a bridge circuit to form a phase-sensitive rectifier, but they must be carefully matched. Advantages and requirements of the mechanical rectifier. The rotating rectifier (Pfaffenberger: using a synchronous-clock movement). The vibrating-reed rectifier, simple type and type with adjustable contact-pause (Froböse), using a rotating-field device working off the mains: the excellent properties of this latter type for measuring purposes. The use of the mechanical rectifier for measuring voltage, current, and power: for point-by-point curve plotting: for the measurement of capacitance and of iron losses.

3465. A New Type of Direct-Current Amplifier [for Measuring & Control Purposes].—Eberhardt, Nüsslein, & Rupp. (*See* 3588.)

3466. Circular-Chart Recording Potentiometer without Galvanometer [primarily for Temperature Recording].—Brown Instrument. (*Review Scient. Instr.*, Aug. 1941, Vol. 12, No. 8, pp. 413–414.)

3467. Elimination of the Effect of the Cold Ends in Thermoelectric Temperature Measurement [Various Methods, including Use of OKL ("without-Cold-Soldered-Junction") Elements].—A. Kuntze. (*Zeitschr. V.D.I.*, 16th Aug. 1941, Vol. 85, No. 33, pp. 703–705.)

3468. A Vacuum-Tube Current Integrator [for Currents of about 0.04–0.9 μA].—G. J. Perlow. (*Review Scient. Instr.*, Aug. 1941, Vol. 12, No. 8, pp. 412–413.) *Cf.* Watt, 3119 of November.

3469. Measurement of Pre-Breakdown Currents in Dielectrics with a Cathode-Ray Tube [Currents around 10^{-8} A: Equipment & Results].—H. H. Race. (*Gen. Elec. Review*, Aug. 1941, Vol. 44, No. 8, pp. 445–450.)

3470. Peak-Factor Measuring Bridge for High Voltages.—H. Warnecke. (*Arch. f. Elektrot.*, 15th April 1941, Vol. 35, No. 4, pp. 229–244.)

3471. Electrolytic Condenser Test Set: a Simple Capacity-Measuring Bridge: Testing for Leakage.—F. A. Boyer. (*Wireless World*, Oct. 1941, Vol. 47, No. 10, pp. 254–255.)

3472. Standardised Condensers: More Efficient Production [Note on War Emergency Specification No. BS 271–1941]. — (*Wireless World*, Oct. 1941, Vol. 47, No. 10, p. 251.)

3473. A.S.T.M. Standards in the Radio Industry [List of Specifications & Test Methods covering General Purpose Materials].—(*ASTM Bulletin*, Aug. 1941, No. 111, p. 60.)

SUBSIDIARY APPARATUS AND MATERIALS

3474. Calculating Conductance [due to Electron Beam traversing a Transverse Alternating Field: Correction], *and* The Deflecting Condenser.—Rodda: Benham. (*See* 3340.)

3475. Addition to My Paper "On the Application of Electric and Magnetic Fields in Electron-Optics."—Brüche. (*T.F.T.*, Dec. 1940, Vol. 29, No. 12, p. 373.) *See* 2665 of 1940.

3476. The Fields of Electric System with Narrow Slits acting as Cylindrical Electron Lenses.—Strashkevich. (*Journ. of Tech. Phys.* [in Russian], No. 2, Vol. 10, 1940, pp. 91–111.)

A detailed theoretical investigation of the electric fields formed at the slits in charged conductors, which can be used as electron lenses. A brief survey of the literature on the subject is given, and systems consisting of one or several parallel planes and of one or several coaxial cylinders are considered. The distribution of potential in the field of such system is discussed and their electron-optical properties are examined. Methods are indicated for determining the trajectory of the electron beam. A theoretical proof is given of the experimental formula (2) due to Davisson and Calbick (*see* 1933 Abstracts, p. 224) for determining the focal length in the case of a plane with a single slit, and formula (28) and (29) are derived for calculating the focal length of a "weak" lens. Certain necessary corrections in the existing theory of the lenses are pointed out.

3477. The Calculation of the Magnetic Field of a Dihedral Angle.—Gubanov. (*Journ. of Tech. Phys.* (in Russian), No. 5, Vol. 10, 1940, pp. 376–394.)

The boundary between two media of magnetic permeability μ_1 and μ_2 is in the shape of a dihedral angle (Fig. 1): a current flows along a conductor N parallel to the edge of the angle, and it is required to determine the magnetic field at any point P of the space. An exact solution is given.

3478. Inductance-Linearised Time Base [Circuit where Charging Current returns to Initial Value just before Discharge, and remains Constant during Discharge: Theory, Experiment, & Design: Advantage of High Voltage - Utilisation Factor: useful for Special Purposes].—Williams & Fairweather. (*Wireless Engineer*, June & July 1941, Vol. 18, Nos. 213 & 214, pp. 224–231 & 271–276.) Chard's description of the operation of a similar circuit (3843 of 1937) is condemned. For a correction *see* August issue, No. 215, p. 312.

3479. Potential Dividers and Retarding Cables in the Oscillographic Recording of Rapid Transient Phenomena [Theoretical & Experimental Investigation of Factors influencing Accuracy of Resulting Records: Rôle of Cable Resistance is Predominant, of Dielectric Loss usually Negligible: Design of Practical Retarding Cable: etc.].—Angelini, Merega. (*Bull. Assoc. suisse des Élec.*, 18th July 1941, Vol. 32, No. 14, pp. 305–315: in French.)

3480. A Phase-Curve Tracer for Television [Phase Curve of Any Network shown on C.R.O. Screen].—Loughlin. (*See* 3410.)

3481. Secondary Emission: Some Effects on Deflector-Plate Characteristics of Cathode-Ray Tubes [Hard, Sealed, Low-Voltage Type: Experimental Investigation of Effects of Secondary Electrons returning from Screen & intercepted by Deflector Plates: of Secondary Electrons produced by Primary Electrons grazing the Plates & the Splitter Plate in Double-Beam Tubes: Interaction between X & Y Plates—"Pimple Effect": etc.].—Moss. (*Wireless Engineer*, Aug. 1941, Vol. 18, No. 215, pp. 309–312.)

3482. Effects of Heat Treatment on Field Emission from Metals.—Daniel. (*See* 3350.)

3483. The Cylindrical Electron Projector Tube in the Study of Thermionic and Field Emission.—Martin. (*See* 3351.)

3484. On the Question of the Space Charge in a Cathode-Ray Beam [and the Influence of the Hot-Cathode Temperature].—Reusse & Ripper. (*T.F.T.*, July 1940, Vol. 29, No. 7, pp. 199–201.)

Recent researches have shown that the electrical charges in a focused beam of electrons are distributed more or less according to a Gaussian curve of errors, with maximum density at the beam axis. The form of the curve is a function of the current strength in the beam and of the velocity of the carriers. Occasionally the "centre of gravity" of the charge is more or less displaced with respect to the axis. These researches (3626 of 1939 and 3366 of 1940: *also* Jacob, 3625 of 1939) also showed that in certain conditions the charge distribution may display inhomogeneities, which are explained on optical lines by the combined actions of the two lenses of which the focusing system generally consists.

Another important question is the influence of the cathode temperature. The theory of the focused beam shows that even if complete geometrical and electrical constancy of the focusing system is assumed, this influence must have its effect: the a in Law's expression for the distribution of charge density in the cross section of the beam (3802 of 1937) involves the absolute temperature T of the emitting surface, and Fig. 3 shows the calculated curves giving the ratio (density i at distance r from the beam axis)/(total emission) as a function of r for various temperatures. A rise from 1000° to 1250° K produces only a small change in the curve, but a rise of 2000° gives a quite different appearance to the charge distribution. Experimentally, this point has hitherto been neglected: Jacob found that a rise of 165° produced no noticeable effect, but this is only to be expected. The experiments here described, with results illustrated by the two i . r curves of Fig. 6 (for a final electron velocity of 4 kv), showed that at 2050° the maximum i ordinate is lower than that at 1070°, while the breadth of the curve along the r abscissa axis is greater. The surfaces enclosed by the two curves are about equal (equal total ray current). For the oxide cathodes at present used, with their limited temperature range, the effect can generally be neglected.

3485. Cathode-Ray Tube Electrode Mounting: *also* Simple Electrode Assembly for Cathode-Ray Tubes giving Ease of Assembly and Improved Rigidity & Alignment]: *and* Operating a Cathode-Ray Tube with Earthed Second Anode.—Anon: R.C.A. Laboratories. (*E. & Television & S-W.W.*, Jan. 1941, Vol. 14, No. 155, pp. 27 and 43: May, No. 159, p. 214: and April, No. 158, p. 150.)

3486. "10 Jahre Elektronenmikroskopie" [Book Review].—AEG Research Institute. (*Schweizer Arch. f. angew. Wiss. u. Tech.*, July 1941, Vol. 7, No. 7, p. 212.)

3487. Recent Developments in the Electron Microscope [leading to Description of the New R.C.A. Instrument (Resolving Power from 100×10^{-7} mm to 30×10^{-7} mm) of Compact Design, with New Stabilised Power Supply].—Hillier & Vance. (*Proc. I.R.E.*, April 1941, Vol. 29, No. 4, pp. 167–176.)

3488. Electron-Microscopy, a Neighbouring Field to Television Technique [Short Survey of Development in Instrument Design and Operating Technique].—von Ardenne. (*T.F.T.*, Dec. 1940, Vol. 29, No. 12, pp. 367–371.)

3489. The Object-Carrier Vibrator, a New Auxiliary for Electron-Microscopy and Microscopy [for Uniform Distribution of Particles over the Carrier-Foil].—von Ardenne. (*Kolloid-Zeitschr.*, No. 11, 1940.) Mentioned in 3488, above.

3490. A 200 kV Universal Electron-Microscope with Object-Shadowing Device [for Living Substances].—von Ardenne. (*Zeitschr. f. Phys.*, Vol. 117, 1941, p. 657 onwards.) Quoted in von Ardenne's paper, 3595, below.

3491. Papers on Electron-Microscopy of Living Substances and the Preparation of Special Object-Carrying Films for Such Purposes.—von Ardenne: Hass & Kehler. (*See* 3595 & 3596.)

3492. New Technique for making Thin Targets [Thicknesses down to 10^{-6} cm, Area 10 cm^2: backed only by Thin Cellulose-Acetate Films].—Pockman & Webster. (*Review Scient. Instr.*, Aug. 1941, Vol. 12, No. 8, pp. 389–392.)

3493. Photoelectric Conductivity of Zinc-Sulphide/Copper Phosphors under the Action of Alpha Rays.—Lappe. (*See* 3415.)

3494. A Supersonic-Cell Fluorometer [particularly suitable for "Fast" Phosphors: Some Results].—Briggs. (*Journ. Opt. Soc. Am.*, Aug. 1941, Vol. 31, No. 8, pp. 543–549.) A summary was dealt with in 1177 of April.

3495. Tantalum and Its Uses [in Transmitting Valves, particularly U.H.F.: Thermionic & Secondary Emission: Balkite Rectifier: Support & Conductor for Anodes (using Its Insulating Oxide Film): Mechanical Properties: etc.].—(*Review Scient. Instr.*, July 1941, Vol. 12, No. 7, pp. 374–375.) *Cf.* Kobayashi & Harashima, 1894 of July.

3496. Construction of Glass Bellows.—Pompeo & Meyer. (*Review Scient. Instr.*, July 1941, Vol. 12, No. 7, pp. 368–369.)

3497. Cements for Glass Inserts in Electrical Apparatus.—Paton. (*Engineering*, 26th Sept. 1941, Vol. 152, p. 245.) Summary of E.R.A. Report Ref. G/T. 131.

3498. Glass-to-Metal Seals: II [especially the Properties of Fernico: "42 Alloy" (Nickel-Iron), matching Special "1075" Glass: Chrome-Iron & Iron Seals: Strength of Seals].—Hull, Burger, & Navias. (*Journ. Applied Phys.*, Sept. 1941, Vol. 12, No. 9, pp. 698–707.) For I *see* 1184 of 1935.

3499. High-Vacuum Pumps and Pumping: an Outline of Modern Apparatus and Methods [including Vacuum Measurement].—Edwards & Company. (*E. & Television & S-W.W.*, Feb. 1941, Vol. 14, No. 156, pp. 55–59.)

3500. On the Outgassing of X-Ray Tubes and Kenotrons.—Popov & Bazykina. (*Journ. of Tech. Phys.* [in Russian], No. 4, Vol. 10, 1940, pp. 323–331.)

An experimental investigation of the outgassing of metallic and glass parts of X-ray tubes and kenotrons during various stages of the manufacturing process: practical suggestions are made.

3501. Thermoelectric Vacuum Meter [Limitations of Usual Hot-Wire Device with Temperature estimated by Resistance-Measurement or Thermoelement: Six-Fold Increase of Effect at Low Pressures obtained by Special Arrangement].—Moll & Burger. (*Zeitschr. f. tech. Phys.*, Vol. 21, 1940, p. 199 onwards: summary in *E.T.Z.*, 5th June 1941, Vol. 62, No. 23, p. 528.)

3502. An Ionisation Gauge Circuit [Pressures 10^{-3} to 10^{-7} mm Hg and below] with a "Magic Eye."—Parkins & Higinbotham. (*Review Scient. Instr.*, July 1941, Vol. 12, No. 7, pp. 366–367.) With "certain advantages" over Ridenour's circuit (2211 of August).

3503. The Ionic Densimeter.—Michelson & Sena. (*Journ. of Tech. Phys.* [in Russian], No. 3, Vol. 10, 1940, pp. 257–262.)

A device has been developed for measuring the density of gas or vapour in such apparatus as mercury-vapour rectifiers. The device is based on the following principle. If a grid D and a collector P parallel to it (Fig. 1) are placed in the gas or vapour whose density δ it is desired to measure, and an ion stream is passed through the grid, then the relationship between the ion current flowing onto P when this is at a negative potential with respect to D and that flowing when P is at a positive potential will be determined by a number of factors of which δ is one. This relationship is represented by formula (1), from which formula (2) is derived for determining δ. The accuracy of the method is discussed and it is shown that satisfactory results are obtained when the range of measurements (in the case of mercury vapour) extends over densities corresponding to pressures from 10^{-4}–10^{-3} mm to 10^{-2}–10^{-1} mm.

3504. On Starting an Electric Spark by Intense Ionisation of the Sparking Space [Use as Electric Relay, etc.].—Shimiza & Hirata. (*See* 3587.)

3505. The Breakdown of Compressed Gases at a High Pressure and with Small Separation between the Electrodes.—Blokhintsev, Vul, & Parnas. (*Journ. of Tech. Phys.* [in Russian], No. 5, Vol. 10, 1940, pp. 357–368.)

The breakdown voltage U of nitrogen was measured under pressures up to 90 kg/cm^2. With a distance of 0.3 mm between the electrodes, values of U of the order of 1.5×10^6 v/cm were obtained. The effect of the cathode material on U was also investigated, and methods are indicated for calculating U.

3506. Measurement of Pre-Breakdown Currents in Dielectrics with a Cathode-Ray Tube.—Race. (*See* 3469.)

3507. Investigation of the Relaxation Time in Mixtures of Polar and Non-Polar Liquids [Nitrobenzol, and Chlorbenzol, in Benzol: Measurements at 13.65 Mc/s: Discussion of Results on Basis of Kronig's Unified Theory of Acoustic, Electric, & Magnetic Relaxation Phenomena].—Spengler. (*Physik. Zeitschr.*, 15th June, 1941, Vol. 42, No. 7/8, pp. 134–143.) For Kronig's work *see* 2573 of 1938 and 1715 of 1939.

3508. Conduction of Electricity by Dielectric Liquids at High Field Strengths.—Plumley. (*Phys. Review*, 15th Jan. 1941, Vol. 59, No. 2, pp. 200–207.) *See* 1501 of May, and *cf.* Dornte, 2541 of September.

3509. Discharges in Insulation under Alternating-Current Stresses [Theoretical & Experimental Study of Internal Discharges in Insulation & in Model Circuits].—Austen & Whitehead. (*Journ. I.E.E.*, March 1941, Vol. 88, Part III, No. 1, pp. 18–22.)

3510. Correlation between Elastic Moduli and Viscosity of Liquids and Plastics [Theory & Applications].—Gemant. (*Journ. Applied Phys.*, Sept. 1941, Vol. 12, No. 9, pp. 680–685.) Prompted by the experimental results of Matteson & Vogt and Davies & Busse (3511 & 3512, below).

3511. Paper on the Velocity of Acoustical Waves in Petroleum Fractions [found to be Function of Density & Viscosity].—Matteson & Vogt. (*Journ. Applied Phys.*, Vol. 11, 1940, p. 658 onwards.) Referred to in Gemant's paper, 3510, above.

3512. Dielectric Properties of Plasticised Polyvinyl Chloride.—Davies & Busse. (*American Chemical Society* paper, referred to in Gemant's paper, 3510, above.)

3513. Contribution to the Theory of Anomalous Dispersion and Dielectric Loss in Solid Bodies [Polyvinyl Products, etc.].—Holzmüller. (*Physik. Zeitschr.*, 15th Nov. 1940, Vol. 41, No. 21/22, pp. 499–508.)

For practical work by the same writer *see* 2481 of September and back reference. Author's summary:—"The occurrence of dielectric loss in polar solids is traced to alteration of the equilibrium setting of the polar groups in the molecule to the individual minima of potential energy. It is shown that in the electric field the number of dipole moments at levels of higher potential energy is larger than when the field is removed. Since the new setting of the dipole moment past an energy threshold can only occur as the result of the combined action of strong heat pulses and electric field, this setting is dependent on time. By the introduction of one or more relaxation times the observed dependence of the dielectric constants and loss angles on frequency and temperature is explained. It is shown how the quantities important for the determination of the internal forces of cohesion in the molecule can be calculated from measurements of dielectric constant and tan δ.

"Since at present the calculations are limited to the establishment of equilibrium in the orientation of dipoles, and its dependence on the forces present, nothing can yet be said about the connection between viscosity and dielectric loss. An investigation in view, on the influence of intermolecular forces in movements of translation, promises to relate viscosity and ionic conductivity to place-interchange processes in solids, and to establish a connection between these different phenomena." Experimental confirmation of the theoretical work dealt with above has already been carried out and will be reported soon.

3514. Polystyrene and the Electrical Industry: a Short Review of Modern Developments [particularly "Distrene" Brand].—Yarsley. (*Electrician*, 10th Oct. 1941, Vol. 127, pp. 203–204.)

3515. Electrical Parts from Polystyrene.—Plax Corporation. (*Review Scient. Instr.*, Aug. 1941, Vol. 12, No. 8, p. 417.)

3516. Dielectric Constants and Loss Factors of Trolitul, etc., for 14 cm Waves.—Borgnis. (*See* 3435.)

3517. The Annealing of Photoelastic Bakelite and the Resulting Effect on Its Physical and Optical Properties.—Lee & Goldstein. (*Journ. Applied Phys.*, Aug. 1941, Vol. 12, No. 8, pp. 623–624: summary only.)

3518. Ceramics in Valve Construction [particularly Ceramic Seals for U.H.F. Valves].—Howard. (*See* 3344.)

3519. Low-Loss Ceramics for Radio-Frequency Use [Development, Manufacture, & Use: including Construction of Trimmer Condensers, High-Stability Inductances, etc.].—Britton. (*E. & Television & S-W.W.*, March & April, 1941, Vol. 14, Nos. 157 & 158, pp. 102–105 & 158–162 [with Corrections], and *Electronic Engineering* [new form of above], July 1941, Vol. 14, No. 161, pp. 301–303, 318.) From Steatite & Porcelain Products, Ltd.

3520. The Electrical Properties of High-Frequency Ceramics.—Rosenthal. (*Electronic Engineering* [formerly *E. & Television & S-W.W.*], Sept. & Oct. 1941, Vol. 14, Nos. 163 & 164, pp. 388–390 & 438–441.) "Much of the data in this article has not been hitherto published."

3521. Investigations on Phenoplastics: Part 3—The Dielectric Properties.—Stäger & others. (*Schweizer Arch. f. angew. Wiss. u. Tech.*, July 1941, Vol. 7, No. 7, pp. 201–208.) Final part of the paper mentioned in 3144 of November: the previous chapters dealt with the mechanical properties.

3522. Diffusion Calculations: Interrelation between Two Solutions of the Fourier Equation [primarily in connection with Plasticiser Losses].—Liebhafsky. (*See* 3552.)

3523. Laminated Impregnated Plastics [including "Permali" & "Pytram"].—Yarsley. (*Electrician*, 12th Sept. 1941, Vol. 127, p. 152.) Also "Jicwood," a special laminated wood "of extraordinary strength yet lighter by bulk than metal."

3524. The Electrical Breakdown of Rochelle Salt.—Gorelik. (*See* 3375.)

3525. Midget Tubular Oil-Filled Condensers [0.006–0.5 μF : up to 2000 V].—Aerovox Corporation. (*Review Scient. Instr.*, Aug. 1941, Vol. 12, No. 8, p. 416.)

3526. Mechanical Rectifiers and Their Use in Measuring Technique.—Peters. (*See* 3464.)

3527. The Influence of Oxygen Concentration in Oxidising and Tempering Stoves on the Direct and Reverse Currents of Cuprous-Oxide Rectifiers.—Tuchkevich. (*Journ. of Tech. Phys.* [in Russian], No. 9, Vol. 10, 1940, pp. 747–751.)

3528. Hall-Effect Measurements on Selenium.—Eckart & Kittel. (*Naturwiss.*, 13th June 1941, Vol. 29, No. 24/25, p. 371.)

Selenium is generally assumed to be an oxidation ("deficiency") semiconductor because in a selenium rectifier the pass direction is the same as in a cuprous-oxide rectifier, but hitherto no quantitative results have been reported to confirm this character and to give data on the mobility of the deficiency electrons in selenium. Now, however, the writers have succeeded in demonstrating an anomalous (positive) Hall effect in a specially highly conductive sample. The measurements yield a value for the mobility of the deficiency electrons (Hall constant × conductivity) of about 1 cm/sec./volt/cm.

3529. A Method for Calculating the Equivalent Noise Voltage and for Designing the Smoothing Choke for an Automatic Grid-Controlled Mercury Rectifier Operated with a Floating Battery.—Gubanov. (*Elektrosvyaz* [in Russian], No. 1, 1941, pp. 47–54.)

An analysis is given of the harmonic content of the rectified voltage as determined by the angle ψ at which the arc strikes (Fig. 1). The maximum value of ψ for a given mains-voltage variation is found, and methods are indicated for calculating the equivalent noise voltage and for designing the smoothing choke. Experiments have confirmed the validity of the methods proposed.

3530. Improvements in B-Battery Portability [Package Size per Unit of Capacity reduced by about 50% : Design of "Minimax" Types].—French : Ever-Ready Company. (*Proc. I.R.E.*, June 1941, Vol. 29, No. 6, pp. 299–303.) *See* also 1062 of April.

3531. The Production of Thin Metal Wires.—Makovski. (*Journ. of Tech. Phys.* [in Russian], No. 4, Vol. 10, 1940, pp. 342–343.)

A small piece of metal is placed inside a glass tube which is then heated (Fig. 1) and extended to obtain a wire of the desired thickness. Wires down to 0.001 mm diam. were thus obtained, even from brittle metals.

3532. "Electrolytische Wanderung in flüssigen und festen Metallen" [Electrolytic Migration in Liquid & Solid Metals : Book Review].—Schwarz. (*Physik. Zeitschr.*, March 1941, Vol. 42, No. 4/5, p. 81.)

3533. Modern Materials in Telecommunications : Part IV—Magnetic Materials : Part V—Metallic Conductors.—Radley & others. (*P.O. Elec. Eng. Journ.*, April & July 1941, Vol. 34, Parts 1 & 2, pp. 19–25 & 72–78.) For previous parts *see* 1210/11 of April.

3534. Load Currents in Transformers with Several Secondary Windings.—Wolff. (*See* 3284.)

3535. Measurement of Iron Cores at Radio Frequencies.—Foster & Newlon. (*See* 3462.)

3536. Ferrocart [Complete Disintegration of Sample Core supplied in 1933 (Schneider, 1933 Abstracts, p. 403) : Enquiry for Other Experiences with This Material].—G.W.O.H. (*Wireless Engineer*, Sept. 1941, Vol. 18, No. 216, p. 352.)

3537. The Manufacture and Properties of Compressed-Powder Permanent Magnets.—Dehler. (*E.T.Z.*, 3rd July 1941, Vol. 62, No. 27, pp. 601–606.)

The writer begins with information about the improved permanent-magnet steels developed during the past ten years, and then discusses their limitations, such as the tendency to form cracks under severe vibration, lack of homogeneity, and general intractability (for any but the simplest designs). He then reviews briefly the recent promising development of sintered materials, both the Japanese "oxide magnets" and the aluminium-nickel-iron materials (*e.g.* Ritzau, 2878 of October), with a possible admixture of cobalt or copper : the objection is their expense. The use of powder contained in permanent containers of the desired shape has been tried, but has its defects : for instance the container is inclined to increase the air-gap undesirably.

The rest of the paper describes the preparation of compressed-powder magnets with synthetic-resin binders. Such materials are produced under the name of Tromalit (German Patent 656 966, Baermann). The circular-sectioned coaxial magnet shown in Fig. 11, with diameter 12 mm and air-gap 1.5 mm, gave a max. gap flux density of 2260 gauss when made of cast Oerstit and of 1720 gauss when made of the powder material : this represents a drop of nearly 25% for the latter, but the difference would decrease with increase of air-gap or with decrease in the size of the core, and in many cases would be eliminated altogether by the possibilities offered by the powder material of special shapes unattainable with the cast material. The saving in labour is very great. The paper includes a number of patent and literature references, some of the latter being to metallurgical journals not dealt with in these Abstracts.

STATIONS, DESIGN AND OPERATION

3538. Observations of Frequency-Modulation Propagation on 26 Megacycles.—Crosby. (*See* 3219.)

3539. Radio Telephone Service in Chesapeake Bay, *and* Radio Equipment for the Crisfield Projects [Ultra-Short-Wave Link between Islands & Mainland].—Taylor : Bailey. (*Bell Lab. Record*, Aug. 1941, Vol. 19, No. 12, pp. 358–362 : pp. 363–366.)

3540. Automatic Relay Stations to increase Range of Transmitters for Forest Fire-Fighting Parachutists.—(*Sci. News Letter*, 21st June 1941, Vol. 39, No. 25, p. 398.)

3541. Radio Equipment for an Unmanned Weather Station.—Pear. (*Sci. Abstracts*, Sec. B, Aug. 1941, Vol. 44, No. 524, p. 164.) *Cf.* Diamond & Hinman, 4463 of 1940.

3542. Some Considerations of Fighter-Aircraft Radio.—Cannell. (*E. & Television & S-W.W.*, May 1941, Vol. 14, No. 159, p. 203.)

3543. A Five-Band Receiver for Automobile Service [and the Suggestion that Short Waves (in International S.W. Band) should be used for the Many Sections of U.S.A. which are without Adequate Daylight Broadcasting Service].—Little & Rettenmeyer. (*Proc. I.R.E.*, April 1941, Vol. 29, No. 4, pp. 151–166.)

3544. Wire-Broadcasting Measuring Technique [developed by German P.O. & Industry : Selective Measurement of Carrier Voltages : Monitoring of Quality (Modulation Factor, Frequency Characteristic, Contrast, Distortion Factor, Non-Linear Cross-Talk, Interference) : Line Attenuation, Input Impedance, Characteristic Impedance : Test Truck for Special Measurements].—Eisele. (*E.T.Z.*, 5th June 1941, Vol. 62, No. 23, pp. 513–519.)

3545. The High-Frequency Distortions in Wire Broadcasting [Non-Linear Distortion More Serious than in A.F. Technique : Amplitude Distortion fundamentally Less Serious, but actually Important owing to Use of Existing Telephone System : Its Production (& Counter-Measures)—Attenuation Distortion, Matching Distortion, Terminal Distortion, Cross-Over Distortion on Overhead Lines].—Klein. (*T.F.T.*, Nov. 1940, Vol. 29, No. 11, pp. 331–334.)

3546. Matching Problems in Wire-Broadcasting Line Material [Trunk Lines, Subscriber's Line, Special H.F. Connections, etc.].—Klein. (*T.F.T.*, Dec. 1940, Vol. 29, No. 12, pp. 363–367.)

3547. Future of European Broadcasting : Some Technical Aspects of Channel Allocation.—Braillard. (*Wireless World*, Oct. 1941, Vol. 47, No. 10, pp. 252–253.) Discussion of Braillard's paper in *Journ. des Télécommunications*.

3548. The Terminal Equipment of the Berne New York Wireless Telephone Link.—Jacot. (*E.T.Z.*, 19th June 1941, Vol. 62, No. 25, pp. 579–580 : summary only.)

3549. Medium-Frequency Telegraphy System (MFS) on Open Lines [Frequencies 3–8 kc/s, giving up to Six Additional Channels, in Gap between L.F. and Carrier-Frequency Telephony Channels].—Fülling & Pretzsch. (*T.F.T.*, Dec. 1940, Vol. 29, No. 12, pp. 345–353.)

MISCELLANEOUS

3550. A Simple Introduction to the Use of Statistics in Telecommunications Engineering : Part I—Samples obeying the Normal Probability Law : Part II—Analysis of Small Samples [and the Nomographic Use of Fisher's "t" Test].—Doust & Josephs. (*P.O. Elec. Eng. Journ.*, April & July 1941, Vol. 34, Parts 1 & 2, pp. 36–41 & 79–84.)

3551. Industrial Mathematics [Mathematical Specialists in Industry : Present & Future Utilisation of Mathematics in Communications, Electrical Manufacturing, & Other Industries].—Fry. (*Bell S. Tech. Journ.*, July 1941, Vol. 20, No. 3, pp. 255–292.)

3552. Diffusion Calculations : Interrelation between Two Solutions of the Fourier Equation [Sine-Series Solution (Slab with Sealed Periphery) & Error-Function Solution (for Semi-Infinite Body) : leading to Simplification in Calculation of Diffusion Constants].—Liebhafsky. (*Journ. Applied Phys.*, Sept. 1941, Vol. 12, No. 9, pp. 707–710.)

Primarily for the evaluation of measured losses of plasticisers from polyvinyl-chloride plastics, but applicable to other cases of flow governed by the fundamental Fourier equation $\partial c/\partial t = D\partial^2 c/\partial x^2$.

3553. Automatic Integration of Linear Second-Order Differential Equations by means of Punched-Card Machines.—Feinstein & Schwarzschild. (*Review Scient. Instr.*, Aug. 1941, Vol. 12, No. 8, pp. 405–408.)

3554. The Solution of A.C. Circuit Problems [Method depending chiefly on Matrix Multiplication (simply performed by Calculating Machine) and avoiding Complex Numbers].—Pipes. (*Journ. Applied Phys.*, Sept. 1941, Vol. 12, No. 9, pp. 685–691.)

3555. "Four-Figure Tables with Mathematical Formulae" [Book Review].—Plummer. (*Phil. Mag.*, June 1941, Vol. 31, No. 209, p. 510.) The collection of formulae is expanded from that originally prepared by C. S. Wright.

3556. "A Bibliography of Orthogonal Polynomials" [Book Review].—Shohat & others. (*Phil. Mag.*, June 1941, Vol. 31, No. 209, p. 507.)

3557. "Mechanical Vibrations: Second Edition" [Book Review].—Den Hartog. (*Engineering*, 26th Sept. 1941, Vol. 152, pp. 243–244.)

3558. Cycles per Second [Editorial on Discussion dealt with in 1813 of June].—G.W.O.H. (*Wireless Engineer*, May 1941, Vol. 18, No. 212, p. 179.)

3559. Circuit-Designation Method [New System].—Caldwell. (*See* 3288.)

3560. New-Style Jamming: Imagination in Wireless Warfare [Editorial on the Deutschlandsender "Voice," etc.].—(*Wireless World*, Oct. 1941, Vol. 47, No. 10, p. 247.) Development of 3161 of November.

3561. Raid Warning by Radio [RCA Alert Receiver automatically Switched-On by Special Inaudible Signal].—(*Sci. News Letter*, 16th Aug. 1941, Vol. 40, No. 7, p. 99: for comments see *Wireless World*, Nov. 1941, p. 284.)

3562. Centralised Remote Control [for A.R.P. Work, etc.]: Details of a New Ripple-Control (Low-Tension System) employing Mains Wiring.—General Electric. (*E. & Television & S-W.W.*, April 1941, Vol. 14, No. 158, pp. 165–167.) *Cf.* 260 of January.

3563. The Detection of Incendiary Bombs by Electrical, Electronic, Thermostatic, and Radio-Active Devices.—I.E.E. Committee. (*E. & Television & S-W.W.*, May 1941, Vol. 14, No. 159, pp. 198–200 and 238: abstract.) *Cf.* 3198 of November.

3564. The "Supply" of Physicists [and the National Roster of Specialised "Personnel"].—(*Journ. Applied Phys.*, Sept. 1941, Vol. 12, No. 9, pp. 655–657.)

3565. Technical Education in New South Wales.—Riddell. (*Journ. Inst. Eng. Australia*, June 1941, Vol. 13, No. 6, pp. 139–145.)

3566. Present-Day Science and Technology in the U.S.S.R.—Bernal. (*Nature*, 27th Sept. 1941, Vol. 148, pp. 360–361.)

3567. The British Association: Contribution of Science to World Order: International Conference in London.—(*Electrician*, 3rd Oct. 1941, Vol. 127, p. 189.) *See* also *Nature*, 4th & 11th Oct. 1941, pp. 388–393 & 424–427: also 18th & 25th October.

3568. A Scientific Press Bureau [Plea for].—Johnston. (*Nature*, 27th Sept. 1941, Vol. 148, p. 375.) *See* also Evans, *ibid.*, 11th Oct., p. 434.

3569. Summer Convention, June 23rd to 25th, 1941, at Detroit: Summaries of Papers, *and* Address of President Terman at the Summer Convention Banquet.—(*Proc. I.R.E.*, April 1941, Vol. 29, No. 4, pp. 220–229: July, No. 7, pp. 406–408.)

3570. Regional Directors proposed in New I.R.E. Constitutional Amendment [with Discussion].—Terman. (*Proc. I.R.E.*, July 1941, Vol. 29, No. 7, pp. 408–411.)

3571. Radio Progress during 1940 [Electronics, Transmitters (& Aerials), Receivers, Frequency Modulation, Television & Facsimile, Electroacoustics, Propagation].—(*Proc. I.R.E.*, March 1941, Vol. 29, No. 3, pp. 89–103.)

3572. Review of Progress in Electronics: I—Introduction and General Bibliography.—Windred. (*E. & Television & S-W.W.*, April 1941, Vol. 14, No. 158, pp. 151–152 and 154.) Beginning of a series.

3573. A Thyratron-Controlled Annealing Furnace.—Tarnopol. (*Review Scient. Instr.*, July 1941, Vol. 12, No. 7, pp. 367–368.) Control better than ± 0.03° C (at 1000° C) for any required long period.

3574. An Integrator for Small Currents [Neon Tube, Amplifier, & Mechanical Counter Combination].—Watt. (*See* 3119 of November.) *See* also 3468, above.

3575. The Dead-Time of a Geiger Counter [Direct Measurements: about 10^{-4} Sec. for 1″-Diam. Counter], *and* Circuit Independence of Charge in Fast Counter Pulses.—Stever. (*Phys. Review*, 15th Jan. 1941, Vol. 59, No. 2, p. 219: 15th July 1941, Vol. 60, No. 2, p. 160: summaries only.)

3576. Time Lags in Geiger-Müller Counter Discharges.—Montgomery & Montgomery. (*Phys. Review*, 15th June 1941, Vol. 59, No. 12, p. 1045.)

3577. The Harmonic Analysis of Geiger-Counter Pulses.—Shankland & Blythe. (*Phys. Review*, 1st July 1941, Vol. 60, No. 1, pp. 64–65: summary only.)

3578. Electronic Cup-Anemometer [Rotation of Perforated Disc interrupts Oscillator].—Gurley. (*Review Scient. Instr.*, July 1941, Vol. 12, No. 7, p. 373.) *Cf.* Goncharski, 2005 of July.

3579. Epicyclic Gear Trains for Difficult Ratios.—Boys. (*Journ. of Scient. Instr.*, Oct. 1941, Vol. 18, No. 10, pp. 195–200.) Complementary to Clay's paper, 1990 of July.

3580. Quartz Indicator with High Natural Frequency [for I.C. Engines, etc: Ordinary Quartz Pick-Up unsuitable for Knock Investigations: Development of Type with Natural Frequency as high as 100 kc/s].—Schmidt. (*Zeitschr. V.D.I.*, 19th July 1941, Vol. 85, No. 29, p. 644: summary only.) *See* also 2810 of 1940.

3581. Measurement of the Natural Frequency of Piezoelectric Pressure-Measuring Devices [and the Advantages of the Steel-Ball Impact Method].—Gohlke. (*Zeitschr. f. Instr:kunde*, June 1941, Vol. 61, No. 6, pp. 197–198: summary only.)

3582. Theory and Application of Resistance Tuning [Special Suitability of Transitron Oscillator: Applications to Industrial (Temperature, Pressure, Humidity, etc.) Measurements].—Brunetti & Weiss. (*See* 3253.)

3583. The Measurement of Variable Stresses by a String Method.—Sobolev. (*Journ. of Tech. Phys.* [in Russian], No. 4, Vol. 10, 1940, pp. 309–315.)

A wire is stretched between two points on the object under investigation and excited into oscillations by two electromagnets spaced apart along the wire and fed respectively from the input and output of a 3-valve amplifier (Fig. 4). The resulting oscillations are frequency-modulated by the periodic movement of the supports. The output of the amplifier is used to pull a second oscillator into synchronism. The coupling circuit will then contain the modulating frequency, *i.e.* the oscillation frequency of the object, which is rectified and recorded on sensitised paper.

3584. Investigations on Electrodynamic Testing [of the Mechanical Strength of Conductors subject to Short-Circuit Currents, etc: Tests with Square-Wave Pulses, & Detection of Movement by Capacity-Change Method].—Aebi. (*Schweizer Arch. f. angew. Wiss. u. Tech.*, July 1941, Vol. 7, No. 7, pp. 185–195.)

3585. Velocity Measurement of Transient Mechanical Motions [of Cam Mechanisms, Triggers, etc: using a Mirror Oscillograph].—Keilien. (*Journ. Applied Phys.*, Aug. 1941, Vol. 12, No. 8, pp. 634–637.)

3586. Eddy-Current Induction applied to the Determination of Accelerations [and Possible Applications of the New Principle, including to Motor Speed Control].—Forbes. (*Review Scient. Instr.*, Aug. 1941, Vol. 12, No. 8, pp. 398–401.)

3587. On Starting an Electric Spark by Intense Ionisation of the Sparking Space [One Electrode hollowed, with Thin Metal Window and High-Vacuum Cathode-Ray (Triode) Generator: Critical Potential reduced by 30%, Spark Time Lag less than 10^{-7} Sec: Use as Electric Relay, Light Source for Instantaneous Photography, Chronograph for Short Time Intervals].—Shimiza & Hirata. (*Journ. Roy. Aeron. Soc.*, Oct. 1941, Vol. 45, No. 370, pp. 346–347: abstract only.)

3588. A New Type of Direct-Current Amplifier [for Measuring Purposes, Supervision & Control of Processes, etc.].—Eberhardt, Nüsslein, & Rupp. (*E.T.Z.*, 29th May, 1941, Vol. 62, No. 22, pp. 493–497.)

Authors' summary:—"After a short survey of the previous development of d.c. amplifiers for measuring purposes, culminating in the photocell-compensator [Gilbert's "photoelectric potentiometer," 1651 of 1936], fundamental considerations on opposed-coupling d.c. amplifiers are discussed.

"A practically useful d.c. amplifier for process measurements, possessing a constant amplification in face of supply-voltage fluctuations and the ageing of valves, and in addition a constant zero point, can be developed by the following combination:—transformation of the d.c. voltage under measurement, as it enters the amplifier, into an alternating voltage: amplification of this, followed by rectification by a phase-sensitive rectifier: compensation of the input voltage by opposed coupling of the output voltage [theoretical scheme Fig. 1]. By special design of the opposed-coupling channel [insertion of a suitable RC element], the effect of an 'elastic lead-back' can be obtained which will reduce the response time of the indicating or controlling instrument connected to the output terminals. The employment of non-linear elements in the opposed-coupling channel gives the amplifier a definite non-linear relation between input and output values, so that the characteristic of a non-linear pick-up device or receiver can be compensated. . . ." The elimination of a sensitive control-galvanometer renders the apparatus insensitive to vibrations (in railway trains, etc.) and the circuit enables it to stand practically any overload.

3589. Regulating Methods in Controllable Electrical Systems and the Criteria for Their Stability.—Artus. (*See* 3256.)

3590. Gas-Filled Triodes and Their Practical Use [in Laboratory & in Industry].—Windred. (*See* 3359.)

3591. Magnetic Methods used for Testing Industrial Goods [Survey].—Grigorov. (*Journ. of Tech. Phys.* [in Russian], No. 6, Vol. 10, 1940, pp. 441–458.)

3592. Ultrasonics [with Particular Attention to Metallurgical Applications].—(*See* 3079 of November.)

3593. Detection and Examination of the Protecting Passive Oxide Layers formed on Iron, with the Help of the Electron Scanner [which brings out the Varying Secondary Emission].—Knoll. (*Physik. Zeitschr.*, 15th June 1941, Vol. 42, No. 7/8, pp. 120–122 and Plate.) *See* 4111 of 1939.

3594. Surface Studies with the Electron Microscope [of Standard "Transmission" Type, by preparing Suitable Replicas: Special Techniques].—Zworykin & Ramberg. (*Journ. Applied Phys.*, Sept. 1941, Vol. 12, No. 9, pp. 692–695.) Pending, perhaps, the full development of the electron-probe scanning method.

3595. Electron-Microscopy of Living Substances, *and* The Germination of Spores of *Bacillus Vulgatus* after Previous Observation in the 200 kV Universal Electron-Microscope.—von Ardenne: von Ardenne & Friedrich-Freksa. (*Naturwiss.*, 29th Aug. 1941, Vol. 29, No. 35, pp. 521–523: pp. 523–528.)

The conclusions reached in the writer's paper (4108 of 1939) on the possibility of such a technique have been applied to the design of the special Universal electron-microscope with "object-shadowing" device (3490, above). It was then found that the advantages of the recommended increase in accelerating potential had been underestimated, since it not only decreased the number of electrons necessary for blackening the photographic plate but also diminished the sensitivity of the living material to damage by the electrons; it is estimated that the "loading conditions" of the living substance improve with the 2.5th power of the accelerating potential, so that the change from the usual 60 kv to 200 kv improved these conditions in the proportion of about 1 : 20. Further, the increased potential rendered the object-carrier (Hass & Kehler's aluminium-oxide foil—3596, below) completely transparent, so that the safety factor of 10 allowing for the attenuation due to the carrier could be omitted, thus improving the ratio to about 1 : 200 compared with the original estimate. These facts, combined with the "object-shadowing" device, have enabled the new instrument to take the first electron-microscope records of living processes, examples of which are reproduced in the second of these two papers : loadings around 10^{-6} coulomb/cm^2 are estimated. The first paper quotes (from the complete account of the apparatus, *loc. cit.*) a general expression for the highest resolving power possible for the photographic recording of the images of living substances, and applies this to the present conditions and future possibilities ; it then concentrates on the design and use of the "object-shadowing" device (with the refinements necessary for its successful adjustment) by which the object is protected against the electrons except during the critical moment of exposure.

3596. A TEMPERATURE-RESISTANT AND DURABLE CARRIER-FILM FOR ELECTRON - INTERFERENCE RECORDING AND ELECTRON-MICROSCOPIC INVESTIGATIONS [Aluminium-Oxide Film].—Hass & Kehler. (*Kolloid-Zeitschr.*, No. 1, Vol. 95, 1941, p. 26 onwards.) Quoted in 3595, above.

3597. THE GENERATION OF HIGH POWERS ON SHORT WAVES WITH QUENCHED SPARK GAPS.—Schönfeld. (*See* 3289.)

3598. LOW-FREQUENCY ["Shock"] THERAPY : A NEW TECHNIQUE IN THE TREATMENT OF MENTAL DISEASES, *and* DESIGN FOR 3-METRE RADIO - THERAPY APPARATUS. — Edison-Swan : Clark. (*E. & Television & S-W.W.*, Feb. 1941, Vol. 14, No. 156, pp. 71 and 95 : April, No. 158, pp. 155–157.)

3599. THE DEPENDENCE OF THE SECONDARY ELECTRON EMISSION PRODUCED BY GAMMA RADIATION UPON THE DIRECTION OF THE RADIATION [in Radiation Therapy].—Wilson. (*Proc. Phys. Soc.*, 1st Sept. 1941, Vol. 53, Part 5, No. 299, pp. 613–623.)

3600. PRODUCTION AND USE OF NEUTRONS.—Heyn. (*E. & Television & S-W.W.*, April 1941, Vol. 14, No. 158, pp. 171–173 and 186, 187.) From the Philips laboratories.

3601. JUNIOR ELECTROENCEPHALOGRAPH [Rugged & Simple : Instantaneous Dry-Tape Recording : Sensitivity ½ mm/μV].—Electro-Medical Laboratory. (*Review Scient. Instr.*, Aug. 1941, Vol. 12, No. 8, p. 414.)

3602. ELECTRETS MADE FROM DRY-MIXED COMPONENTS, *and* EFFECT OF PRESSURE ON THE SURFACE CHARGE OF AN ELECTRET.—Dodds, Stranathan, Sheppard. (*See* 3251.)

3603. CONTACT ELECTRIFICATION OF SOLID PARTICLES [and Fleming's Results].—Schnurmann. (*Proc. Phys. Soc.*, 1st Sept. 1941, Vol. 53, Part 5, No. 299, pp. 547–553.) *Cf.* 1001 of March.

3604. A NOTE ON THE DEMONSTRATION OF THE PHOTOEFFECT WITH A GLOW-DISCHARGE LAMP [and the Possibility of using a Modern 110 V Lamp (with Barium-treated Electrodes) to replace a Photocell in Various Applications, particularly for Demonstrations].—Metzger. (*Physik. Zeitschr.*, 15th Nov. 1940, Vol. 41, No. 21/22, pp. 508–510.)

Although the decrease in ignition voltage occurring in a glow-discharge lamp on irradiation will increase the relaxation-oscillation frequency of a suitable circuit, such an arrangement cannot be used for photometric measurements because there is no simple relation between the voltage-reduction and the intensity of illumination. The writer, however, has found that the Osram "Beehive" glow-discharge bulbs for 110 volts (not those for 220 volts), having barium-treated electrodes, display a photoeffect resulting not only in the decrease of ignition voltage but also in a photocurrent capable of working a relay. The max. sensitivity is around 420–530 mμ, but there is a certain amount of response in the red region : the photocurrent for daylight is 3 or 4 times larger than for the light of an incandescent bulb. For voltages at least 30% below the ignition voltage the photocurrent/illumination curve is linear.

3605. A REVIEW OF THE DEVELOPMENT OF SENSITIVE PHOTOTUBES [with over 80 Literature References].—Glover. (*Proc. I.R.E.*, Aug. 1941, Vol. 29, No. 8, pp. 413–423.)

3606. THE TREND TOWARDS ELECTRONICS IN ENGINEERING [including Use of Photocells, etc., in Industry].—Langford Smith. (*Journ. Inst. Eng. Australia*, June 1941, Vol. 13, No. 6, p. 147 : summary only.)

3607. PHOTOCELL CONTROL OF WATER CHLORINATION [with Help of Ortho-Tolidine as Indicator].—Harrington. (*E.T.Z.*, 10th July 1941, Vol. 62, No. 28, p. 630 : summary of Canadian paper.)

3608. ON THE PREPARATION OF A THERMAL LIGHT-SOURCE WHICH CAN BE MODULATED AT NOTE FREQUENCIES.—Lattmann. (*Schweizer Arch. f. angew. Wiss. u. Tech.*, Aug. 1940, Vol. 6, No. 8, pp. 212–224.)

Concluded from a previous issue. Conversion of elder pith into a carbon cellular structure, into a tungsten structure, and into a tantalum carbide structure : the construction of experimental tubes for heating these structures by electron bombardment, controlled by a grid : tests on modulation : etc. "Modulation factors at the higher note frequencies can be attained such as have never previously been possible with thermal modulation. Since it is possible by this method easily to prepare luminous surfaces of high light density, it is quite particularly suitable for the construction of a radiator for optical telephony." The previous instalment deals with the theoretical treatment of the problem : its results are confirmed by these tests.

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