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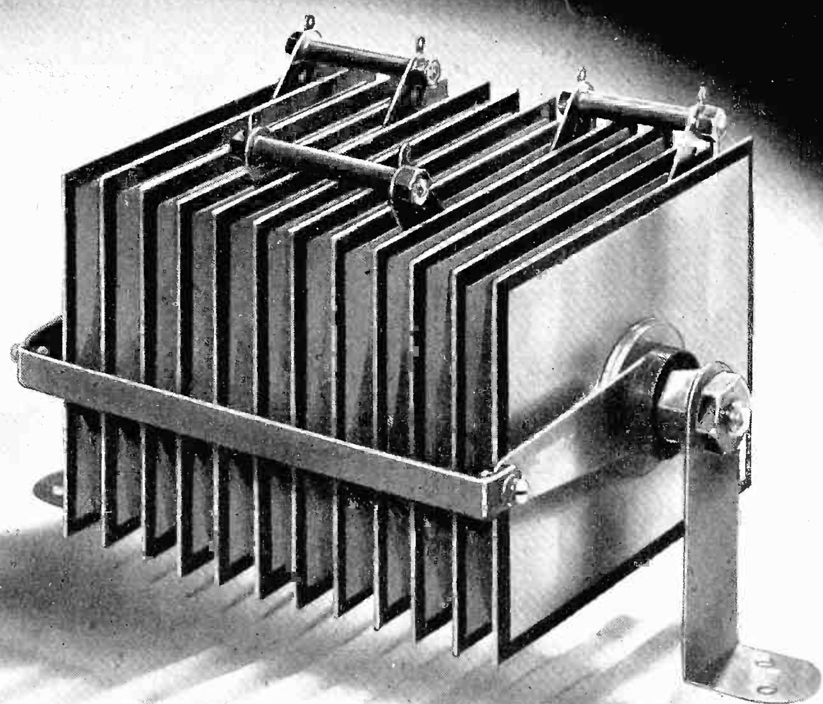

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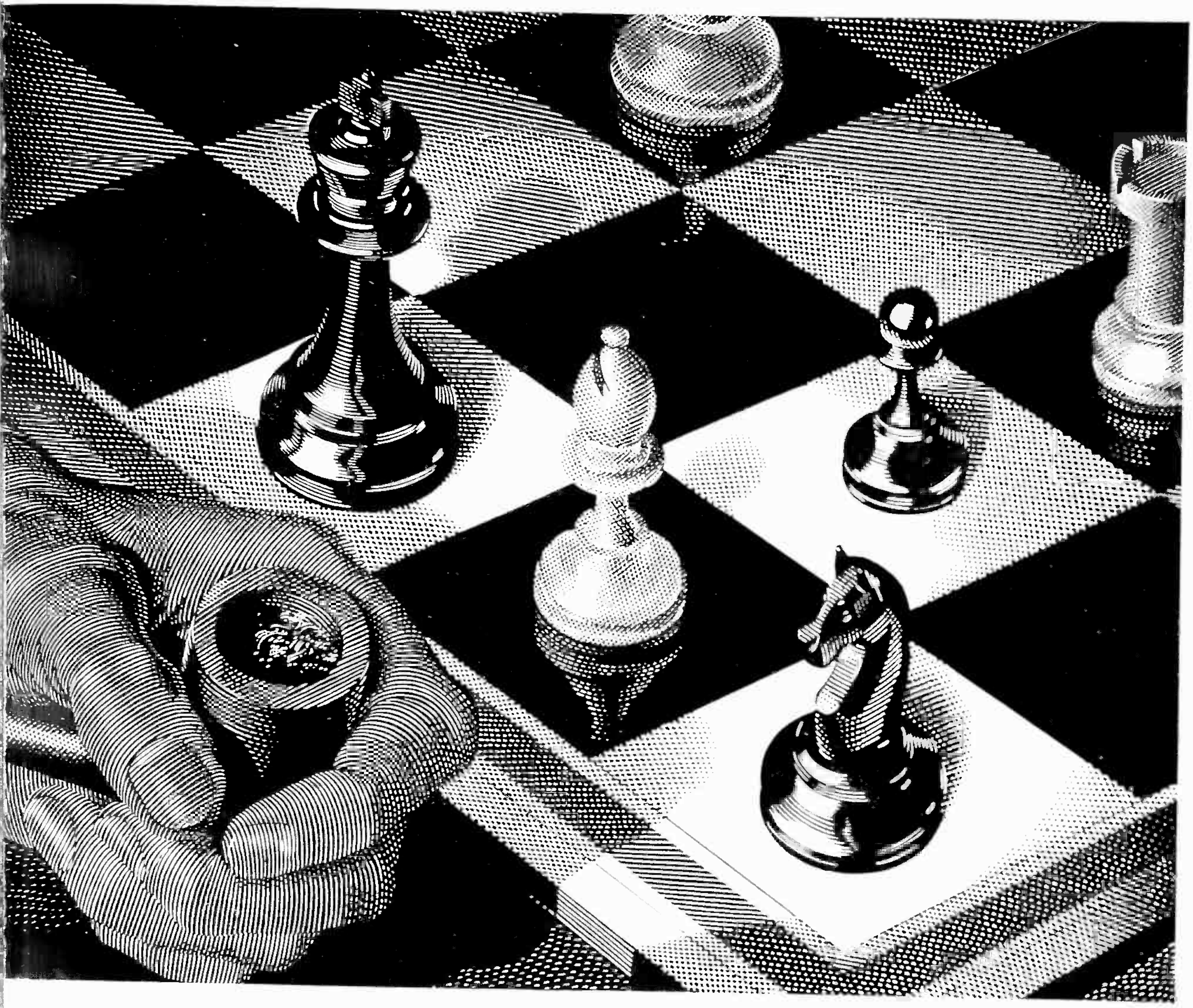

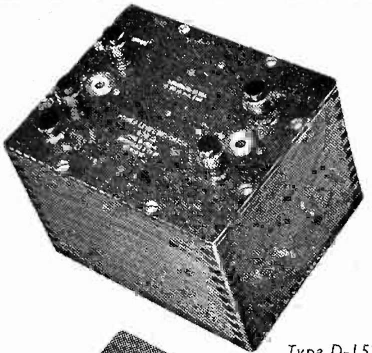

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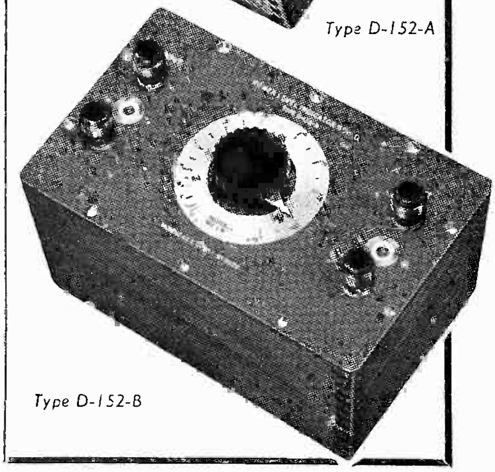

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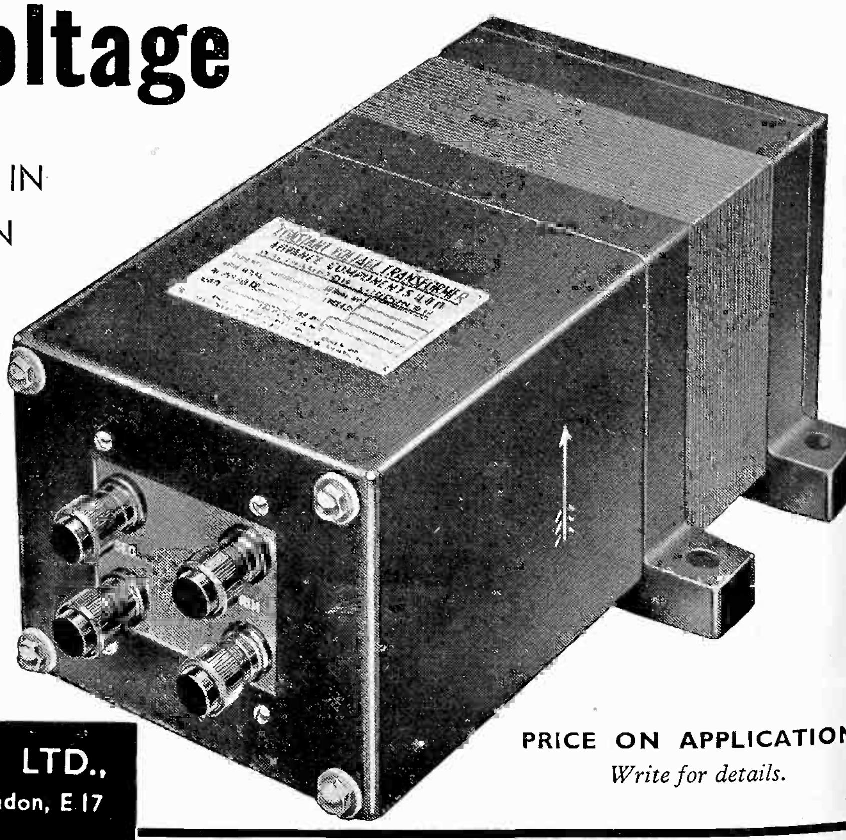

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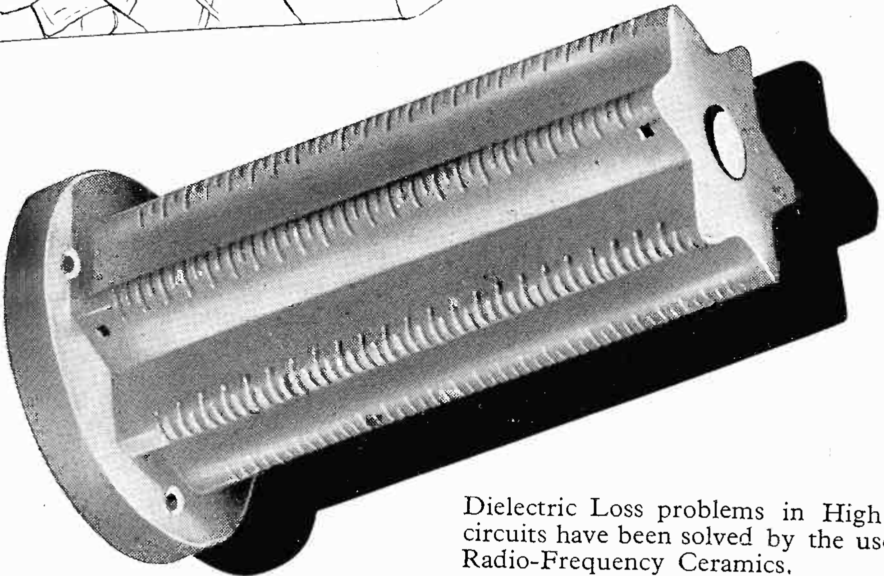

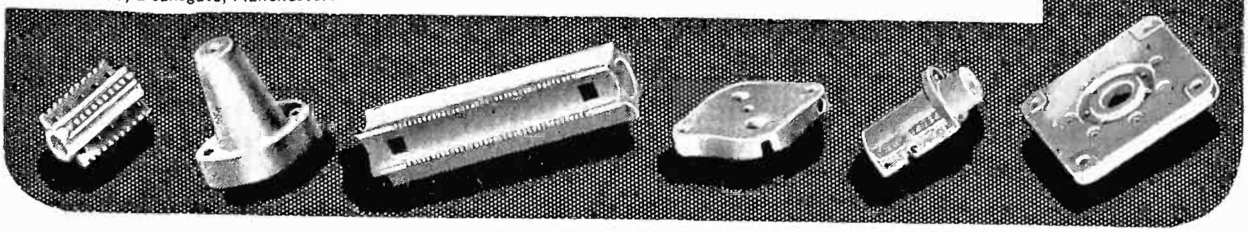

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WIRELESS ENGINEER

Editor HUGH S. POCOCK, M.I.E.E. Technical Editor Prof. G. W. O. HOWE, D.Sc., M.I.E.E

VOL. XIX JULY 1942 No. 226

Editorial

Permanent Magnets

NO subject is more full of surprises than magnetism. What would we think if, on making an alloy of copper and iron, we found it to be a good insulator, or if, on mixing ebonite and bakelite in certain proportions, we discovered the product to be a good conductor? In magnetism, however, we have now grown accustomed to very analogous surprises. As long ago as 1889 Hopkinson discovered that an alloy of 75 per cent. iron and 25 per cent. nickel was practically non-magnetic, and in 1903 Heusler found that an alloy of manganese, copper and aluminium was strongly magnetic. An alloy of 80 per cent. nickel and 20 per cent. iron has an initial permeability 20 or 30 times that of pure iron and is known as permalloy, whilst a 50 per cent. iron-cobalt alloy with 2 per cent. of vanadium has a permeability at high flux densities several times that of pure iron. Turning to material for permanent magnets, Ewing wrote in 1891: "Chromium and tungsten increase the coercive force immensely; and tungsten in particular is a usual constituent in magnet steel. In soft iron, as we have seen, the coercive force is about 2, or sometimes even less. In chrome steel, hardened by quenching in oil, it is 40, and in tungsten steel it may exceed 50." Permanent magnets can now be made with a coercive force of 600 and without a trace of tungsten or chromium. This has been the result of successive discoveries; first that of the cobalt steels about 25 years ago, the 35 per cent. cobalt steel having about four times the coercive force of tungsten steel for a small sacrifice of remanence, then in recent years the further addition of nickel and aluminium giving the "Alnico" type of alloys with a further doubling of the coercive force, and finally the effect of the application of a magnetic field during cooling with a considerable increase in the remanence in the desired direction. According to the patent specification* the application of a magnetic field in the desired direction during the cooling from about 1,200 deg. C. in the magnetic hardening process will in certain alloys more than double the value of $(BH)_{max}$, giving values between 4.10^6 and 5.10^6. The value of $(BH)_{max}$ depends not only on the remanent induction B_r and the coercive force H_c but also on the shape of the demagnetisation curve, anything that causes the curve to arch or bulge giving obviously a bigger value of $(BH)_{max}$ and therefore a better material for permanent magnets. One might at first sight think that it would be important to maintain the polarity in the desired direction the same as that given to it during cooling, but this is not so. Provided that the magnetising force is great enough, it does not matter which end is made north and which south, the remanent induction is the same in either direction and about double what it is in a direction at right angles. The effect of the

* No. 522,731 of 1938 (Philips).

applied field during cooling is to align the domains or atomic groups so that one of their preferred directions of magnetisation lies predominatingly along the desired axis. Their other preferred directions may be in any directions at right angles to the axis. If one arranged a lot of cubes so that they all faced one way, the other four sides could face in every possible direction at right angles. In this way the material is given a magnetic directional structure. It used to be a rule in the permanent magnet industry to employ a magnetising force six or more times the coercive force, but experiments have shown that this is quite unnecessary with the new materials. Safe figures are 5 times the coercive force for cobalt steel, 3 times for Alnico, and twice for directional steels. Taking the coercive force of cobalt steel as 220 and that of Alnico and the directional steels as 600, the magnetising force available should therefore be 1,100 for cobalt steels, 1,800 for Alnico, and 1,200 for the directional steels.

Recent Improvements

Most of the points to which we have referred are illustrated in Figs. 1 and 2. In Fig. 1 the demagnetisation curves are given for four materials, while in Fig. 2 the product BH is plotted against H for the same materials. Since the maximum value reached by this product is a measure of the quality of the material as a permanent

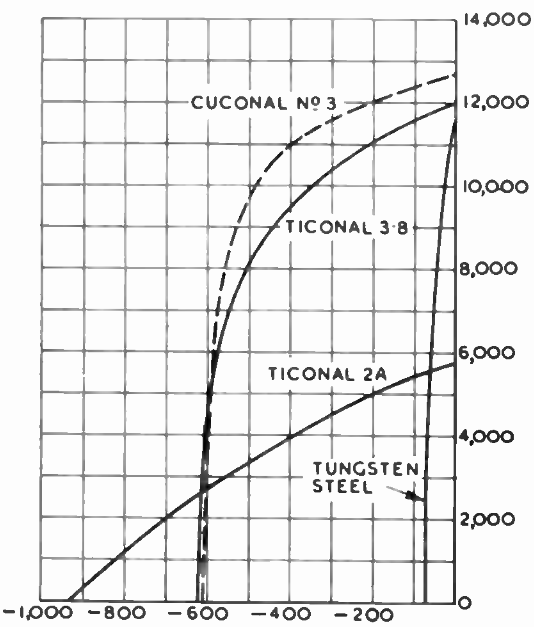


Fig. 1.

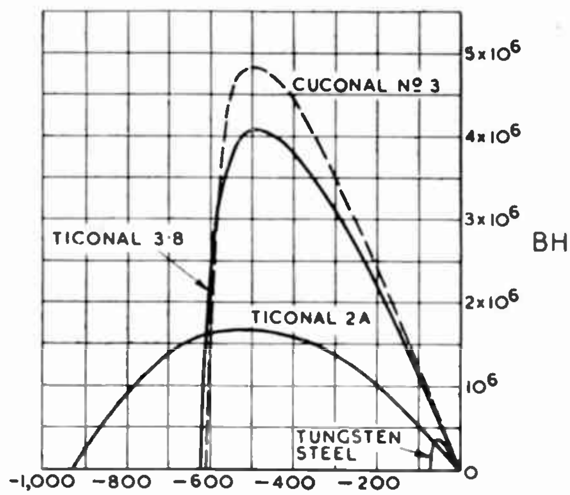


Fig. 2.

magnet, Fig. 2 brings out very clearly the great improvement that has taken place. Ticonal 2A and 3.8 are two titanium-cobalt-nickel-aluminium alloys—hence the name. The former was not subjected to magneto-thermal treatment, whereas the latter was, and the high remanence of 12,000 is only obtained in the proper direction. The best results in Figs. 1 and 2 refer to an alloy in which the titanium is replaced by copper. Its composition is given by the makers as nickel 13.5, aluminium 8, cobalt 24, copper 3, and iron the remaining 51.5 per cent., but we must confess to having coined the name "Cuconal." The properties and compositions of a large number of alloys are given in the patent specification and this is No. 3 in the list.

Designation of Alloys

The makers have recently introduced a new and extremely useful method of designating the various alloys. The two most important figures so far as the user is concerned are the maximum value of BH and the value of H at which it occurs. In Fig. 2 it is seen that the material there called Ticonal 3.8 has a maximum BH of about 40×10^5 which occurs for $H = 500$. In future such an alloy will be designated Ticonal 40/50.

We have not referred to the mechanical properties of these alloys. These have revolutionised production methods, since they cannot be turned, milled, tapped, etc., in the usual way, but have to be cast and ground. This raised many problems of manufacture but these have been overcome and such magnets are now in regular large-scale production.

As an interesting example of the possibilities with these new directional alloys, a magnet was made by fitting pole-pieces of the highly permeable cobalt-iron alloy to a small cube of 4 mm. edge of Ticonal 3.8 weighing 0.47 gramme. By very careful construction and magnetisation *in situ*, it was found that this magnet could support a weight of 1.65 kg which is 3,500 times the weight of the Ticonal cube.

In another example of different construction a weight of 65 kg was supported by a magnet in which the weight of the magnet alloy was only 13 grammes, i.e. a ratio of 5,000. It should be pointed out, however, that as the scale is increased this ratio must decrease since, while the mass increases as the cube, the area of the pole-face increases only as the square of the linear dimensions.

New Information

Since this article was written we have received the *General Electric Review* (America) for April, which contains an article entitled "Alnico; properties and equipment for magnetisation and test." The directional alloy which we have referred to as "cuconal" is there called "Alnico V," and it is recommended that when magnetising it the field should be at least 3,000 oersteds, which gives a B of 17,200 and a remanent B of 12,500. This is probably erring on the safe side since tests made in 1940 by the Joseph Lucas Research Laboratories in Birmingham showed that a magnetising force of 1,800 oersteds gave the highest attainable remanence and coercive force even when it was applied in the opposite direction to the polarity produced during cooling.

The same journal contains an account of a highly interesting magnetic novelty. Stainless steel containing 18 per cent. chromium and 8 per cent. nickel is ordinarily non-magnetic due to the small amount of nitrogen which it contains. If the nitrogen is removed and the steel is cooled from 1,100 deg. F it becomes magnetic on reaching 212 deg. F, but if instead of allowing it to cool slowly, one quenches a thin strip of it in water and places it under a magnet, nothing happens for about a minute and a half, when it suddenly jumps to the magnet. The atomic rearrangement is thus not instantaneous but proceeds slowly and is said to require at least a day before reaching a state of equilibrium. G. W. O. H.

Honours

MR. R. A. WATSON WATT, C.B., who, until his appointment as scientific adviser on telecommunications at the Ministry of Aircraft Production, was superintendent of the Radio Department at the National Physical Laboratory, had a Knighthood conferred upon him in the King's Birthday Honours List. His name has been inseparably linked with radiolocation.

Mr. F. W. Ogilvie, LL.D., director-general of the B.B.C. from 1938 until this year, was also created a Knight.

Dr. C. G. Darwin, M.C., Sc.D., LL.D., F.R.S., director, National Physical Laboratory, Department of Scientific and Industrial Research, has been appointed a Knight Commander of the British Empire.

Mr. S. Butterworth, M.Sc., principal scientific officer at the Admiralty, and Mr. R. P. Browne, B.Sc., secretary of the Radio Manufacturers' Association, were appointed Officers of the Order of the British Empire.

Brigadier F. T. Chapman, D.Sc., Deputy Director of Military Training (Technical), who by virtue of his office is largely responsible for the training of army wireless personnel, has been appointed a Commander of the Order of the British Empire.

Obituary

IT is recorded with regret that Mr. C. O. Browne, who was a designer and research engineer at Electric and Musical Industries, has died as a result of an accident. Prior to being lent to the Government for research work his time was devoted to the development of television and he was largely responsible for the equipment used for the B.B.C. television transmitter. Mr. Browne has contributed to *Wireless Engineer*.

Superheterodyne Tracking Charts—II*

By Ruby Payne-Scott, M.Sc., and A. L. Green, Ph.D.

ABSTRACT.—A solution is given to the problem of obtaining exact tracking between the signal and oscillator circuits of a superheterodyne receiver at three arbitrary frequencies, the oscillator circuit being of the most general form. The solution is in a form suitable for rapid computation, and a number of charts is given to facilitate calculations. Several important relations between the oscillator-circuit components are derived during the analysis, and lead to a rapid method of calculating the effect of a change in value of one of the oscillator components on the values required for the others. These relations also determine the allowable range of values for each of the oscillator components. The introduction of capacitance in parallel with the oscillator coil is shown to reduce the L/C ratio of the oscillator circuit, the effect being serious at low frequencies. In an appendix it is shown that exact tracking cannot be obtained at more than three frequencies for the general circuits here considered.

1. Introduction

THE design of a superheterodyne receiver involves the construction of two circuits, the oscillator and signal circuits, whose resonance frequencies shall have a constant difference at all points in the tuning band, i.e., shall "track" exactly. It is well known that, if identical tuning condensers are to be used in the signal and oscillator circuits, and these are to be the only variable components, perfect tracking cannot be obtained. In fact it can be shown (see Appendix) that, at most, exact tracking can be obtained at three frequencies.

Solutions of the problem of calculating the circuit components required for exact tracking at three arbitrary frequencies have been given by various writers, notably by Sowerby (1932). The practical objection to these solutions is that laborious calculations are required for each particular design considered. The object of the present paper is to provide a solution of the general case in a form suitable for rapid calculations. A number of charts, which still further facilitate calculations, are given for the case, common in practice, in which the third tracking frequency is equal to the arithmetic mean of the extreme tracking frequencies.

In Part I† of this paper (Green, 1941‡), a solution of the 3-point tracking problem was given in a form suitable for slide-rule calculation. In that case, the analysis leading up to the simple solution of the 3-point tracking problem was designed to emphasise the historical progress of the superheterodyne principle and the experimental manner in which practical radio engineers customarily attack alignment problems in multi-band communication receivers. In brief, Part I demonstrated that values of the components in the oscillator circuit may be readily calculated using the simple analysis that corresponds with 2-point tracking, and that such values approximate to those required for 3-point tracking in the high-frequency bands of a receiver. When the signal frequency approaches, and particularly when it is less than, the intermediate frequency of the receiver, serious discrepancies appear between the 2-point and the 3-point component values. Nevertheless, the paper showed that these discrepancies may readily be removed by introducing a certain correction factor k, whose values were plotted in the form of charts.

In the introductory paper, two important simplifications were introduced, one being the assumption that the capacitance in shunt with the oscillator coil was negligibly small, and the other that the third or intermediate tracking frequency had the arithmetic mean value of the outer alignment frequencies. The latter assumption appears to be desirable if the number of charts is to be kept within manageable proportions, but the problem of the distribution of stray and trimming capacitances in the oscillator circuit is considered in the present paper and is found to

* Reprinted from *A.W.A. Technical Review*, 1941, Vol. 5, No. 6, by arrangement with Amalgamated Wireless (Australasia), Ltd.

† There are some unavoidable changes in corresponding symbols used in Parts I and II, but the present paper supersedes the particular case considered in Part I.

‡ Reprinted in *Wireless Engineer*, June, 1942.

lead to some interesting conclusions. In practice, the oscillator coil itself on low-frequency bands has appreciable self-capacitance, and, apart from this, it may be desirable in some applications to connect the trimming capacitance across the coil rather than across the tuning condenser. Thus a convenient solution of the more general problem is required. Also, in the present paper, the form in which the solution is given, and the accompanying charts have been so chosen that the rapidity and accuracy of calculation of the oscillator components is greatly increased.

In the course of the analysis, three important relations between the components of the oscillator circuit appear. The value of these relations resides in the ease with which it is then possible to calculate, assuming a specified change in value of one of the components of the oscillator circuit, the corresponding variations in the remainder of the components required to maintain tracking. By way of example, it is a simple matter to calculate the variations in the padder capacitance corresponding with changes in the distribution of shunt stray capacitances across the coil and the tuning condenser.

Also, it appears that tracking at three specified frequencies, using a given intermediate frequency, implies that each of the oscillator components can only assume a definite range of values, and expressions are derived giving the maximum and minimum allowable values for each of the oscillator components.

2. Analysis of the General Tracking Circuits for Three-Point Tracking

Notation.—The notation used in the following analysis is summarised below:

ω_1 = low-frequency tracking point of the signal circuit,

ω_2 = high-frequency tracking point of the signal circuit,

ω_3 = third tracking frequency for signal circuit,

ω_i = intermediate frequency,

$\alpha = \dfrac{\omega_2}{\omega_1}$

$\beta = \dfrac{\omega_2 + \omega_i}{\omega_1 + \omega_i}$

$\gamma = \dfrac{\omega_3}{\omega_1}$

$\eta = \dfrac{\omega_3 + \omega_i}{\omega_1 + \omega_i}$

L, L_o = signal and oscillator inductances,

G = incremental capacitance of each section of the ganged tuning condensers, measured from its value at signal frequency ω_2,

G_{max} = value of G at signal frequency ω_1,

G_3 = value of G at signal frequency ω_3,

T = capacitance in signal circuit at signal frequency ω_2, ($G = 0$),

T_L = fixed capacitance in parallel with L_o,

T_c = fixed capacitance in parallel with G in the oscillator circuit,

P = oscillator padding capacitance.

$$r = \frac{\alpha^2}{\beta^2} \cdot \frac{1 + \dfrac{2(\alpha - \beta)}{(\beta - 1)(\alpha + \gamma)}}{1 + \dfrac{2(\alpha - \beta)}{(\beta - 1)\,1 + \gamma)}}$$

$$\rho = \frac{\alpha^2}{\beta^2} \cdot \frac{3 + \alpha}{3 + \beta} \cdot \frac{1 + 3\beta}{1 + 3\alpha} = \text{value of } r$$
when $\omega_3 = \frac{1}{2}(\omega_1 + \omega_2)$.*

When the extreme tracking points do not coincide with the band limits, we need the following additional notation:

ω'_1 = low-frequency limit of signal band,

ω'_2 = high-frequency limit of signal band,

$\alpha' = \dfrac{\omega'_1}{\omega'_2}$

G'_{max} = total incremental capacitance of each section of the ganged tuning condensers between signal frequencies, ω'_1, and ω'_2,

T', T'_c = T, T_c less the incremental capacitance of each section of the ganged tuning condensers between signal frequencies ω_2 and ω'_2.

---

* The correction factor k, used in Part I, is related to ρ by the expression $1 - k = \rho\beta^2/\alpha^2$.

Circuits.—The signal and oscillator circuits discussed in the following analysis are shown in Fig. 1.

G represents the increment in capacitance of the tuning condenser from its value at the upper tracking frequency, ω_2, of the signal circuit. G_{max} is the value of G at the lower tracking frequency, ω_1, of the signal circuit, and G_3 its value at the third tracking frequency ω_3. In the case where the extreme tracking frequencies coincide with the limits of the tuning band, G_{max} is equal to the range of the tuning condenser, and is a known quantity. We shall consider this case first, and will then show how the solution obtained can be applied to the more general case in which the extreme tracking frequencies do not coincide with the band limits.

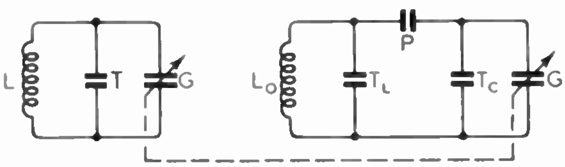


Fig. 1. *Skeleton circuits on which the analysis is based.*

P is the padding capacitance in the oscillator circuit. The trimming capacitance T_c includes not only the customary variable and fixed capacitances of the trimmers, but also components due to the capacitance of the ganged tuning condenser at signal frequency ω_2 (its minimum capacitance if ω_2 is also the high-frequency band limit), valve capacitances, and all strays, while T_L similarly includes the self-capacitance of the oscillator coil and all strays. T represents the total capacitance in the signal circuit when G is zero, and thus includes the capacitance of the tuning condenser at signal frequency ω_2 and the self-capacitance of the coil L, as well as strays.

The Signal Circuit.—For the signal circuit we have

$$L(G_{max} + T)\omega_1^2 = 1 \qquad (1)$$

$$LT\omega_2^2 = 1 \qquad (2)$$

giving immediately,

$$T = \frac{G_{max}}{\alpha^2 - 1} \qquad (3)$$

and

$$L = \frac{\alpha^2 - 1}{G_{max}\omega_2^2} \qquad (4)$$

for the components of the signal circuit.

Also, in order to obtain G_3, the value of G at the third tracking frequency, which is required in the analysis of the oscillator circuit, we substitute in the equation

$$L(G_3 + T)\omega_3^2 = 1$$

the values of L and T from equations (3) and (4), and use the definition

$$\gamma = \frac{\omega_3}{\omega_1}$$

obtaining

$$G_3 = G_{max}\frac{\alpha^2 - \gamma^2}{\gamma^2(\alpha^2 - 1)} \qquad (5)$$

When the third tracking frequency is the arithmetic mean of the extreme tracking frequencies, i.e.,

$$\omega_3 = \tfrac{1}{2}(\omega_1 + \omega_2),$$

so that

$$\gamma = \tfrac{1}{2}(1 + \alpha),$$

equation (5) becomes

$$G_3 = G_{max}\frac{1 + 3\alpha}{(1 + \alpha)^3} \qquad (6)$$

The Oscillator Circuit.—At each of the tracking frequencies, we have for the oscillator circuit,

$$L_o(\omega + \omega_i)^2\left[T_L + \frac{P(G + T_c)}{P + G + T_c}\right] = 1$$

or

$$\frac{P + T_L}{P^2} - \frac{1}{L_oP^2(\omega + \omega_i)^2} - \frac{1}{P + T_c + G} = 0.$$

Thus, using the definitions of β and η, the three equations for the oscillator circuit are

$$\frac{P + T_L}{P^2} - \frac{1}{L_oP^2(\omega_1 + \omega_i)^2} - \frac{1}{P + T_c + G_{max}} = 0 \qquad (7)$$

$$\frac{P + T_L}{P^2} - \frac{1}{\eta^2L_oP^2(\omega_1 + \omega_i)^2} - \frac{1}{P + T_c + G_3} = 0 \qquad (8)$$

$$\frac{P + T_L}{P^2} - \frac{1}{\beta^2L_oP^2(\omega_1 + \omega_i)^2} - \frac{1}{P + T_c} = 0 \qquad (9)$$

the value of G_3 being given by equation (5).

Since we have here only three equations but four variables (L_o, P, T_L, and T_C), the appropriate solution will consist of expressions for three of these in terms of the fourth. It is apparent from the form of equations (7), (8) and (9) that we can obtain solutions in the form,

$$\frac{P+T_L}{P^2} = fn.\ (\omega_1, \omega_2, \omega_3, \omega_i, G_{max}) = \text{constant},$$

$$P^2L_o = fn.\ (\omega_1, \omega_2, \omega_3, \omega_i, G_{max}) = \text{constant},$$

$$P + T_C = fn.\ (\omega_1, \omega_2, \omega_3, \omega_i, G_{max}) = \text{constant}.$$

These three equations will immediately give each of the other three components when P is known. This is not, however, the form generally required in practice, for it is usually the value of either T_C or T_L that is first fixed by design considerations. On the other hand, the three relationships given above are of great value in calculating the change required in the other three circuit components when the value of one component of the oscillator circuit is for any reason altered. This is demonstrated later in this paper. Also, as we have seen, solutions in this form can be most readily obtained from the original oscillator circuit equations. Thus we shall first solve the oscillator equations for $\frac{P+T_L}{P^2}$, P^2L_o, $P+T_C$, obtaining the constants in the relationships given above, and then from these derive equations giving P, T_L, and L_o in terms of T_C, and again P, T_C and L_o in terms of T_L, these equations being in a form suitable for rapid computation.

As a first step in solving equations (7), (8) and (9), subtract them in pairs to eliminate $\frac{P+T_L}{P^2}$. By subtracting equations (7) and (9), we obtain

$$\frac{1}{L_oP^2(\omega_1+\omega_i)^2}\cdot\left(1-\frac{1}{\beta^2}\right) = \frac{G_{max}}{(P+T_C)(P+T_C+G_{max})} \qquad (10)$$

and on subtracting equations (8) and (9),

$$\frac{1}{LP^2(\omega_1+\omega_i)^2}\cdot\left(\frac{1}{\eta^2}-\frac{1}{\beta^2}\right) = \frac{G_3}{(P+T_C)(P+T_C+G_3)} \qquad (11)$$

Dividing equation (11) by equation (10), we obtain, since $P + T_c \neq 0$,

$$\left(1+\frac{P+T_C}{G_{max}}\right)\eta^2(\beta^2-1) = \left(1+\frac{P+T_C}{G_3}\right)(\beta^2-\eta^2)$$

or

$$P+T_C = \frac{G_{max}\beta^2(\eta^2-1)}{\frac{G_{max}}{G_3}(\beta^2-\eta^2)-\eta^2(\beta^2-1)}$$

or

$$P+T_C = \frac{G_{max}}{r-1} \qquad \ldots \qquad (12)$$

where

$$r = \frac{(\beta^2-\alpha^2)\frac{G_{max}}{G_3}-1}{\beta^2(\eta^2-1)}$$

Equation (12) gives the relationship between T_C and P.

To eliminate η and G_3 from the expression for r, we use equation (5) and the following relation, which can be readily derived from the definition of η,

$$\eta = \frac{\gamma(\beta-1)+\alpha-\beta}{\alpha-1}$$

obtaining finally,

$$r = \frac{\alpha^2}{\beta^2}\cdot\frac{1+\frac{2(\alpha-\beta)}{(\beta-1)(\alpha+\gamma)}}{1+\frac{2(\alpha-\beta)}{(\beta-1)(1+\gamma)}} \qquad \ldots \qquad (13)$$

If we denote by ρ the value of r when

$$\omega_3 = \frac{\omega_1+\omega_2}{2}$$

then

$$\rho = \frac{\alpha^2}{\beta^2}\cdot\frac{3+\alpha}{3+\beta}\cdot\frac{1+3\beta}{1+3\alpha} \qquad \ldots \qquad (14)$$

To derive the relationship between L_o and P, we substitute equation (12) in equation (10), obtaining

$$L_oP^2 = \frac{1}{\beta^2(\omega_1+\omega_i)^2}\cdot\frac{r(\beta^2-1)}{(r-1)^2}\cdot G_{max} \qquad \ldots \qquad (15)$$

Finally, substituting the values of $(P+T_C)$ and P^2L_o from equations (12) and (15) in equation (9), we obtain the relationship between T_L and P,

$$\frac{P+T_L}{P^2} = \frac{(r-1)}{G_{max}}\cdot\frac{r\beta^2-1}{r(\beta^2-1)} \qquad \ldots \qquad (16)$$

The next step is to use these three relationships to obtain a set of equations for P, T_L and L_o in terms of T_C and a further set for P, T_C and L_o in terms of T_L. To obtain these equations in a convenient form suitable for computation from charts, we shall make use of the values of the circuit components when T_L is zero and again when T_C is zero.

When $T_L = 0$, from equation (16), P has its minimum value

$$P_{min} = \frac{\beta^2 - 1}{r\beta^2 - 1} \cdot \frac{r}{r-1} \cdot G_{max} \quad .. \quad (17)$$

and then from equation (12), T_C has its maximum value

$$(T_C)_{max} = \frac{G_{max}}{r\beta^2 - 1} \quad .. \quad .. \quad (18)$$

When $T_C = 0$, P and T_L both have their maximum values, and from equation (12),

$$P_{max} = \frac{G_{max}}{r-1} \quad .. \quad .. \quad .. \quad (19)$$

and then from equation (16),

$$(T_L)_{max} = \frac{G_{max}}{r(\beta^2 - 1)} \quad .. \quad .. \quad (20)$$

From equation (12) we can obtain the relationship

$$P_{max} = P_{min} + (T_C)_{max} \quad .. \quad .. \quad (21)$$

and from (17), (18), (19) and (20)

$$\frac{P_{max}}{P_{min}} = \frac{(T_L)_{max}}{(T_C)_{max}} \quad .. \quad .. \quad .. \quad (22)$$

These relationships enable us to calculate any two of the quantities P_{max}, P_{min}, $(T_C)_{max}$, and $(T_L)_{max}$ when the other two are known.

Using equations (17) to (21), we can express equations (12), (15) and (16) in terms of P_{max}, P_{min}, $(T_C)_{max}$, and $(T_L)_{max}$. Using equation (19), equation (12) becomes

$$P = P_{max} - T_C \quad .. \quad .. \quad .. \quad (23a)$$

Using equation (17), equation (16) becomes

$$T_L = \frac{P}{P_{min}}(P - P_{min}) \quad .. \quad .. \quad (24a)$$

or using equations (21) and (23a),

$$T_L = \frac{P}{P_{min}}\left[(T_C)_{max} - T_C\right] \quad .. \quad (24b)$$

Alternatively, equations (24a) and (23a), may be written

$$P = \frac{P_{min}}{2}\left[1 + \sqrt{\frac{P_{min} + 4T_L}{P_{min}}}\right] \quad (25)$$

$$T_C = P_{max} - P \quad .. \quad .. \quad .. \quad (23b)$$

Using equations (19) and (20), equation (15) may be written

$$L_o(\omega^2 + \omega_i)^2 = \left(\frac{P_{max}}{P}\right)^2 \cdot \frac{1}{(T_L)_{max}} \quad (26a)$$

or, from equation (22),

$$L_o(\omega_2 + \omega_i)^2 = \frac{P_{min} \cdot P_{max}}{(T_C)_{max}} \cdot \frac{1}{P^2} \quad (26b)$$

or, from equation (23a)

$$L_o(\omega_2 + \omega_i)^2 = \frac{1}{\left(1 - \frac{T_C}{P_{max}}\right)^2} \cdot \frac{1}{(T_L)_{max}} \quad .. \quad .. \quad (26c)$$

The first group of equations, (23a) and (24), enable us to calculate P and T_L when T_C is given, and we may then calculate L_o from any convenient form of equation (26). The second pair of equations, (25) and (23b), enable us to calculate P and T_C when T_L is given, and L_o may then be calculated from equation (26). We have thus achieved our aim of providing formulae by which the other circuit components may be rapidly calculated when either T_C or T_L is given.

Auxiliary Formulae when the Extreme Tracking Points do not coincide with the Band Limits.—The formulae given so far are all in terms of G_{max}, the increment in capacitance of the tuning condenser between the tracking frequencies ω_2 and ω_1. If these frequencies are also the limits of the band, then G_{max} is the capacitance range of each section of the ganged tuning condenser and is known. It is, however possible to reduce the tracking errors by choosing the extreme tracking points somewhat *in* from each end of the band and, in this case, G_{max} is not directly known. Also the values of T and T_C, which represent the total capacitance across the tuning condenser at the highest tracking frequency, will now each contain a component equal to the difference between the capacitance of the tuning condenser at the highest tracking frequency and at the highest tuning frequency. Thus, to apply the formulae already derived to this case, we need auxiliary formulae giving G_{max} in terms of the total incremental capacitance of each section of the tuning condenser and giving the component mentioned above.

Using the notation given at the beginning of the analysis, we have for the signal circuit

$$L(G'_{max} + T')\omega'^2_1 = 1 \quad .. \quad .. \quad (27)$$

$$L(G'_{max} + T)\omega_1^2 = 1 \quad .. \quad .. \quad (1)$$

$$LT\omega_2^2 = 1 \quad .. \quad .. \quad (2)$$

$$LT'\omega'^2_2 = 1 \quad .. \quad .. \quad (28)$$

From these equations we obtain

$$\frac{G_{max}}{G'_{max}} = \left(\frac{\omega'_2}{\omega_2}\right)^2 \cdot \frac{\alpha^2 - 1}{\alpha'^2 - 1} \quad .. \quad .. \quad (29)$$

$$\frac{T'}{T} = \left(\frac{\omega_2}{\omega'_2}\right)^2 \quad .. \quad .. \quad .. \quad (30)$$

Equation (29) gives the required relation between G_{max} and G'_{max}, and then, having calculated G_{max} from this equation, we can proceed to use the formulae already developed to calculate L and T for the signal circuit and L_o, P, T_L, and T_c for the oscillator circuit. To obtain T' and T'_c, we use equation (30) and the fact, already mentioned, that

$$T_c - T'_c = T - T' \quad .. \quad .. \quad (31)$$

3. Relations between Oscillator - Circuit Components

Before proceeding to illustrate the application of the formulae developed in the preceding section to the calculation of components in practical design problems, we shall consider certain conclusions that can be drawn from the foregoing analysis.

Effect of change in one Component of the Oscillator Circuit on the Values required for the other Components.—For given values of the intermediate frequency and the tracking frequencies, and a given G_{max}, we have the three relations,

$$P + T_c = \text{constant} \quad .. \quad .. \quad (12)$$

$$\frac{P + T_L}{P^2} = \text{constant} \quad .. \quad .. \quad (16)$$

$$P^2 L_o = \text{constant} \quad .. \quad .. \quad (15)$$

These relations are of great value in allowing the effect of a change in one of the oscillator components on the other three to be readily calculated. The change in which we are interested is often small and in such cases it is simpler to use the differential form of the above relations. If we denote by the prefix δ a small change in the prefixed quantity, we have

$$\delta T_c = -\delta P \quad .. \quad .. \quad .. \quad (32)$$

$$\delta T_L = \left(1 + \frac{2T_L}{P}\right)\delta P \quad .. \quad .. \quad (33)$$

$$\delta L_o = \frac{2L_o}{P} . \delta P \quad .. \quad .. \quad .. \quad (34)$$

As an example of the use of these relations to calculate changes in circuit components, consider a circuit in which originally $P = 510$ μμF, $T_c = 12$ μμF, $T_L = 50$ μμF, and it is subsequently decided that T_c should be increased by 5 μμF. The corresponding changes required in the other components are

$$\delta P = -5 \ \mu\mu\text{F}$$

$$\delta T_L = -\left(1 + \frac{100}{510}\right) \times 5 = -6 \ \mu\mu\text{F}$$

$$\frac{\delta L_o}{L_o} = -\frac{2(-5)}{510} = 0.02$$

i.e., P should be decreased by 5 μμF and T_L by 6 μμF, while the inductance should be increased by 2 per cent.

It is of interest to note that the changes required in the circuit components are independent of the values of the tracking or intermediate frequencies, as long as these are not also altered.

When T_L is small compared with P, equations (32) and (33) become, with sufficient accuracy,

$$\delta P = -\delta T_c = \delta T_L \quad .. \quad .. \quad (35)$$

This equation shows that, for example, the effect of a change in self-capacitance of the coil may be compensated by increasing the padder capacitance by an amount equal to this change and decreasing T_c by the same amount, at the same time making the appropriate change in inductance as indicated by equation (34).

Permissible Values for the Components of the Oscillator Circuit.—It is clear from the foregoing analysis that, for given values of the tracking frequencies and of the intermediate frequencies, only a certain range of values is permissible for each of the oscillator circuit components. From equations (17) and (19), we have

$$\frac{\beta^2 - 1}{r\beta^2 - 1} \cdot \frac{r}{r - 1} \cdot G_{max} \leq P \leq \frac{G_{max}}{r - 1}$$

from (18),

$$0 \leq T_c \leq \frac{G_{max}}{r\beta 2 - 1}$$

from (20),

$$0 \leq T_L \leq \frac{G_{max}}{r(\beta^2 - 1)}$$

and from (15), (17) and (19),

$$\frac{r(\beta^2 - 1)}{G_{max}(\omega_2 + \omega_i)^2} \leq L_o$$
$$\leq \frac{(r\beta^2 - 1)^2}{r(\beta^2 - 1)G_{max}(\omega_2 + \omega_i)^2}$$

In practice, T_C and T_L have a minimum value greater than zero, owing to the presence of minimum capacitance in the tuning condenser, self-capacitance in the coil, and strays.

4. Calculation of Circuit Components

4.1.—*Summary of Formulae*

Signal Circuit—

$$T = \frac{G_{max}}{\alpha^2 - 1} \quad \ldots \quad \ldots \quad \ldots \quad (3)$$

$$L = \frac{\alpha^2 - 1}{G_{max}\omega_2^2} - \frac{1}{T\omega_2^2} \quad \ldots \quad \ldots \quad (4)$$

Oscillator Circuit—

(a) General formulae for padding and trimming capacitances.

(i) T_C given,

$$P = P_{max} - T_C = P_{min} + (T_C)_{max} - T_C \quad \ldots \quad \ldots \quad (23a)$$

$$T_L = \frac{P}{P_{min}}\left[(T_C)_{max} - T_C\right] \quad \ldots \quad (24b)$$

(ii) T_L given,

$$P = \frac{P_{min}}{2}\left(1 + \sqrt{\frac{P_{min} + 4T_L}{P_{min}}}\right) \quad (25)$$

$$T_C = P_{max} - P = P_{min} + (T_C)_{max} - P \quad \ldots \quad \ldots \quad (23b)$$

(b) Formulae when $T_L << P$.

$$P = P_{min} + T_L$$
$$T_C = (T_C)_{max} - T_L.$$

The errors incurred in making this approximation are:

$$\text{error in } P = -\left(\frac{T_L}{P}\right)^2 \times 100 \text{ per cent.}$$

$$\text{error in } T_C = \frac{T_L^2}{P \times T_C} \times 100 \text{ per cent.}$$

(c) Formulae for inductance of oscillator coil.

$$L_o(\omega_2 \times \omega_i)^2 = \left(\frac{P_{max}}{P}\right)^2 \cdot \frac{1}{(T_L)_{max}}$$
$$= \frac{P_{min}P_{max}}{(T_C)_{max}} \cdot \frac{1}{P^2} \quad \ldots \quad (26)$$

Auxiliary formulae when the outer tracking frequencies do not coincide with the band limits—

$$G_{max} = \left(\frac{\omega'_2}{\omega_2}\right)^2 \cdot \frac{\alpha^2 - 1}{\alpha'^2 - 1} \cdot G'_{max} \quad \ldots \quad (29)$$

$$\frac{T'}{T} = \left(\frac{\omega_2}{\omega'_2}\right)^2 \quad \ldots \quad \ldots \quad (30)$$

$$T_C - T'_C = T - T' \quad \ldots \quad (31)$$

Relations between P_{max}, P_{min}, $(T_C)_{max}$, and $(T_L)_{max}$,

$$P_{max} = P_{min} + (T_C)_{max} \quad \ldots \quad \ldots \quad (21)$$

$$\frac{P_{max}}{P_{min}} = \frac{(T_L)_{max}}{(T_C)_{max}} \quad \ldots \quad \ldots \quad \ldots \quad (22)$$

4.2—*Direct Computation*

The formulae for the components of the signal circuit obviously lend themselves readily to direct computation. To calculate the components of the oscillator circuit, the simplest method is first to compute ρ (or r, if the third tracking frequency is not the arithmetic mean of the other two), the expression for ρ being in a form suitable for logarithmic computation, and then to compute $P_{max}\left(=\frac{G_{max}}{\rho - 1}\right)$ and $(T_C)_{max}$ $\left(=\frac{G_{max}}{\rho\beta^2 - 1}\right)$. The difference between these immediately gives P_{min}, and the circuit components may then be readily calculated. The example given at the beginning of the next section shows that the total amount of numerical work involved in directly computing the circuit components is relatively small.

Care needs to be taken when β approaches its limiting values 1 or α. When β is nearly equal to α, ρ becomes almost 1 and must be computed to a number of figures if $P_{max}\left(=\frac{G_{max}}{\rho - 1}\right)$ is to be obtained accurately. At low values of β, P_{max} and $(T_C)_{max}$ are almost equal, and must be computed to a number of figures to obtain their difference, P_{min}, accurately.

4.3—*Computation with the Aid of Charts*

It would obviously simplify the calculation of the components of the oscillator circuit if charts were available giving the values of at least two of the quantities

$$\frac{P_{min}}{G_{max}}, \quad \frac{P_{max}}{G_{max}}, \quad \frac{(T_C)_{max}}{G_{max}}, \text{ and } \frac{(T_L)_{max}}{G_{max}}$$

(any two of these being readily calculable from the other two). The provision of such charts is made possible by the fact that each of these quantities is a function of α, β, and γ only, so that, if the value of γ is chosen, charts may be drawn of each of these quantities against β with α as parameter. Such charts are provided for the case most common in practice, in which the tracking frequency is the arithmetic mean of the extreme tracking frequencies, so that $r = \rho$. Charts are given in Figs. 2 and 3 of $\frac{(T_C)_{max}}{G_{max}}$ and $\frac{P_{min}}{G_{max}}$ respectively for values of α of 1.5, 2, 2.5, 3 and 3.5, β varying continuously from 1 to α. P_{min} has been chosen in preference to P_{max}, as the latter can be readily and accurately derived from the formula

$$P_{max} = P_{min} + (T_C)_{max}$$

while the calculation of P_{min} from P_{max} and $(T_C)_{max}$ involves, at small values of β, the subtraction of two nearly equal quantities, with consequent inaccuracy. Although $(T_L)_{max}$ could be calculated from $(T_C)_{max}$ and P_{min}, it has been considered convenient to include in Fig. 3 curves giving the value of $\frac{(T_L)_{max}}{G_{max}}$.

When using the charts, the procedure is to obtain from them the values of

$$\frac{(T_C)_{max}}{G_{max}}, \quad \frac{P_{min}}{G_{max}}, \text{ and } \frac{(T_L)_{max}}{G_{max}}$$

for the appropriate values of α and β and then continue as in direct computation. The use of the charts, as well as facilitating calculation, has the additional advantage that the allowable range, P_{min} to P_{max}, of the padding condenser and the values of

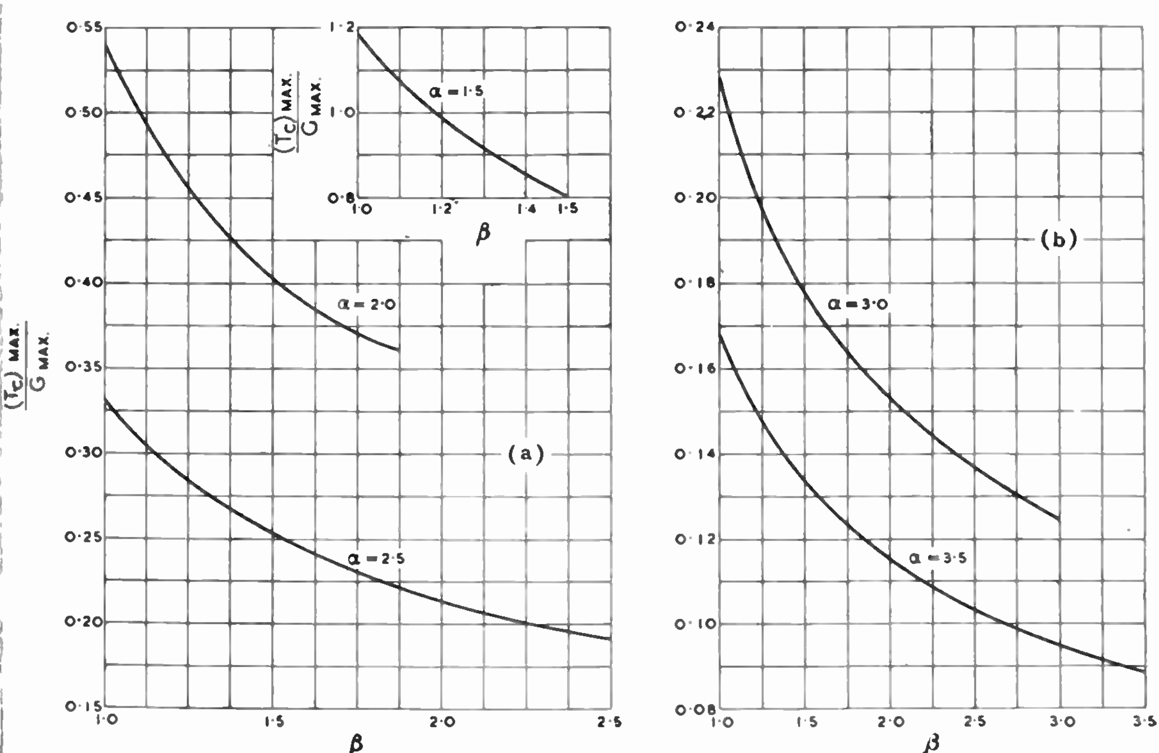


Fig. 2. (*a*) *Chart giving the value of* $\frac{(T_C)_{max}}{G_{max}}$ *in terms of the oscillator-frequency ratio* β *for the signal frequency ratio* α *equal to* 1.5, 2.0 *and* 2.5 *respectively, third tracking frequency being equal to mean of extreme tracking frequencies.* (*b*) *Chart similar to that of* (*a*) *for* $\alpha = 3.0$ *and* 3.5.

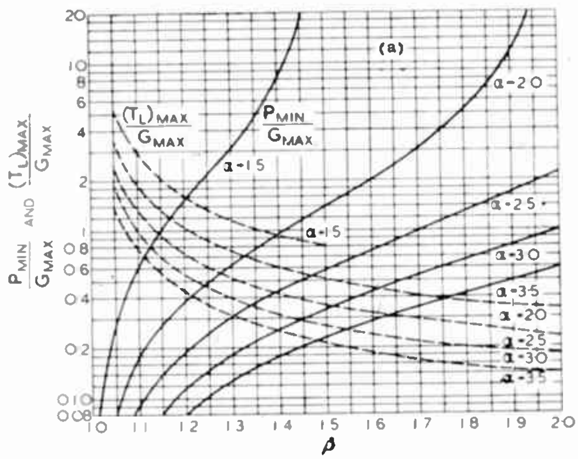
$(T_c)_{max}$ and $(T_L)_{max}$ are obtained immediately. The designer can estimate the values of $(T_c)_{min}$ (determined by the values of the minimum capacitance of the tuning condenser and the self-capacitance of the coil respectively, together with strays and valve capacitances) and thus knows the allowable range of each of the condensers and has all the information necessary to decide the most advantageous arrangement. In designing multi-band receivers, it is often very convenient to be able to determine quickly the permissible range of the padder and trimmers on each band before deciding on the actual arrangement to be used.

4.4—*Accuracy Using Charts*

When the charts are used for computing the actual component values, the accuracy of the final results depends on how closely the value of α, the ratio of the extreme tracking frequencies, in the problem under consideration approximates to one of the values for which a graph is provided. In all the numerical examples given in which charts are used, the ratio α has one of the values for which a curve is given, i.e., 1.5, 2, 2.5, 3, or 3.5. In such cases, the values of

$$\frac{(T_c)_{max}}{G_{max}},\ \frac{P_{max}}{G_{max}},\ \text{and}\ \frac{(T_L)_{max}}{G_{max}}$$

can be read from the charts with an accuracy of 2 per cent., and accordingly P_{min}, P_{max}, $(T_c)_{max}$, and $(T_L)_{max}$ are known correct to 2 per cent., if G_{max} is known accurately. Consideration of the formulae given in the first section and of the numerical examples shows that, when T_L or T_c is given a practical value, P and either T_c or T_L are obtained with an accuracy of about 3 per cent. and L_0 with an accuracy of about 6 per cent. by using values obtained from the charts. These accuracies are sufficient in practice.



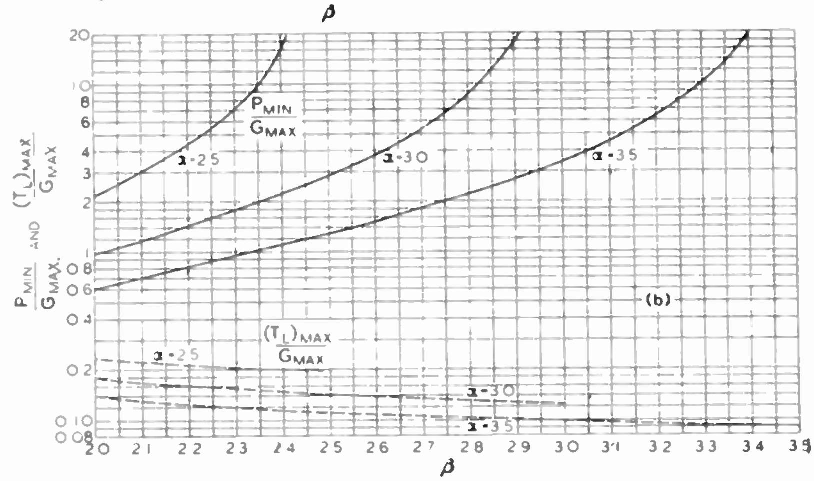


Fig. 3. (*a*) *Chart giving the values of* $\frac{P_{min}}{G_{max}}$ *(continuous curves) and* $\frac{T_{(L)max}}{G_{max}}$ *(broken curves) in terms of the oscillator-frequency ratio* β *for various values of the signal-frequency ratio* α. *Range of* $\beta = 1$ *to* 2. *Third tracking frequency equal to mean of extreme tracking frequencies.* (*b*) *Chart similar to that of* (*a*) *for values of* β *ranging from* 2.0 *to* 3.5.

Many cases arise, however, in which the value of α is not one of those for which a curve is given, and to make use of the charts it would be necessary to interpolate between curves. In this process considerable accuracy is lost, as the variation with α of the quantities graphed is by no means linear. In some cases it may be practicable to alter the position of the tracking frequencies slightly to make α conform with one of the curves. Otherwise the only way of obtaining accurate values of the circuit components is by direct computation.

The charts are still of value, however, in two respects. First, they provide a useful check on the results obtained by direct computation. Secondly, they still allow the limiting values of P, T_C, and T_L to be estimated with fair accuracy, providing useful design information before any actual computations are carried out.

5. Numerical Examples

5.1.—*Direct Computation*

Broadcast band, $T_L = 0$, extreme tracking frequencies not coincident with band limits—

Total frequency coverage = 540 – 1,700 kc/s.

Extreme tracking frequencies = 700 and 1,500 kc/s.

Arithmetic-mean tracking frequency = $\frac{1}{2}(700 + 1{,}500) = 1{,}100$ kc/s.

Intermediate frequency = 455 kc/s.

$$G'_{max} = 420\ \mu\mu F$$

$$\alpha = \frac{1{,}500}{700} = 2.143$$

$$\beta = \frac{1{,}500 + 455}{700 + 455} = 1.693.$$

To calculate G_{max}, we have

$$\alpha' = \frac{1{,}700}{540} = 3.148$$

therefore from (29)

$$G_{max} = \left(\frac{1{,}700}{1{,}500}\right)^2 \times \frac{2.143^2 - 1}{3.148^2 - 1} \times 420 = 217\ \mu\mu F.$$

Signal Circuit—

$$T = \frac{217}{2.143^2 - 1} = 60\ \mu\mu F \qquad \text{from (3)}$$

therefore

$$T' = \left(\frac{1{,}500}{1{,}700}\right)^2 \times 60 = 47\ \mu\mu F \qquad \text{from (30)}$$

$$L = \frac{10^{12}}{60 \times 4\pi^2 \times 1{,}500^2 \times 10^6} \text{ henries} \qquad \text{from (4)}$$

$$= 188\ \mu H.$$

Oscillator Circuit—

$$\rho = \frac{2.143^2}{1.693^2} \cdot \frac{5.143}{4.693} \cdot \frac{6.079}{7.429} = 1.437$$

$$\frac{P_{max}}{G_{max}} = \frac{1}{\rho - 1} = \frac{1}{0.437} = 2.29$$

$$\frac{(T_C)_{max}}{G_{max}} = \frac{1}{\rho\beta^2 - 1} = \frac{1}{1.437 \times 1.693^2 - 1} = 0.321$$

therefore

$$\frac{P_{min}}{G_{max}} = 2.29 - 0.32 = 1.97 \qquad \text{from (21)}$$

hence

$$P_{min} = 217 \times 1.97 = 427\ \mu\mu F$$

and

$$(T_C)_{max} = 217 \times 0.321 = 70\ \mu\mu F.$$

Since $T_L = 0$, $P_{min} = P$, the value of padding capacitance required. To obtain T'_C we have

$$T_C - T'_C = T - T' = 60 - 47 = 13 \qquad \text{from (31)}$$

therefore, since $(T_C)_{max} = T_C$

$$T'_C = 70 - 13 = 57\ \mu\mu F.$$

Also

$$L = \frac{P_{min} \cdot P_{max}}{(T_C)_{max}} \cdot \frac{1}{P^2(\omega_2 + \omega_i)^2}$$

$$= \frac{P_{min} + (T_C)_{max}}{P_{min}(T_C)_{max}} \cdot \frac{1}{(\omega_2 + \omega_i)^2}$$

when $P = P_{min}$, and using (21)

$$= \frac{427 + 70}{427 \times 70} \times \frac{10^{12}}{4\pi^2(1{,}500 + 455)^2 \times 10^6} \text{ henries}$$

$$= 110\ \mu H.$$

5.2.—*Computation with the Aid of Charts*

(a) *Short-wave band, $T_L = 0$, extreme tracking frequencies coincident with band limits—*

Total frequency coverage = 7.67 – 23 Mc/s (13 – 39 metres).

Extreme tracking frequencies = 7.67 and 23 Mc/s.

Third tracking frequency = $\frac{1}{2}(7.67 + 23)$ = 15.34 Mc/s.

Intermediate frequency = 455 kc/s.

$$G_{max} = 420\ \mu\mu F$$

$$\alpha = \frac{23}{7.67} = 3$$

$$\beta = \frac{23 + 0.455}{7.67 + 0.455} = 2.887$$

Signal Circuit—

$$T = \frac{420}{3^2 - 1} = 52.5\ \mu\mu F$$

$$L = \frac{10^{12}}{52.5 \times 4\pi^2 \times 23^2 \times 10^{12}} \text{ henries}$$

$$= 0.91\ \mu H.$$

Oscillator Circuit.—From the charts,

$$P_{min} = 17.0 \times 420 = 7140 \ \mu\mu F$$

$$(T_c)_{max} = 0.127 \times 420 = 53.3 \ \mu\mu F,$$

and, since $T = 0$, these are the required padding and trimming capacitances.

Also

$$L_o = \frac{7193.3 \times 10^{12}}{7140 \times 53.3} \times \frac{1}{4\pi^2 \times 23.455^2 \times 10^{12}} \text{ henries}$$

$$= 0.87 \ \mu H.$$

(b) *Broadcast band, $T_L = 0$, extreme tracking frequencies and coincident with band limits*—

Total frequency coverage = 540 — 1,700 kc/s.

Extreme tracking frequencies = 750 and 1,500 kc/s

Third tracking frequency = $\frac{1}{2}(750 + 1{,}500)$ = 1,125 kc/s.

Intermediate frequency = 455 kc/s.

$$G'_{max} = 420 \ \mu\mu F$$

$$\alpha = \frac{1{,}500}{750} = 2.00$$

$$\beta = \frac{1{,}500 + 455}{750 + 455} = 1.623.$$

To calculate G_{max}, we have

$$\alpha' = \frac{1{,}700}{540} = 3.15$$

therefore

$$G_{max} = \left(\frac{1{,}700}{1{,}500}\right)^2 \times \frac{2^2 - 1}{3.15^2 - 1} \times 420 = 181 \ \mu\mu F.$$

Signal Circuit—

$$T = \frac{181}{2^2 - 1} = 60.3 \ \mu\mu F$$

therefore

$$T' = \left(\frac{1{,}500}{1{,}700}\right)^2 \times 60.3 = 47 \ \mu\mu F$$

$$L = \frac{10^{12}}{60.3 \times 4\pi^2 \times 1500^2 \times 10^6} \text{ henries}$$

$$= 187 \ \mu H.$$

Oscillator Circuit.—From the charts we have

$$P_{min} = 2.24 \times 181 = 405 \ \mu\mu F$$

$$(T_o)_{max} = 0.380 \times 181 = 69 \ \mu\mu F.$$

Since $T_L = 0$, P_{min} is the padding capacitance required. To obtain T'_c, $= (T'_c)_{max}$, we have

$$T_c - T'_c = T - T' = 13 \ \mu\mu F$$

therefore

$$T'_c = 56 \ \mu\mu F.$$

Also

$$L = \frac{405 + 69}{405 \times 69} \times \frac{10^{12}}{4\pi^2 \times 1955^2 \times 10^6}$$

$$= 112 \ \mu H.$$

(c) *Long-wave band, $T_L \neq 0$, extreme frequencies coincident with band limits*—

Total frequency coverage = 130 — 340 kc/s.

Extreme tracking frequencies = 130 and 340 kc/s.

Third tracking frequency = $\frac{1}{2}(130 + 340)$ = 238 kc/s.

Intermediate frequency = 755 kc/s.

$$G_{max} = 420 \ \mu\mu F$$

$$\alpha = \frac{340}{130} = 2.5$$

$$\beta = \frac{340 + 755}{130 + 755} = 1.229$$

Signal Circuit—

$$T = \frac{420}{2.5^2 - 1} = 80 \ \mu\mu F$$

$$L = \frac{10^{12}}{80 \times 4\pi^2 \times 340^2 \times 10^6} \text{ henries}$$

$$= 2.74 \ mH.$$

Oscillator Circuit.—From the charts

$$P_{min} = 0.219 \times 420 = 92 \ \mu\mu F$$

$$(T_c)_{max} = 0.286 \times 420 = 120 \ \mu\mu F.$$

Therefore

$$P_{max} = 92 + 120 = 212 \ \mu\mu F.$$

Also

$$(T_L)_{max} = 0.650 \times 420 = 273 \ \mu\mu F.$$

Case 1.—Trimming capacitance across ganged condenser, T_L = self-capacitance of coil = 10 $\mu\mu$F — Since $T_L << P$, the approximate formulae of equation (35) can be used, and we have

$$T_c = 120 - 10 = 110 \ \mu\mu F$$

$$P = 92 + 10 = 102 \ \mu\mu F$$

and from (26a)

$$L_0 = \left(\frac{212}{102}\right)^2 \times \frac{10^{12}}{273 \times 4\pi^2 \times 1095^2 \times 10^6} \text{ henries}$$

$$= 334 \ \mu\text{H}.$$

Case II.—Trimming capacitance across oscillator coil, T_C = minimum of ganged condenser + stray capacitances = 15 μμF—

$$P = 212 - 15 = 197 \ \mu\mu\text{F}$$

$$T_L = \frac{197}{92} \times (120 - 15) = 225 \ \mu\mu\text{F}$$

from (24b)

$$L_o = \left(\frac{212}{197}\right)^2 \times \frac{10^{12}}{273 \times 4\pi^2 \times 1095^2 \times 10^6}$$

$$= 89.6 \ \mu\text{H}.$$

Case III.—T_C fixed at 70 μμF—

$$P = 212 - 70 = 142 \ \mu\mu\text{F}$$

$$T_L = \frac{142}{92}(120 - 70) = 77 \ \mu\mu\text{F}$$

$$L_o = \left(\frac{212}{142}\right)^2 \times \frac{10^{12}}{273 \times 4\pi^2 \times 1095^2 \times 10^6}$$

$$= 172 \ \mu\text{H}.$$

6. Effect of the Position of the Trimmer on the L/C Ratio of the Oscillator Circuit

In some designs it is convenient to connect part or all of the oscillator trimmer across the coil rather than across the tuning condenser. The last numerical example in the preceding section shows clearly that such a procedure will seriously decrease the L/C ratio of the oscillator circuit on low-frequency bands. In this particular example, the change in position of the trimmer from across the tuning condenser to across the coil results in a decrease of L_o from 334 μH to 89.6 μH, thus decreasing the L/C ratio of the circuit, which is proportional to L^2, by a factor of 14. The presence of self-capacitance in the coil similarly decreases the L/C ratio.

That the L/C ratio will always decrease when T_L is increased can be seen from an inspection of the formula for the oscillator inductance L_o, which gives

$$L_o \propto \frac{1}{P^2}.$$

When T_L is zero, P is a minimum and hence L_o is a maximum, and as T_L increases, P increases and L_o decreases, with corresponding decrease in the L/C ratio of the circuit.

At high frequencies, the ratio of $(L_o)_{max}$ to $(L_o)_{min}$ is considerably less than at lower frequencies, and hence the L/C ratio is less dependent on the position of the trimmer. For example, as against the possible change of 14 times in the L/C ratio on the long-wave band, the corresponding change in the broadcast band is only 1.4 times and in the shortwave band only 1.02 times.

Thus we may conclude that, although the presence of capacitance directly in parallel with the oscillator coil has little effect on the L/C ratio of the circuit at high frequencies, at low frequencies such capacitance seriously decreases the L/C ratio and should be avoided. This involves winding the oscillator coil in such a manner as to minimise its self-capacitance, and placing all the trimming capacitance in the oscillator circuit directly in parallel with the tuning condenser.

APPENDIX

The Maximum Number of Frequencies at which Exact Tracking may be Obtained

For the signal circuit we have

$$G + T = \frac{1}{L\omega^2} \qquad \ldots \qquad (36)$$

and for the oscillator circuit at the tracking frequencies,

$$Lo(\omega + \omega_i)^2\left[T_L + \frac{P(G + T_C)}{P + G + T_C}\right] = 1 \qquad (37)$$

The values of ω that satisfy equations (36) and (37) simultaneously are the frequencies at which exact tracking will occur.

It is obvious from the form of equations (36) and (37) that, on eliminating G between them, we obtain a quartic in ω, the four roots of this quartic giving the tracking frequencies. Thus it might appear that exact tracking can be obtained at four frequencies. It remains to be seen how many of these roots are real and positive, i.e., how many correspond to physically realisable frequencies.

If we put

$$\frac{P + T_L}{P^2} = a, \quad P + T_C - T = b, \quad \frac{1}{P^2 L_O} = c$$

we may write equation (36) in the form

$$a - \frac{1}{b + G + T} = \frac{c}{(\omega + \omega_i)^2}.$$

Substituting for $(G + T)$ from equation (36) and collecting powers of ω, we obtain the equation of the quartic in the form

$$L\omega^4(1 - ab) + 2\omega_i L\omega^3(1 - ab) + \omega^2\left[L\omega_i^2(1 - ab) + Lbc - a\right] - 2a\omega\omega_i + c - a\omega_i^2 = 0 \qquad \ldots \qquad (38)$$

It is apparent that in this equation the coefficients of ω^4 and ω^3 have the same sign, i.e., the sum of the four roots of the equation must be negative, and therefore at least one of these roots must be negative and correspond to a physically unrealisable frequency. Thus *exact tracking can never be secured at more than three frequencies*, even with the very general oscillator circuit considered in this paper.

It has already been shown in the body of the paper that, provided certain conditions are fulfilled as to the values of the circuit components, exact tracking can be obtained at three frequencies, i.e., the values of a, b, and c can be so chosen that equation (38) has three real and positive roots.

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Book Reviews

Short-wave Radio

By *J.* H. REYNER. Pp. xiv + 180, with 97 Figs. Sir Isaac Pitman & Sons, Ltd., Parker Street, Kingsway, London, W.C.2. Price 10s. 6d.

This is the third edition of a book first published in 1937. Certain details have been amended, the chapter on receiver design has been expanded and a separate chapter has been devoted to frequency modulation. The book represents an attempt to present a non-mathematical résumé of the short-wave position and forms a companion volume to the author's Modern Radio Communication. Such a non-mathematical treatment of the subject has obvious limitations but references are always given to books and papers to which the reader can turn for more detailed information. After discussing the classification of short, ultra-short and micro-waves, their propagation is considered, then aerials, feeders, aerial arrays and receiving aerials are described with the aid of a large number of diagrams. Short-wave transmitters are then discussed with the usual amplitude modulation and such variants as suppressed carrier working. Then follow chapters on short-wave receivers, ultra-short waves, frequency modulation and micro-waves. The book is prefaced by a glossary in which the author says: "It has been assumed that the reader has a good working knowledge of ordinary theory. Some of the more specialised terms, however, are briefly elucidated." After which one is surprised to find that the first of these highly specialised terms is "A.C. alternating current, i.e. a current which flows first in one direction and then in the other, usually changing in a rhythmic manner," to be followed later by "Earth's Field. The earth behaves as a huge magnet, etc." One wonders what the author considers "a good working knowledge of ordinary theory." The treatment of frequency modulation is not at all satisfactory. The author says "Two possibilities exist. We can—

"(*a*) Vary the carrier frequency by an amount equal to the modulation frequency desired.

"(*b*) Vary the carrier by a given percentage *at a rate* depending on the modulation frequency desired."

The first method is too delightfully simple; if the carrier frequency is 10^6 and the modulation frequency 1,000, the carrier frequency is varied between 1,001,000 and 999,000, irrespective of the depth of modulation which apparently is ignored. The second method is not quite so bad, although there is no suggestion in the above description, nor indeed anywhere in the section in which it occurs, that the given percentage may be made to depend on the depth of modulation. This factor is first mentioned in the following section in which Armstrong's Frequency Modulation System is described, and where it is stated that the change of frequency is proportional to the amplitude of the modulation. This is then followed by the amazing statement that "the rate of change of frequency was dependent on the modulation frequency, being actually *inversely* proportional to the modulation frequency." The italics are ours. Hence the higher the modulation frequency, that is, the shorter the duration of the interval during which the change of carrier frequency has to take place, the lower the rate of change. This is then contradicted in the following section on "methods of frequency modulation," where it is stated correctly that "the rate at which the deviations occur will obviously depend upon the frequency of the modulation, being relatively slow at low modulation frequencies and rapid at high frequencies, which is, of course, direct and not inverse proportionality.

The book is well illustrated and well produced.

G. W. O. H.

The Behaviour of Slow Electrons in Gases

By R. H. HEALEY, D.Sc., and J. W. REED. Pp. 179 with 39 Figs. Published by Amalgamated Wireless (Australasia), Ltd. 20s. Distributed in Great Britain from the offices of *Wireless World* and *Wireless Engineer*, Dorset House, Stamford Street, London, S.E.1.

This book has the sub-title "An account of diffusion methods together with a comparison between results obtained by these and by various other methods." The authors, who are both associated with the Amalgamated Wireless Valve Co. of Australia, discuss the work of the last twenty-five years on such problems as the mean free paths, average energy losses and probabilities of attachment of electrons moving through a gas with energies not exceeding a few electron volts. Attention is mainly focused on the diffusion methods developed by Townsend at Oxford and by Bailey at Sydney, but other methods are also briefly described and discussed. The final chapter is devoted to the motion of electrons in alternating fields and such ionospheric problems as the Luxemburg effect and the effect of thunderstorms on the ionosphere. This final chapter will be of special interest to those concerned with the propagation of radio waves; it serves to emphasise the practical importance of the subject. The authors have endeavoured to make the presentation sufficiently complete and straightforward to prove of value to the general physicist and to final year physics students. The book is well illustrated, the results, wherever possible, being represented by graphs. Numerous references are given to original papers and there is a very comprehensive bibliography.

Those who are interested in the mechanism of the ionosphere will welcome this critical survey of the mass of material which has accumulated during the last twenty-five years, much of which is only available in the original communications.

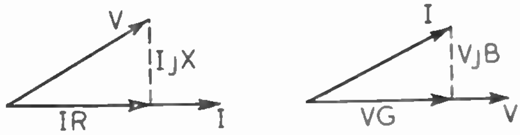
G. W. O. H.

Alternating Current Electrical Engineering

By PHILIP KEMP. Pp. IX + 617, with 425 Figs. Macmillan & Co., Ltd., St. Martin's Street, London, W.C.2. Price 18s.

This is the sixth edition of this well-known book first published in 1918. It is an excellent textbook covering the alternating current principles required by students preparing for the National Certificate Examinations or for the B.Sc. degree. The author explains that the success of the earlier editions has led him to expand the original work but without departing from the general plan of adhering to principles rather than describing particular types of machinery and apparatus. Every important type of machine and apparatus is considered. Transmission is not included; in fact, the words line, cable and transmission do not appear in the index.

A number of designs of transformers, generators and motors are worked out in detail. Considerable attention is devoted to power factor control, protection of a.c. systems, transients, etc. In dealing with symmetrical components the author makes a mistake. In Fig. 90 the lettering of the three vectors is changed to make the negative phase sequence, but the arrow showing the direction of rotation is also reversed, thus restoring the phase sequence to the positive order, viz., a, b, c. One can do either of two things to indicate the change from positive to negative sequence; one can leave the direction of rotation unchanged but change the vectors a, b, c, to a, c, b, or one can leave the vectors unchanged but reverse the direction of rotation, but one must not do both. Another



(a) (b)

point, which is to some extent a matter of taste, is the sign employed when splitting up admittance into conductance and susceptance. The author writes $Z = R + jX$ but $Y = G - jB$. Now there is no real reason for making this strange assumption about the two components of Y. Just as we write $V = IZ = I(R + jX)$ knowing that X can be either positive or negative, Fig. (a), so we can write $I = VY = V(G + jB)$ knowing that B can be either positive or negative, Fig. (b).

If in Fig. (a) X is inductive, the voltage will lead, IjX will be above the base line as shown and we must write $X = \omega L$, whereas if it is capacitive, the voltage will lag, IjX will be below the base line and we must write $X = -\dfrac{1}{\omega C}$. If in Fig. (b) X is capacitive, the current will lead, VjB will be above the base line, as shown, and we must write $B = \omega C$, whereas if it is inductive, the current will lag, VjB will be below the base line and we must write $B = -\dfrac{1}{\omega L}$. The reason why some people write $Y = G - jB$ is because they wish to avoid this change of sign, but a study of Figs. (a) and (b) shows that on changing over from the impedance to the admittance conception, there is not merely a turning upside down of the reactances but there is also a change of direction or sign. The susceptance is not really the reciprocal of ωL but of $j\omega L$ which is equal to $j\left(-\dfrac{1}{\omega L}\right)$. One might be tempted to say that the author on p. 568 proves the correctness of $G - jB$, but this is not so, for instead of writing

$$I = E\left[\frac{R}{R^2 + X^2} - j\frac{X}{R^2 + X^2}\right] = E\,[G - jB]$$

he could have written

$$I = E\left[\frac{R}{R^2 + X^2} + j\frac{-X}{R^2 + X^2}\right] = E\,[G + jB]$$

which is in keeping with what we have said above about the necessity for changing the sign of X when passing from Fig. (a) to Fig. (b).

G. W. O. H.

Standard for Soft Solders

A WAR emergency revision of the British Standard, BS 210, which deals with the composition of soft solders, has been issued by the British Standards Institution at the request of the Non-Ferrous Metals Control in order to effect economy in tin. The Specification, which is obtainable from the Institution, 28, Victoria Street, London, S.W.1, at 2s. 3d. (including postage), is accompanied by a memorandum which recommends various methods of economising in the use of solder.

Unnecessary Paper Hoarding

TO avoid the retention of documents for an unnecessarily long period by those who have an exaggerated idea of their legal importance, the Waste Paper Recovery Association, 154, Fleet Street, London, E.C.4 (Telephone: Central 1345), recently issued a leaflet on the subject. Written by two leading chartered accountants it gives advice on the length of time for which documents of various types should be retained.

Tropical Climate and Telecommunication Technique*

THE tropical climate may be subdivided into three: the jungle climate, in which the air rises and causes the formation of heavy clouds and permanent heavy rains; the climate of the deserts in which the air descends, prevents the formation of any clouds and causes drought; the third climate exists in the intermediate region where it is raining periodically owing to monsoon and trade-winds. The amount of humidity in the atmosphere at a particular place is dependent upon the amount of rain, and on the situation of the place relative to the coast. Near the coast the sea causes a comparatively high amount of humidity, even if no rain occurs.

The atmospheric humidity is the most important factor influencing electro-technical equipments, and in particular telecommunication equipments. For this reason, in Germany the relative atmospheric moisture content in automatic telephone exchanges is kept between 45 and 75 per cent. This condition can easily be complied with in our climate, but is difficult in tropical climates. In tropical climates where it is permanently or periodically raining, the moisture content may reach, particularly at nights, 90 per cent., while in dry regions the moisture content may fall to 2 or 3 per cent. The conditions within enclosed rooms are similar to those of the open air, except that the variations are somewhat smaller and delayed.

Extreme moisture conditions may cause mechanical, chemical and electrical faults.

Mechanically: Insulating material, which is sensitive to moisture, may warp and may thus cause current conducting metal parts to become loose or dislodged.

Chemically: A high degree of moisture may cause corrosion, leading to an increase of contact resistance, or even to an interruption of contact.

Under the influence of increased atmospheric humidity an insulating sheath made of fabric lacquered with oil becomes sticky, softens and finally the oil may run out. The insulation of the fabric may be so reduced that leakages, or even short circuits, occur. Simultaneously, the increased acidity of the remaining fabric may cause corrosion. Insulating sheaths impregnated with cellulosic lacquers have proved to be satisfactory.

Electrically: The insulating resistance of insulating materials is decreased by atmospheric humidity. For this reason, wires insulated by silk, cotton, wool, or wax, are unsuitable for tropical climates, while wires using cellulosic acetates have proved to be satisfactory.

Not only hygroscopical fibrous materials used for the insulation of wires are affected by an increased atmospheric moisture content, but also many solid, dense and homogeneous insulating materials. In such cases, the resistance often decreases very slowly. In this respect an interesting effect was observed. When a plate of insulating material type S* has been subjected to moisture for a considerable time, its insulation decreases, but when it is subsequently dried it assumes approximately its original insulating resistance. When now subjected again to the influence of increased humidity, the insulation decreases in a much shorter time, the time being the shorter the longer the material was subjected to moisture in the preceding treatment. This effect was observed on materials consisting of phenoplast and sawdust. Such materials, therefore, cannot be recommended for use in tropical climates. They should be replaced by plastics, particularly such comprising aniline, resins, and polyvinylcarbazol, which are known in Germany under the trade marks "Iganil," "Cibanit" and "Luvican."

Similarly, the dielectric losses of insulating materials are dependent on the moisture content. Alterations of the dielectric losses influence, particularly at high frequencies, the damping of resonant circuits in connection with which the materials are used. Fig. 1 shows that aniline-resin and "Luvican" are much more advantageous than the

* Extracted by Dr. Walther Wolff from a paper by W. M. H. Schulze (A.E.G. Laboratory, Berlin), published in *E.N.T.*, June 1941, Vol. 18, No. 6.

normally used pressed materials Type S and Type S*.

In many cases the behaviour of the insulating resistance permits conclusions to be drawn with regard to the alteration of the loss angle, but this is not always true, since there exist cases where the insulation resistance decreases while the loss angle remains substantially constant. On the other hand, the loss angle may vary while the insulation resistance remains constant. For example, in a particular case it was found that when a rubber-insulated wire was exposed for a considerable time to 100 per cent. humidity, the insulation resistance remained substantially constant, while the loss angle increased quickly during the first month, and then decreased. The reverse occurs when the rubber insulated wire is subsequently subjected to dry air. In this case, the loss angle first continues to increase, reaches a maximum value and then decreases. The capacitance of the rubber insulated wire increases permanently. This is of importance, particularly with high frequency where variations of capacitance and dielectric loss may cause alterations of the resonant frequency and of the selectivity.

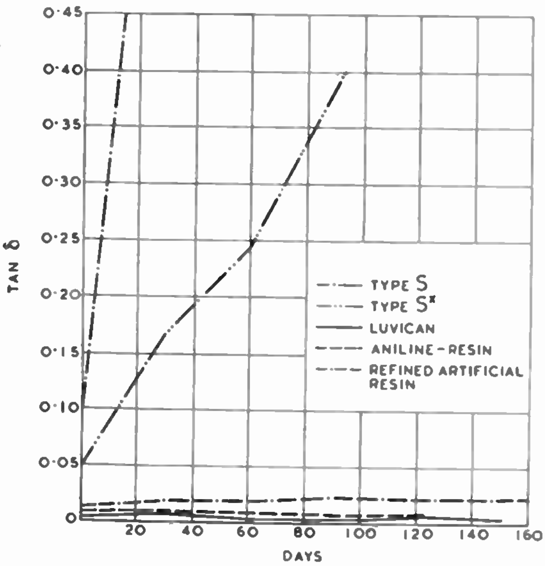


Fig. 1. *The variation of loss angle at 800 c/s of several pressed materials with the time of exposure to 100 per cent. relative atmospheric humidity.*

Since it is impossible to use only insulating materials which are independent of the moisture content of the atmosphere, it is necessary to protect coils, condensers and the like against moisture in order to keep the electrical values sufficiently constant. As Fig. 2 shows, the usual protection by lacquering, impregnating or covering causes only a certain delay, and thus gives but little protection.

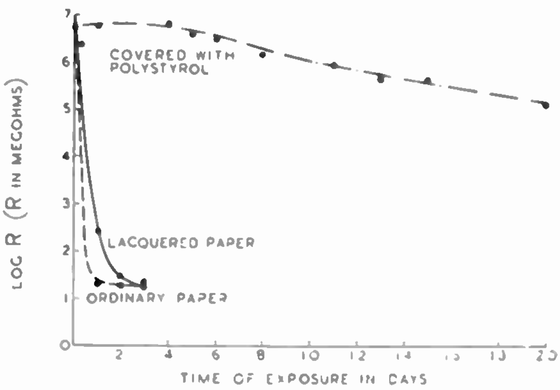


Fig. 2. *Insulation of different paper condensers when exposed to 80 per cent. relative atmospheric humidity.*

In order to meet the high requirements in constancy, condensers and the like should be enclosed in air-tight boxes of glass, ceramic, or the like.

A further essential climatic feature is the deposition of dew which causes corrosion of metal and influences certain non-metallic materials, such as wood. Near the coast dew appears on 150 to 250 days of the year. The deposit of dew is much larger than in non-tropical regions. The dew starts falling before midnight and sometimes even in the early hours of the evening.

Very important is also the temperature in tropical regions. In the moist jungle climate the temperature rises very seldom above 35 deg. to 40 deg. C., but may occasionally reach 65 deg. C. These temperatures are the real air temperatures which bodies assume in the shade. However, if the conditions are unfavourable, and there is no protection against sun rays, temperatures up to 70 deg. C. may occur.

It is fortunate that, in general, the high temperatures do not coincide with high values of atmospheric moisture content. When at a certain place the moisture content rises the temperature falls. This is important, since at high temperature and with a simultaneous high relative moisture content insulating and other materials are much more quickly and intensively affected as shown in Fig. 3, from which it can be seen that the sample of pressed material Type S in a room kept at tropical conditions deteriorated at 40 deg. C., much more quickly than the sample which was kept at about 20 deg. C. in moist air.

The temperatures given above refer to air at about 1.5 to 2 metres above earth. Towards the earth the air becomes warmer, the highest temperature exists at earth level where the temperature can rise to about 80 deg. C.

Bodies which are directly subjected to sun rays can assume much higher temperatures. The temperature depends on the quality of the body, its size and colour and also on existing wind condition. It may be assumed that temperatures of such bodies may be 30 deg. to 40 deg. C. higher than the air temperature in the shade.

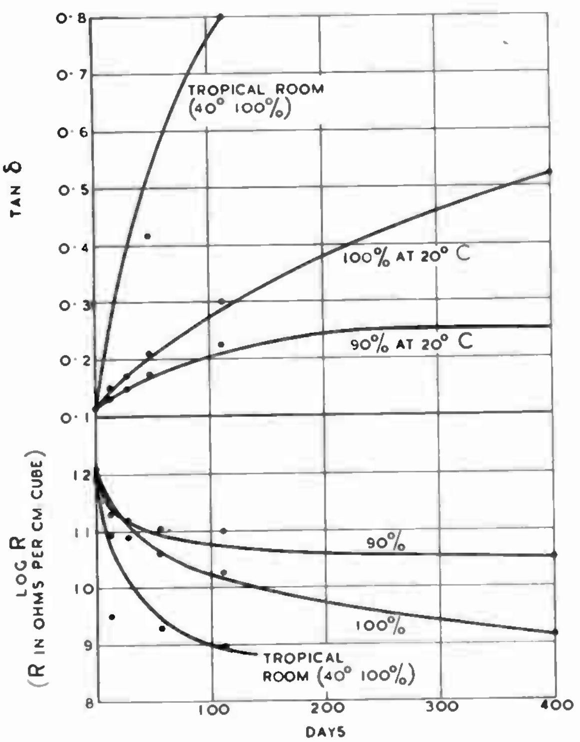


Fig. 3. *Loss angle at 800 c/s and specific insulation resistance of pressed material Type S when exposed to different conditions of moist air.*

It is advisable to give apparatus and arrangements which are permanently or often exposed to sun radiation in the open air a light-protective colour. Nevertheless, one should reckon with maximum temperatures of 80 deg. C., and therefore no materials should be used for insulating purposes with a lower heat resistivity than at least 90 deg. to 100 deg. [This is probably the temperature difference per cm. for a heat flow of 1 calorie per cm² per second], and no impregnating materials with a melting point below 90 deg. C. Moreover, sufficient space should be allowed for the thermal expansion of condensers, coils and the like. If possible, artificial ventilation should be provided for.

The temperature within the earth near its surface may reach 30 deg. to 35 deg. C.

Temperature variations are also of importance. In rainy regions, the variations may amount to 10 deg. to 15 deg. C., and in dry regions, up to 25 deg. C., and sometimes even to 30 deg. C. or 40 deg. C., particularly, near the earth's surface. The earth's surface, and objects, which are during the day subjected to direct sun radiation, and cool off during the night, show the highest temperature variations. Therefore, even in rainy climates apparatus in the open air is subjected to considerable temperature differences. In dry climates temperatures down to 10 deg. C. may occur during the night. Therefore, impregnating and the like substances must not show any inclination to form cracks at such low temperature. The influence of temperature variations upon electric and magnetic qualities has to be carefully considered. Generally speaking, the insulation resistance decreases exponentially with increasing temperature. Therefore, it is necessary to raise the general insulation level so high that when the insulation is decreased by a rise in temperature, the necessary minimum insulation is maintained even at maximum temperature.

More important than the insulation resistance is in most cases the loss angle. Dielectrics with only, or mainly, conductivity losses such as glass and ceramics, show in general more or less increasing loss with rising temperature. The temperature characteristics of insulating materials comprising polarised molecules are more complicated. With these materials, in addition to the pure conductivity losses, there are frictional losses owing to resonance oscillations of polarised groups, atoms or molecules, according to the theory of Debye. Compared with materials consisting of non-polarised molecules or such with low dipole momentum, such as ceresine, polystyrene, polyvinylcarbazol ("Luvican,") materials having polarised groups or molecules may have very bad dielectric qualities within a certain range of temperatures, and may show large variations with change of temperature. The range of temperatures over which, at a certain frequency, such dipole losses occur, is displaced towards higher temperatures when the frequency increases. When using such insulating materials, care has to be taken that within the range of frequencies for which the material is to be used the maximum of the dipole losses and thus the range of maximum alteration of ε falls outside the working temperatures. Fig. 4 shows how it is possible, for example, to displace the maximum of losses towards lower or higher temperatures by softening or hardening the insulating material.

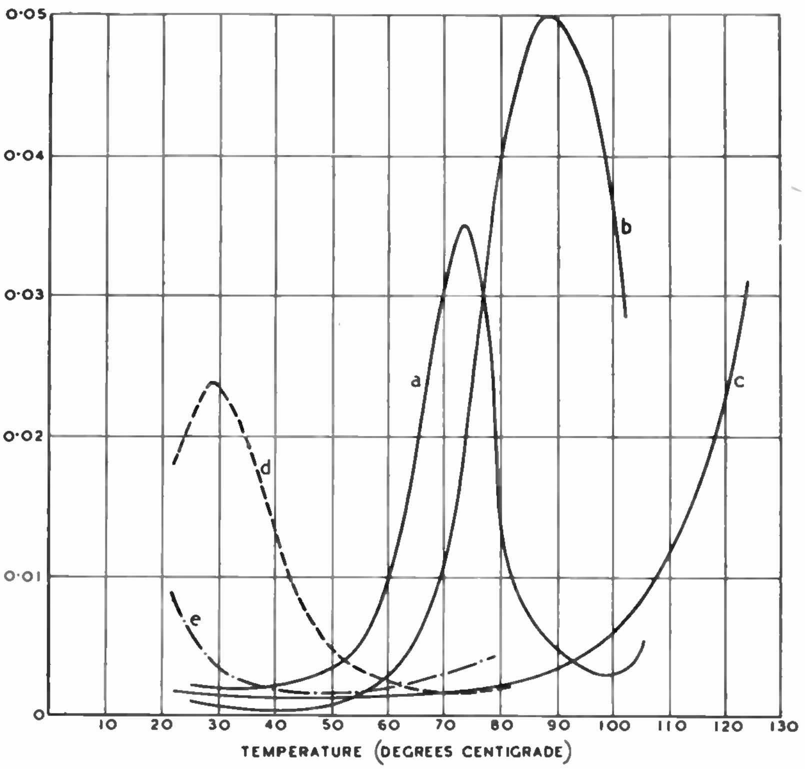


Fig. 4. *Dependence of the dielectric losses upon the temperature at* 800 *c/s of resin and influence of hardening and softening.* (*a*) *Colophony* (*WW resin*); (*b*) *Hardened with* 2 *per cent. calcium hydroxide;* (*c*) *Hardened with* 4 *per cent. calcium hydroxide;* (*d*) *With* 33.4 *per cent. addition of vaseline;* (*e*) *With* 100 *per cent. addition of vaseline.*

Similar conditions with regard to the temperature characteristics of the losses can exist with certain mixtures such as filled india-rubber plastic materials and the like. By properly choosing suitable components, the losses can be kept low at a desired range of temperatures and frequencies.

The temperature coefficient may be compensated by the addition of insulating material having the opposite temperature coefficient. For example, with paper condensers two different kinds of paper (cellulosic sodium and cellulosic sulphite) may be combined to reduce the temperature coefficient of the condenser.

The rise in temperature may also cause permanent alterations of the electric values of the capacitance in coils, condensers and the like. This effect can be decreased by ageing the apparatus, that is to say, by exposing it to a temperature which is higher than the maximum temperature which may occur in use. For tropical purposes, ageing of coils, condensers, resistances, and the like should be effected at least at 100 deg. C.

The influence of light is not very important, but some disturbances may be caused thereby. The ultra-violet light in the tropical climate is of the same intensity as in our region for the same altitude of the sun. However, since the altitude of the sun at noon is higher in the tropics than in our region the effects are much more increased leading to cracking and peeling off of lacquers, cracking of india-rubber and the like. Some insulating materials, most of all vulcanised india-rubber, can be changed chemically on the surface, causing a high surface conductivity. Simple washing with water is sufficient for removing this effect. Alternatively, insulating materials which are not sensitive to light, such as aniline resin ("Iganil") may be used.

Some disturbances may be caused by heavy storms, which carry with them enormous quantities of fine dust, which may lead to disturbances of contacts and the like. By suitable mechanical means this influence may be overcome, and the apparatus may be made sufficiently dust-proof.

The number of thunderstorms is very small in the dry tropics. In the rainy tropics, on the other hand, they are about five to ten times as numerous as in Europe. Such thunderstorms may influence adversely wireless communication.

Besides the influence of the climate the influence of tropical plants and animals must be considered. Mildew and bacteria that cause decay and quickly attack organic insulating material and even pressed material have to be considered. Lacquers may also be attacked. By using mildew-proof materials and specific poisons this danger can be overcome. Amongst animals, ants and insects, termites are particularly harmful, since they reproduce themselves very quickly. They attack wood, and similar marerials, wool, leather and the like, and sometimes even mortar and metals. This danger can be avoided by using suitable protecting means, termite-proof woods and the like. The quick growth of the jungle vegetation can also lead to disturbances, for example, trees may touch overhead conductors and thus cause leakages.

Correspondence

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

"The Temperature Compensation of Condensers"

To the Editor, "Wireless Engineer."

SIR,—From his communication published in your June issue, I think that Mr. Britton, whose interest lies chiefly in the more widely used commercial products, has formed the erroneous impression that I have classed ceramic condensers as inferior to high quality mica condensers *of the commercial grade*. On the contrary, although such products were outside the scope of my article on "The Temperature Compensation of Condensers," I was careful to point out that ceramic condensers ". . . are better than commercial mica condensers, although still inferior to the best mica condensers *which have been considered in the foregoing*." The italics have been introduced to emphasise the fact that the "best mica condensers" to which I referred are those of substandard quality of my own design, although modesty forbade mention of this fact.

It was to these mica condensers only that the commercial ceramic condensers were classed inferior. This should cause Mr. Britton no regret especially as I go further to say that even these *superlative* mica condensers are inferior to air condensers over the range of capacitance which shows the ceramic condenser at its best. The cold fact is, of course, that air dielectric condensers are much better than *any* solid dielectric condenser for capacitance values below 500 $\mu\mu$F. Above this capacitance the qualities of the ceramic condenser fall below those of the mica condenser principally owing to the great discrepancy between the minimum practicable thicknesses of mica and ceramic dielectric layers: This precludes the possibility of using good ceramics because of their low permittivities and necessitates a change-over to other ceramic materials the permittivities of which are high and, unfortunately, less stable with temperature and with frequency. Therefore, the ceramic condenser has no chance of competing with the *substandard* mica condenser because, obviously, for low values of capacitance an air dielectric condenser should be used if substandard qualities are required. It was for this reason also that I thought it obvious that my term "best mica condensers" applied only to those of over 500 $\mu\mu$F capacitance.

Most of the points raised by Mr. Britton are, I think, dealt with adequately in my letter appearing in your June issue. It is my duty to point out, however, that the specification of the latest titania-magnesia type of ceramic which he gives is not sufficient to prove its suitability for use as the dielectric of a standard of capacitance. For example, the frequency coefficient of permittivity of this material is not stated; it is probably much too high and almost certainly higher than that of mica. Moreover, the frequency coefficient of power-factor is also left in doubt and this again, I fear, would be inferior to that of mica. Nevertheless this material may prove very useful for the manufacture of high quality condensers *of low capacitance for high frequency*.

Finally, I would state that I cannot understand why Mr. Britton should think that I am not fully acquainted with the range of British materials available merely because I referred to a particular ceramic compensator of German origin which, besides serving admirably to illustrate the principle of adjustable compensation by ceramics, must be quantitatively representative of other compensators of similar type.

In conclusion, I should like to explain the varying terms used to indicate the qualities of condensers. In my article I referred to " best mica condensers," by which I meant those of the highest quality possible—built and adjusted under laboratory conditions. Some of your correspondents, among them Mr. Britton, have rather misinterpreted this description as applying to the best quality mica condensers of the commercial grade. With the possibility of this misinterpretation in mind when writing my previous letter on this subject, I referred intentionally to these best condensers as mica *standards* in order to emphasise the enormous difference which exists between these two classes of product.

The more pedantic of your readers will probably think that I should not have used the term " standard " in connection with mica condensers and I would hasten to explain that I should not have employed this nomenclature had my letter been a reply only to those ordinarily accustomed to thinking in terms of standards. Such condensers should more correctly be termed substandards, especially if their capacitance values fall within the range in which the more perfect air dielectric condenser standards are practicable propositions.

W. H. F. GRIFFITHS.

Reigate, Surrey.

"Pulsatance, Rotatance or Velocitance?"

To the Editor, " Wireless Engineer."

SIR,—The need for a term to describe ω or p the vector angular velocity, requires no stressing to those responsible for teaching radio engineering. The terms pulsatance and rotatance are too antiphonious for general use but why should they not be shortened to pulsance or rotance? Professor Howe has justified this for capacitive (*Wireless Engineer*, January 1933, p. 3). Of the two I would prefer the first (in spite of the limitation of its meaning) on the score of prior usage of pulsatance.

If a correctly descriptive term is considered essential, why not " angulocity "!

K. R. STURLEY.

The Marconi School of
Wireless Communication.

The Frequency Spectrum

To the Editor, " Wireless Engineer."

SIR,—Anyone brought up on the " Admiralty Handbook," from early editions, will be familiar with the excellent diagram of the frequency spectrum from 0 to cosmic rays. We should therefore all be extremely grateful to Mr. Fleming-Williams and define forthwith :—

frequency in Flemings* $= \log_{10} f$ in c/s.

The purist will then insist that 3.5 is the mean of 3 and 4 Fl.

Ware, Herts. GERALD SAYERS.

* Abbreviation Fl.

GOODS FOR EXPORT

The fact that goods made of raw materials in short supply owing to war conditions are advertised in this journal should not be taken as an indication that they are necessarily available for export.

Wireless Patents

A Summary of Recently Accepted Specifications

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

ACOUSTICS AND AUDIO-FREQUENCY CIRCUITS AND APPARATUS

543 035.—Audio-frequency amplifier having negative feed-back at the lower frequencies but in which a positive feed-back is produced as the result of any phase-shift at higher frequencies.

The British Thomson-Houston Co. Convention date (U.S.A.) 17th August, 1939.

AERIALS AND AERIAL SYSTEMS

543 299.—Multiple-unit aerial system of the kind in which the maximum response lobe can be " steered " into a desired direction.

Standard Telephones and Cables (assignees of D. H. Ring). Convention date (U.S.A.) 14th July, 1939.

543 334.—Transmission line particularly constructed for the propagation of magnetic fluxes.

Marconi's W.T. Co. (assignees of G. L. Usselman). Convention date (U.S.A.) 16th August, 1939.

543 337.—Aerial with quarter-wave sleeves or cages spaced along its length for suppressing undesired radiation and increasing the effective field strength in a given direction.

Standard Telephones and Cables (assignees of A. B. Bailey). Convention date (U.S.A.) 26th January, 1940.

543 376.—Construction and tuning of a dipole aerial which is enclosed inside a stream-lined casing for direction finding on aircraft.

Marconi's W.T. Co. (assignees of V. D. Landon and W. La V. Carlson). Convention date (U.S.A.) 31st August, 1939.

543 471.—Short-wave aerial array in which each dipole is mounted across the common gap in a longitudinally-split tube or transmission line.

Marconi's W.T. Co. (assignees of G. L. Usselman). Convention date (U.S.A.) 19th September, 1939.

DIRECTIONAL WIRELESS

543 229.—Radio-navigational beacon for defining a substantially constant path for the blind landing of aircraft.

Standard Telephones and Cables (assignees of A. Alford). Convention date (U.S.A.) 11th October, 1939.

543 336.—Short-wave beacon station for radiating a field pattern which is free from distinctive lobes.

Standard Telephones and Cables (assignees of A. Alford). Convention date (U.S.A.) 19th October, 1939.

RECEIVING CIRCUITS AND APPARATUS

(*See also under Television*)

542 813.—Grid modulation system in which negative feed-back is utilised to increase overall efficiency when feeding a load of varying impedance.

Marconi's W.T. Co. (assignees of D. Pollack). Convention date (U.S.A.) 25th July, 1939.

542 911.—Arrangement for limiting or adjusting maximum and minimum signal amplitudes, particularly in frequency- or pulse-modulated systems.

Standard Telephones and Cables and W. A. Beatty. Application date 30th July, 1940.

542 930.—Means for minimising negative reaction in an amplifier or modulator of the type in which the exciting voltage is applied to the cathode instead of the grid.

Standard Telephones and Cables (assignees of Le Matériel Téléphonique Soc. Anon.). Convention date (France) 2nd August, 1939.

543 050.—Receiving circuit for secret system of carrier-wave telegraphy involving both phase and amplitude modulation.

Standard Telephones and Cables; F. Ralph; and F. Fairley. Application date 6th May, 1940.

543 104.—Remotely controlled selecting devices, particularly for "spot tuning" a wireless set.

Marconi's W.T. Co.; C. S. Cockerell; and M. D. Tooley. Application date 8th August, 1940.

543 251.—Key-set arrangement for automatically tuning a wireless receiver to a number of pre-selected stations.

Philips Lamps (communicated by N. V. Philips Gloeilampenfabrieken). Application date 29th April, 1940.

543 252.—Wave-change switch with an elastic coupling which allows it to take any one of three positions in a manner favourable for push-button control.

Philips Lamps (communicated by N. V. Philips Gloeilampenfabrieken). Application date 30th April, 1940.

543 332.—Circuit arrangement for controlling the critical level and compression factor in a combined volume compressor and expander for radio and other signals.

Marconi's W.T. Co.; and H. Jefferson. Application date 8th August, 1940.

543 387.—Automatic volume control with automatic suppression of high and low notes during the reception of weak signals in order to discriminate against noise.

Philips Lamps (communicated by N. V. Philips Gloeilampenfabrieken). Application date 23rd April, 1940.

543 503.—Diode-triode circuit for developing an automatic gain control voltage strictly proportional to variations in the carrier-wave input.

Ferranti and G. I. Thomas. Application date 28th September, 1940.

TELEVISION CIRCUITS AND APPARATUS

FOR TRANSMISSION AND RECEPTION

542 639.—Television receiver in which a local pulse-generator is controlled by and serves to strengthen the incoming synchronising impulses.

Philco Radio and Television Corpn. (assignees of N. F. Smith, Junr.). Convention date (U.S.A.) 4th May, 1939.

542 820.—Circuit for expanding the contrast range in a television receiver, particularly when projecting a picture on to a large-sized viewing screen.

Baird Television. Convention date (U.S.A.) 29th August, 1939.

543 185.—Television system in which each picture element is modulated on a different carrier frequency, the complex of these frequencies being transmitted over a single channel.

Scophony and F. Okolicsanyi. Application date 10th June, 1940.

543 474.—Television transmitting system of the kind where the carrier wave is negatively modulated by the picture signal.

Marconi's W.T. Co. (assignees of R. D. Kell). Convention date (U.S.A.) 30th September, 1939.

543 485.—Projecting a large-scale television picture by focusing an external source of light on to the electron-sensitive screen of a cathode-ray tube.

Ges. für Förderung &c. Technischen Hochschule, Zurich. Convention date (Switzerland) 8th November, 1939.

543 565.—Reproducing television pictures by a light ray which is modulated and scanned inside a cathode-ray tube but is projected on to an external viewing screen. [Addition to 543 485.]

Ges für Förderung &c. Technischen Hochschule, Convention date (Switzerland) 9th December, 1939.

TRANSMITTING CIRCUITS AND APPARATUS

(*See also under Television*)

542 424.—Simplified method of rendering telephony secret by changing the normal modulation frequencies.

The General Electric Co. and A. Bloch. Application date 20th August, 1940.

542 510.—Plug-in type of amplifier, for use in multi-channel signalling systems, in which each valve automatically assumes the impedance required at the point into which it is plugged.

Standard Telephones and Cables; B. B. Jacobsen; and A. H. Roche. Application date 12th July, 1940.

542 693.—Radio transmission system in which two carrier waves of the same frequency but of different phase, are phase-modulated and radiated as a resultant of varying polarity.

Marconi's W.T. Co. (assignees of G. L. Usselman). Convention date (U.S.A.) 17th June, 1939.

543 048.—System of secret and non-secret multiplex telegraphy based upon the use of two carrier waves of different frequency, one being phase-modulated.

Standard Telephones and Cables; F. Ralph; and F. Fairley. Application date 8th March, 1940.

CONSTRUCTION OF ELECTRONIC-DISCHARGE DEVICES

542 971.—Single valve arranged for push-pull operation from a single cathode for generating short waves at a high level of power.

Marconi's W.T. Co. (assignees of L. P. Garner). Convention date (U.S.A.) 29th July, 1939.

542 994.—Cathode-ray tube in which a resonance effect is combined with the magnetic scanning voltages applied to the deflecting plates.

Philco Radio and Television Corpn. (assignees of R. C. Moore). Convention date (U.S.A.) 16th June, 1939.

543 022.—Control means for varying the cross-section of an electron stream without producing any resultant velocity-changes in undesired directions.

J. D. McGee; H. Miller; and G. S. P. Freeman. Application date 2nd May, 1940.

543 051.—Cathode-ray indicator for measuring the frequency range of a frequency-modulated wave.

Electrical Research Products Inc. Convention date (U.S.A.) 26th July, 1939.

543 106.—Cathode of "pepper-pot" construction to increase secondary emission, particularly for electron multipliers. [Addition to 516 621.]

F. J. G. van den Bosch and Vacuum-Science Products. Application date 9th August, 1940.

543 201.—Method of producing an electro-positive metal with a high coefficient of secondary emission, particularly when bombarded with primary electrons.

International Television Corpn; P. Nagy; and M. J. Goddard. Application date 16th August, 1940.

543 351.—Cathode-ray monitor tube for indicating variations of the carrier-wave in a frequency-modulated signalling system.

Farnsworth Television and Radio Corpn. Convention date (U.S.A.) 16th September, 1940.

543 400.—Electron-discharge tube incorporating high-frequency resonators of the concentric-line type for velocity modulation.

Standard Telephones and Cables; and C. N. Smyth. Application date 23rd August, 1940.

543 493.—Electrode arrangement and alignment for an amplifier and detector of centimetre waves.

Standard Telephones and Cables (assignees of E. Bruce). Convention date (U.S.A.) 6th October, 1939.

543 499.—Electron-discharge device for projecting a plurality of electron streams against as many different fluorescent screens.

The British Thomson-Houston Co. Convention date (U.S.A.) 9th September, 1939.

543 522.—Electrode arrangement of an oscillation generator in which resonating chambers are included.

Marconi's W.T. Co. (assignees of E. G. Linder). Convention date (U.S.A.) 31st August, 1939.

SUBSIDIARY APPARATUS AND MATERIALS

542 634.—Indicating the distance and direction of normally invisible objects by utilising the beat-frequency between transmitted and reflected waves.

H. F. Rost and P. H. E. Claesson. Application date 16th October, 1939.

543 045.—Filtering network comprising two passive quadrupoles in which frequency separation is effected by virtue of inherent phase-changing characteristics.

Telefon. A B L.M. Ericsson. Convention date (Sweden) 13th July, 1938.

543 052.—Resonator of the concentric transmission-line type containing a diode rectifier for measuring very-high frequencies.

Electrical Research Products Inc. Convention date (U.S.A.) 26th July, 1939.

543 068.—Electrical counting device including an oscillating valve for aggregating plus and minus indications.

Standard Telephones and Cables and R. M. Barnard. Application date 6th August, 1940.

543 126.—Means for offsetting the effect of varying temperature on the frequency of a circuit including a tapped inductance.

Marconi's W.T. Co.; and N. Lea. Application date 8th August, 1940.

543 148.—Method of securing a more accurate control of the magnetising and demagnetising required in certain types of meter.

J. H. Reyner. Application date 9th August, 1940.

543 153.—Compact assembly of a plurality of ultra-short-wave oscillators operating as a single unit.

Marconi's W.T. Co. (assignees of H. E. Goldstine). Convention date (U.S.A.) 10th August, 1939.

543 222.—Circuit arrangement of the rotary-field type for measuring and regulating phase-differences between currents of very-high frequency.

Marconi's W.T. Co.; and L. W. Whitaker. Application date 8th August, 1940.

543 301.—Circuit arrangement for generating at will any one of a large range of frequencies, particularly for measuring and testing purposes.

Marconi's W.T. Co. (assignees of A. C. Stocker). Convention date (U.S.A.) 16th June, 1939.

543 504.—Saw-toothed oscillation generator for developing a wave with a long forward flank and short return.

Hazeltine Corpn. (assignees of H. A. Wheeler). Convention date (U.S.A.) 25th October, 1939.

543 550.—Valve circuit for frequency multiplying which will operate over a wide range without requiring readjustment.

Marconi's W.T. Co. (assignees of L. E. Norton). Convention date (U.S.A.) 1st September, 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

1880. THE PROPAGATION OF ULTRA-SHORT [Decimetric] WAVES ALONG A "DIELECTRIC LINE" [of Water & Acid Solutions].—K. E. Slevogt. (*Hochf:tech. u. Elek:akus.*, Jan. 1942, Vol. 59, No. 1, pp. 1–10.)

If the inner conductor of a concentric-tube system is formed by a liquid in a tubular container (*e.g.* a glass tube), the conducting mechanism depends on the dielectric constant and conductivity of the liquid at the particular frequency employed. Such an inner conductor is termed a "dielectric line," and it is found that for decimetric waves a water line displays a much lower attenuation than would be expected from the dipole conductivity of water. The present experiments therefore investigate the conduction mechanism by measurements on water and on aqueous solutions of sulphuric acid, alcohols, etc., at wavelengths of 14, 21.3, and 48.9 cm: the 14 cm wave was obtained from a Pintsch "Resotank" retarding-field generator (2258 of 1938).

The results are summarised as follows:—(1) At all three wavelengths the apparent conductivity of the water is much greater (by a whole order of magnitude) than that given by the Debye theory of dipole conductivity, assuming pure conduction: although check measurements by the "ratio" method used by the writer previously (754 of 1940) show that the conductivity of the actual water behaved according to the Debye theory. (2) The measurements on water show an increase in wavelength as the containing-tube radius was diminished, this increase becoming rapid as the radius decreased below about 0.5 cm (Fig. 9). (3) Attenuation equivalent and phase velocity are functions of this radius: the variation of attenuation equivalent with radius shows a minimum. (4) No dependence of attenuation equivalent on field strength or temperature could be detected. (5) The marked dependence of attenuation equivalent and wavelength on the radius of the inner conductor finds its explanation in the assumption of a transition from a cavity-air-wave mode (E_0 wave type) to a Hondros "secondary" wave (as contrasted to the "principal" wave given by Sommerfeld's theory: *see* top of p. 2 and reference "2"). (6) The attenuation equivalent rises with the addition of ions to a maximum, at about 1% sulphuric acid, and then drops again (Figs. 12–14: the maximum is less marked for the 48.9 cm wavelength, because the ionic conductivity has already had its effect in relation to the already much smaller apparent conductivity of the water for this longer wave). The addition of ions to the water brings about a transition from cavity wave to conduction wave.

It is thus seen that by a suitable choice of inner-conductor dimensions and of dielectric, the same apparatus can be made to yield cavity waves, "secondary" Hondros waves, and conduction waves. This may lead to useful developments in research both on liquids and on cavity resonators.

1881. ON THE THEORY OF THE CYLINDRICAL-PARABOLIC REFLECTOR.—Magnus. (*See* 1966.)

1882. THE DOPPLER EFFECT OF RADIO WAVES.—D. Nasilov. (*Journ. of Tech. Phys.* [in Russian], No. 10, Vol. 10, 1940, pp. 851–852.)

It is generally accepted that the Doppler effect is caused by changes in the ionisation of the lower layers of the atmosphere. The ionisation of these layers is greatly affected by the presence of storm clouds, and the consequent variation in the field intensity of a radio station may be of the following two types: it may vary in both directions or in one direction only from the average value, depending on whether the clouds move along or across the path of the radio waves. Only in the second case can the Doppler effect take place, sometimes even if the storm occurs not far from the receiving point. Experimental curves showing the variation of the field intensity of long-wave radio transmitting stations are given.

1883. THE EFFECT OF CLIMATIC CONDITIONS [such as Fog] ON RADIO COMMUNICATION.—A. Loidis & D. Nasilov. (*Journ. of Tech. Phys.* [in Russian], No. 10, Vol. 10, 1940, pp. 853–854.)

It is pointed out that in investigating the conditions of the atmosphere and their effect on radio communication, little attention has been paid to the layer immediately adjacent to the earth's surface. It is suggested, for example, that fog may play an important rôle, and an experimental curve is shown (Fig. 1) indicating a sharp decline in the field intensity (wavelength 1107 m) with the appearance of fog. This suggestion is put forward as a possible explanation of the well-known deterioration in radio communication between Great Britain and the U.S.A. during the winter months (the "November effect"). It is pointed out that November is the month of prevalence of fogs in the region of the Gulf Stream at the latitude of Great Britain: in summer the fogs move further North. Reports are also mentioned from Russian explorers in the Arctic on complete breakdowns of radio communication during fogs.

1884. ON THE PROPAGATION OF ELECTROMAGNETIC WAVES IN A MAGNETISED MEDIUM, FOR VERTICAL INCIDENCE [and the Question of Secondary Splitting].—K. Försterling. (*Hochf:tech. u. Elek:akus.*, Jan. 1942, Vol. 59, No. 1, pp. 10–22.)

An extension, backed by the German *Gesellschaft für Luftfahrt*, of the Försterling-Lassen investigation dealt with in 1934 Abstracts, pp. 28–29. "In a magnetised medium two waves are propagated with different velocities. Thus in the reflection of short electromagnetic waves at the 'upper Heaviside layer' there occur two reflected waves, elliptically polarised in opposite senses. Occasionally one of the waves further splits itself into two waves. In the following pages the question is examined whether the theory allows one to expect such a repeated splitting, on the assumption of values for the gradient of refractive index which are probable in the ionosphere." For the main conclusions *see* last paragraph of this abstract.

The treatment is as follows:—§2—The equations connecting the field vectors $\mathfrak{E}$ and $\mathfrak{D}$ (the 3 equations of eqn. 5), and the derivation of conditions in which the relation between $\mathfrak{E}_x$ and $\mathfrak{D}_x$ are completely symmetrical with respect to that between $\mathfrak{E}_y$ and $\mathfrak{D}_y$: these conditions are given by eqn. 8. §3—Division of vector $\mathfrak{D}$ into two partial-field vectors $\mathfrak{D}^{(1)}$ and $\mathfrak{D}^{(2)}$, in such a way that $\mathfrak{D}_y{}^{(1)} = iq^{(1)} \mathfrak{D}_x{}^{(1)}$ and $\mathfrak{D}_y{}^{(2)} = iq^{(2)} \mathfrak{D}_x{}^{(2)}$, where $q^{(1)}$ and $q^{(2)}$ are taken from eqn. 8. The field strength $\mathfrak{E}$ is similarly divided into two fields $\mathfrak{E}^{(1)}$ and $\mathfrak{E}^{(2)}$, and the relations between $\mathfrak{E}$ and $\mathfrak{D}$ for the two fields (1) and (2) are now given by eqn. 14, applying both to homogeneous and inhomogeneous media. §4—Derivation of the differential equation for the propagation of a wave: the two top equations of eqn. 5, for $\mathfrak{E}_x$ and $\mathfrak{E}_y$, are taken, and $\mathfrak{E}$ is eliminated with the help of the Maxwell equations and the relations of eqn. 14, resulting in eqn. 16 which, when the left-hand side is also split into the two partial fields, becomes eqn. 18, leading to eqn. 19. Replacing $\mathfrak{E}_x{}^{(1)}$ and $\mathfrak{E}_y{}^{(2)}$ again, according to eqn. 14, eqn. 20 is obtained, and finally the two differential equations, by the simplifying substitutions of eqn. 21, take the form of eqn. 22.

§5—These two equations are solved approximately by the method of variation of constants, the necessary assumption for the approximation being that the coupling terms linking the two waves of eqn. 20 are small; that is, that the first and second derivatives of q are small. §6—Discussion of the special case when Q varies slowly with the height (for Q *see* eqns. 35–37). §7—Discussion of special cases of total reflection. §8—Discussion of the special case of small double refraction.

In all the above cases the conclusion is that only a very weak "subsidiary," split-off wave can be expected. Actually, the conditions for the occurrence of such a wave are still more unfavourable, since the electron density does *not* rise linearly to the maximum but slopes off at the border of the layer. §9, however, points out that hitherto only the case of very small electron or ion densities has been considered, absorption being neglected: "these assumptions should be fulfilled at the lower (and upper) boundary of the Heaviside layer". But in the lower regions, down to the surface of the earth, there are still electrons present, though at extremely low densities. Here σ can be put at zero, but not the attenuation factor ω', for this is proportional to the number of collisions suffered by an electron in a unit of time, and this number increases with the density of the air molecules. This case is considered, and the conclusion is that "a wave reflected from the Heaviside layer possesses the same polarisation state iq_0 on its arrival at the earth's surface as when it left the layer at the point z_0, where the refractive index of the layer was about equal to unity." Throughout the paper, only first-order terms of $\partial q/\partial z$ (alteration of polarisation state with height) have been considered, but in his final remarks the writer points out that closer approximations would modify his results very little. He sums up as follows:—"So long as the variation of ϵ with height depends only on the change in electron density, and the ϵ gradient has only such values as may be assumed normally in the ionosphere, then the refractive index and the form of oscillation are to be calculated according to the known laws of magneto-optics for homogeneous media. An appreciable exchange of energy between the two waves does not occur. In the lower layers of the atmosphere, where the electron concentration is very low and practically only the attenuation varies, with the increasing density of the neutral air molecules, the polarisation state given by the magneto-optics of homogeneous media no longer occurs: on the contrary, in these regions the polarisation state suffers no alteration with height."

1885. AN INVESTIGATION OF THE PHASE STRUCTURE OF AN ELECTROMAGNETIC FIELD AND THE VELOCITY OF RADIO WAVES.—Al'pert & others. (*Journ. of Phys.* [of USSR], No. 1/2, Vol. 4, 1941, pp. 13–38: in English.) The original Russian paper was dealt with in 622 of March. A summary from this English version can be found in *Sci. Abstracts*, Sec. B, March 1942, Vol. 45, No. 531, p. 60, and another in *Physik. Berichte*, 15th Jan. 1942, Vol. 23, No. 2, p. 248. *Cf.* also Grosskopf, 964 of March.

1886. INFLUENCE OF TEMPERATURE ON THE ABSORPTION SPECTRUM OF OZONE (HUGGINS' BANDS) [in Connection with Calculations of Stratospheric Temperature from Stellar Spectra].—D. Barbier & D. Chalonge. (*Comptes Rendus* [Paris], 10th Nov. 1941, Vol. 213, No. 19, pp. 650–652.)

1887. MESOTRON STUDIES WITH DUAL TELESCOPE [used in Investigations of Variation with Upper-Air Temperatures, 642 of March].—F. A. Benedetto & others. (*Phys. Review*, 1st/15th March 1942, Vol. 61, No. 5/6, pp. 266–269.)

1888. THE RELATION BETWEEN COSMIC-RAY INTENSITY VARIATIONS AND SUNSPOTS, AND THE SPECIAL MAGNETIC DISTURBANCES DUE TO THESE VARIATIONS.—J. W. Broxon, Foster Evans. (*Science*, 27th Feb. 1942, Vol. 95, Supp. p. 10: summary only.) *See* also 2353 & 2630 of 1941, and 962 of April & back reference.

1889. PHOTOPHORESIS AND ITS INTERPRETATION BY ELECTRIC AND MAGNETIC IONS.—F. Ehrenhaft. (*Journ. Franklin Inst.*, March 1942, Vol. 233, No. 3, pp. 235–256.) With 83 literature references: for previous work *see* 11, 222, 675, 1304, & 2974 of 1941, and 888 of March, and back references.

1890. THE FORBIDDEN DOUBLET ^4S–^2D OF THE NEUTRAL ATOM OF NITROGEN IN THE SPECTRUM OF CERTAIN AURORAS VISIBLE AT LOW LATITUDES [New Results give Definite Confirmation: Consequent Existence of Free Atoms of Nitrogen in Upper Atmosphere, in Great Abundance (at any rate in Certain Circumstances): Other Observations, on "Red" Auroras (at Much Greater Heights than Usual Type)].—J. Dufay & T. Mao-Lin. (*Comptes Rendus* [Paris], 17th Nov. 1941, Vol. 213, No. 20, pp. 692–694.)

1891. THE PRESENCE OF FORBIDDEN RAYS IN THE SPECTRA OF THE NIGHT SKY AND THE AURORA, AND THE CONSTITUTION OF THE UPPER ATMOSPHERE [Discussion of Collision Conditions of Metastable Atoms leads to Conclusion that Nitrogen & Oxygen must be Completely Dissociated into the Atomic State above 100 km, Molecules being only present as Traces].—J. Gauzit. (*Comptes Rendus* [Paris], 17th Nov. 1941, Vol. 213, No. 20, pp. 695–697.)

1892. ON THE INTERPRETATION OF THE SUN-LIT AURORA.—P. Jordan. (*Zeitschr. f. Phys.*, No. 7/8, Vol. 118, 1941, pp. 441–442.)

Störmer found that aurora was formed more readily in the sun-lit part of the upper atmosphere than within the shadow of the earth: in the latter it usually reaches a height of no more than 400–450 km, whereas in the former zone it may occur up to and beyond a height of 1000 km. The rays of the sun-lit aurora usually end, in the downward direction, above the earth's shadow, often nearly reaching the edge of this. Occasionally they penetrate into the shadow, but their light is interrupted just at the border line. Only one explanation of this peculiar phenomenon has been offered, by Vegard, who suggested that the density of the air in the upper stmosphere does not decrease steadily with increase of height but has a minimum at the border of the earth's shadow, and increases again in the sun-lit zone. The present writer is not convinced by Vegard's reasoning, and interprets the phenomenon by attributing to the sun-lit upper atmosphere a physical state differing from that of an equally high layer in the earth's shadow, and capable of yielding pronounced light intensities in spite of considerably lower air densities. One possibility, supported by auroral spectroscopy, is that under the action of the ultra-violet solar radiation there occurs in the high layers a piling-up of excited N_2 and O_2 molecules in a long-lived excitation state: probably (using the Herzberg notation) for N_2 the metastable lower combination term of the second positive group, $A^3\Sigma_u{}^+$, and for O_2 the term $^3\Sigma_u{}^+$.

1893. SUNSPOT GROUP OF 25TH FEB./1ST MARCH GAVE HIGHEST MAGNETIC FIELD [5100 Gauss] EVER MEASURED AT MOUNT WILSON OBSERVATORY.—(*Sci. News Letter*, 21st March 1942, Vol. 41, No. 12, p. 183: *Science*, 20th March, Vol. 95, Supp. pp. 10, 12.)

1894. NOTE ON THE DISTRIBUTION OF FACULAE AND SUNSPOTS, *and* SUNSPOTS AND TREE RINGS [including Evidence of Cycle of about 90 Years].—G. H. A. Archenhold: E. L. Moseley. (*Sci. Abstracts*, Sec. A, March 1942, Vol. 45, No. 531, p. 78: p. 78.)

1895. COMPARISON OF H AND He RADIATION IN SOLAR PROMINENCES.—A. D. Thackeray. (*Sci. Abstracts*, Sec. A, March 1942, Vol. 45, No. 531, p. 79.)

1896. "INTRODUCTION TO METEOROLOGY" [Book Review].—S. Petterssen. (*Nature*, 18th April 1942, Vol. 149, p. 423.) For his other recent book *see* 1626 of June: and *cf.* 1897, below.

1897. WEATHER AND WAR [and the Apparently Successful Use by Germany, in This War, of the Franz Baur Method of Medium-Range Prediction].—(*Sci. & Culture* [Calcutta], July 1941, Vol. 7, No. 1, pp. 23–24.) Based on a paper by Petterson (Petterssen? *see* for example 1896, above).

1898. THE "DIFFUSING EFFECT" OF FOG.—W. E. K. Middleton. (*Journ. Opt. Soc. Am.*, March 1942, Vol. 32, No. 3, pp. 139–143.)

1899. The Light diffused Forwards by a Drop of Mist [Measurements on Drops of Mean Radius ranging from 4μ to 8μ].—J. Bricard. (*Comptes Rendus* [Paris], 13th Oct. 1941, Vol. 213, No. 15, pp. 495–498.) Continuation of the work dealt with in 379 of February. Within 8–10% the distribution of the diffused light is independent of the mean radius.

1900. The Transmission of Light in the Atmosphere, with Application to Aviation [Absorption & Scattering, over the Spectrum: the Need for an Instrument for measuring the Scattering Coefficient: etc.].—H. G. Houghton. (*Journ. Roy. Aeron. Soc.*, May 1942, Vol. 46, No. 377, pp. 159–160: abstract only.)

1901. Absorption of Light and Heat Radiation by Small Spherical Particles: II—Scattering of Light by Small Carbon Spheres.—R. Ruedy. (*Canadian Journ. of Res.*, March 1942, Vol. 20, No. 3, Sec. A, pp. 25–32.) For I *see* 937 of April.

1902. Possible Earth's Field Effect on Atmospheric Spectrum Intensities [explaining the Observed Rapid Variations: Justification for Assumption of Electric Dipole in Atmospheric-Oxygen Molecule].—A. B. Arlick. (*Sci. & Culture* [Calcutta], Feb. 1941, Vol. 6, No. 8, pp. 486–487.) Continued from 4279 of 1939. For further development *see* issue for Sept. 1941, Vol. 7, No. 3, pp. 170–171.

1903. Surge Propagation: II.—T. F. Wall. (*Engineering*, 3rd & 17th April & 1st May 1942, Vol. 153, pp. 261–263, 301–302, & 341–342.) For Part I *see* 1293 of May.

1904. On Activation Waves along "Passive" Iron Wires [taken as Model for Action-Current Propagation along Nerves].—Bonhoeffer & Renneberg. (*See* 2207.)

1905. Corrections to "Data Sheets IX, X, & XI: On the Resonant Length of Capacity-Loaded Transmission Lines".—(*See* 1923.)

ATMOSPHERICS AND ATMOSPHERIC ELECTRICITY

1906. The Effect of Sunset on Atmospherics, *and* Lightning and Atmospherics.—N. S. S. Rao: F. E. Lutkin. (*Sci. Abstracts*, Sec. A, March 1942, Vol. 45, No. 531, p. 108: p. 108.)

1907. Distribution of Electricity in Thunderclouds.—G. D. Robinson. (*Sci. Abstracts*, Sec. A, March 1942, Vol. 45, No. 531, p. 108.) *See* also 1307 of 1941.

1908. Physics of Lightning [including Tentative Mechanisms for Propagation of the Various Strokes and for Initiation of Discharge at Surfaces of Individual Raindrops].—T. E. Allibone. (*Sci. Abstracts*, Sec. A, March 1942, Vol. 45, No. 531, p. 108.)

1909. Threshold Field Studies of Various Positive Corona Phenomena [and Verification of Loeb & Meek's Streamer Theory of Spark Discharge: Effects of Humidity, etc.].—K. E. Fitzsimmons. (*Phys. Review*, 1st/15th Feb. 1942, Vol. 61, No. 3/4, pp. 175–182.)

1910. Lightning Arresters [Survey, and the G.E.C. Surge Valve Arrester].—W. Wilson. (*G.E.C. Journal*, Feb. 1942, Vol. 12, No. 1, pp. 4–14.)

1911. Line-Voltage Regulator [Plug-in Unit] used as Protection for Radio Receivers against Lightning on Power Lines.—Clarostat. (*Review Scient. Instr.*, Feb. 1942, Vol. 13, No. 2, p. 87.)

1912. Surge Propagation: II.—Wall. (*See* 1903.)

1913. The "High Frequency Potential Sonde", a New Apparatus for the Instantaneous Measurement of Potential Gradients [carried into Stratosphere by Balloon in 1–2 Hours].—P. Wenk. (*Naturwiss.*, 3rd April 1942, Vol. 30, No. 14/15, pp. 225–226.)

The advantages claimed are that the measured value is received immediately at the ground station, together with the height at which the measurement has taken place; that both positive and negative gradients can be measured; and that the sensitivity can easily be varied between 100 and 10 000 v/m. Two "Radiothor" potential devices, S_1 and S_2, with a fixed distance between them, are connected across a resistance R_1: the potential differences appearing across this resistance are applied to the control grid and cathode of a special two-grid valve (for particular reasons an electrometer type is not used), and the resulting anode-current changes produce their effects at the precision resistance R_2. By these, through a "controlled contact device" K, the large condenser C is charged during a short time, and discharges itself through a high resistance R_3, the discharging time being a function of the applied potential. For example, if the original potential gradient is zero, the discharge would last, say, 12 seconds; a positive gradient would give a longer time, a negative gradient a shorter. The negative and positive ends of R_3 are connected respectively to the grid and cathode of a second valve, so that the anode current of this is blocked during the discharge of C and leaves un-energised a simple relay, with the result that the oscillation of a small short-wave transmitter is interrupted. Thus the break in the signals recorded at the ground station represents by its duration both the sense and magnitude of the potential gradient. Simultaneously, the atmospheric pressure is communicated by the same transmitter, by a barometric pick-up connected across the oscillatory circuit.

1914. The Point-Discharge Recorder—Recording Microammeter [primarily for Study of Electrostatic Field near Ground Level (1300 of May): Constructional Details (Prevention of Backlash, etc.)].—J. L. Candler. (*Journ. of Scient. Instr.*, May 1942, Vol. 19, No. 5, pp. 75–78.) E.R.A. Report Ref. S/T 30a.

1915. Study of the Mobility Spectrum of the Large Atmospheric Ions.—P. Quéney. (*Comptes Rendus* [Paris], 13th Oct. 1941, Vol. 213, No. 15, pp. 498–500.)

1916. New Method of Measuring the Magnetic Declination and Dip.—Tenani. (*See* 2039.)

PROPERTIES OF CIRCUITS

1917. Non-Linear Distortion, with Particular Reference to the Theory of Frequency-Modulated Waves: Part II [Application of F.M. Wave to Four-Terminal Network having a Linear Amplitude Frequency Characteristic: having a Linear Phase-Shift Frequency Characteristic: having Both Characteristics Linear: Same for Non-Linear Characteristics (Band-Pass Filters & Converters): etc: Results Not Limited to Condition of Carrier Frequency Large compared with Frequency Excursion].—E. C. Cherry & R. S. Rivlin. (*Phil. Mag.*, April 1942, Vol. 33, No. 219, pp. 272–293.) For Part I *see* 31 of January.

1918. The Response of a Network to an Arbitrary Periodic Driving Force [Method giving Solution in Closed Form by Use of Heaviside Expansion Theorem & Du Hamel's Integral: Useful when Power or R.M.S. Value of Response is of Importance: gives Different Approach to Resonance Phenomenon, and forms New Way of developing Summation Formulae for Fourier-Series Results].—E. W. Hamlin. (*Journ. Franklin Inst.*, March 1942, Vol. 233, No. 3, pp. 257–270.) The general method was used for television circuits (Carnahan, 230 of 1936).

1919. Operational Methods of dealing with Circuits excited by Sinusoidal Impulses.—W. B. Coulthard. (*Canadian Journ. of Res.*, April 1942, Vol. 20, No. 4, Sec. A, pp. 33–38.)

"A method is developed [based on Jeffrey's work] of deducing operational expressions for complex wave forms such as repeated sinusoidal impulses. By the use of the Heaviside expansion theorem, formulae are obtained for the current flowing in a circuit consisting of a condenser and a loading resistance when fed from a straight-line rectifier." For other work *see* 1201 of April.

1920. Electrons in Ultra-High-Frequency Valves: II—Hollow Resonators and Circuits of High "Q" [Wave Guides, Cavity Resonators, etc.].—M. Johnson. (*Wireless World*, April 1942, Vol. 48, No. 4, pp. 92–95.) For a letter referring to Part I, and dealing with the transit times of electrons and the allowance for the increase in the mass of the electron at very high voltages, *see* p. 100 (Macquillan).

1921. On the Coupled Systems with Distributed Constants.—V. I. Kalinin & V. A. Tolstikov. (*Journ. of Tech. Phys.* [in Russian], No. 10, Vol. 10, 1940, pp. 830–838.)

Two parallel two-wire lines of length l are considered (Fig. 1). The lines are assumed to have no losses. The coupling between the two lines is determined by constants $\bar{M}$ and $\bar{C}$ corresponding respectively to the mutual inductance and capacitance per unit length. The primary line I is terminated by an impedance Z_1; the secondary line II is loaded at both ends by impedances Z_2 and Z_3 respectively.

Using the method proposed by Pistol'kors, formula (15) is derived for determining the input impedance Z_i of the system (of the primary line). The active and reactive components (17) of this impedance are also determined and certain particular cases are considered separately. The condition of resonance in the system, *i.e.* when $Z_i = 0$, is then discussed, and the corresponding pairs of the "coupled frequencies" of the lines are determined as distinct from the natural frequencies when the lines are considered separately. The discussion is applied to the case of "indirect modulation" of a decimetric-wave oscillator, proposed by Kalinin (*Elektrosvyaz*, No. 2, 1939, p. 52 onwards). In this method a magnetron is connected to the primary line, which is short circuited at the far end (Fig. 5). The secondary line is loaded with two resistances, one of which is modulated.

1922. Impedance-Matching in Concentric Lines [Methods employing Matching Sections composed of Concentric Lines, without involving Use of Standing Waves].—R.C.A. Laboratories. (*Electronic Eng:g*, Nov. 1941, Vol. 14, No. 165, p. 508.)

1923. Corrections to "Data Sheets IX, X, & XI: On the Resonant Length of Capacity-Loaded Transmission Lines."—(*Electronic Eng:g*, Oct. 1941, Vol. 14, No. 164, p. 472.) *See* 1314 of May. Several of the errors were due to the confusion between the typed "l" and "1" referred to in 2404 of 1941.

1924. Reducing Phase Shifts in Transformers [Devices for Reduction of Leakage Inductance between Primary & Secondary of Inter-Stage Transformers].—R.C.A. Laboratories. (*Electronic Eng:g*, Oct. 1941, Vol. 14, No. 164, p. 469.)

1925. Grounding of High-Gain High-Frequency Amplifiers [Technique to avoid Mutual Impedances in Ground Paths of Different Stages].—T. F. Gleichmann. (*Bell Lab. Record*, March 1942, Vol. 20, No. 7, pp. 183–186.)

Used in the 10 Mc/s oscilloscope (1138 of April), this technique gave a separation of at least 50 db between the outputs of two 60 db amplifiers mounted on the same panel.

1926. The Pure R-C Amplifier as a Wide-Band Test Amplifier.—R. Wunderlich. (*T.F.T.*, Aug. 1941, Vol. 30, No. 8, pp. 223–226.)

I.—The behaviour at low frequencies: (a) the single-stage amplifier, leading to eqn. 8 (approximate version 8a, when R_a and R_i are small compared with R_g), stating that the product of the "coupling condenser" and the "lowest frequency at which the amplitude error lies below a predetermined permissible value" is equal to a constant, which can be obtained from the curves of Fig. 3 and the values of the three resistances (R_g only, in the approximate case). It is seen that it is in general advantageous to select the grid resistance as high as possible and to base the coupling-condenser value on this. The limiting amplification is then given by eqn. 1a. (b) The multi-stage amplifier, leading to the conclusion that in calculating an n-stage amplifier with a permissible deviation P of the amplitude characteristic at the lowest frequencies, the error p occurring at a single stage should first be calculated, either exactly by eqn. 10 or sufficiently accurately for practical purposes by eqn. 10a ($p \approx P/n$); the treatment is then as for the single stage. The over-all amplification is given by eqn. 1, or with sufficient accuracy by eqn. 1a. The phase course is determined by eqn. 11, or approximately, for small external phase angles at each stage, by eqn. 11a.

II.—The behaviour at high frequencies: (a) the single-stage amplifier, leading to eqn. 19 (valid within certain limitations) stating that the product of the "limiting value of amplification at low frequencies" and the "highest frequency at which the amplitude error does not exceed the permissible limit p" is a constant, depending only on the factor k_{hmax} (Fig. 8) and on the ratio of the slope to the sum of the unwanted capacitances. The cases where pentodes and triodes are involved are dealt with: for the latter (where the unwanted capacitance is no longer constant) eqns. 19 and 19a are replaced by eqns. 19b and c. (b) The multi-stage amplifier. The use of the results is illustrated by the example of the design calculations for a 5-stage amplifier for the range 50 c/s to 5 Mc/s, the max. permissible amplitude deviation at the lowest and highest frequencies being set at 10%, and a given triode, with a good S/C ratio, being specified. *See* also 1927, below.

1927. An Equivalent Diagram for the Voltage Transmission of a R–C Amplifier Stage.—R. Wunderlich. (*T.F.T.*, Sept. 1941, Vol. 30, No. 9, pp. 251–253.)

Supplement to 1926, above. "It is shown that as regards both the amplitude characteristic and phase-angle characteristic, a r-c amplifier stage can be represented, so far as its voltage transmission is concerned, by a four-terminal network with a damped resonant circuit". The exact and approximate formulae are obtained, and the use of the latter is illustrated by the calculation of the equivalent circuit for a stage embodying an EF14 valve, with modulation free from grid current, for a frequency range of 2 kc/s to 3.5 Mc/s (10% drop at each limit), the output capacitance of the valve (8.2 pF) being loaded with an additional 6.8 pF.

1928. Inverting the Characteristic of an Amplifier [for Systems of Amplitude-Range Compression & Expansion]. — R. C. A. (*Electronic Eng:g*, Oct. 1941, Vol. 14, No. 164, p. 465.)

1929. Regulated Power Supplies [using Negative Feedback: Analysis showing how Limitation of Regulation can be traced to Some Elements of Circuit, and leading to Improved Design with Single Stage of Negative Feedback & Special Voltage Regulation in Screen-Grid Circuit of D.C. Amplifier].—L. Marton & R. G. E. Hutter. (*Phys. Review*, 1st/15th Feb. 1942, Vol. 61, No. 3/4, pp. 205–206: summary only.)

1930. Oscillations in Coupled Systems with Periodically Varying Parameters [and "A New Physical effect"].—V. A. Lazarev. (*Journ. of Tech. Phys.* [in Russian], No. 11, Vol. 10, 1940, pp. 918–935.)

In this paper, which forms Part 1 of a larger work, a detailed theoretical discussion is given of the operation of a non-linear system with two degrees of freedom (two inductively coupled circuits: Fig. 1), one of whose parameters (capacitance) is varied in accordance with the sine law by an external (mechanical) force. It is shown that under certain energy and frequency conditions, and in the absence of any magnetic or electric fields set up for this purpose, a new physical effect can be obtained, namely the appearance of complex oscillations. The paper deals mainly with the conditions necessary for the excitation of the system. A report is also presented on an experimental verification of the theoretical conclusions.

1931. Relaxation Oscillations [Survey].—D. Graffi. (*Alta Frequenza*, Feb. 1942, Vol. 11, No. 2, pp. 80–98.)

Based on the work of van der Pol (1930 Abstracts, pp. 503–504 & 566: 1934 Abstracts, pp. 610–611 [this paper includes a very long bibliography]), Liénard (1928 Abstracts, p. 469), Rocard (3615 of 1937), and Carrara (64 of 1939 and 1357 of 1940). Work by Mandelstam & Papalexi (1932 Abstracts, pp. 279–280) and Fubini-Ghiron (4306 of 1938) is also referred to. The importance of these oscillations in non-electrical (*e.g.* biological) fields is discussed.

1932. Electronic Differentiation [Mutual-Inductance Method: Simple Condenser Method: Condenser-with-Feedback Method: Applications for Each Method].—Schmitt & Tolles. (*See* 2174.)

1933. On the "Practicability Laws" of the Network Matrix of Reactance Quadripoles.—H. Piloty. (*T.F.T.*, Aug. 1941, Vol. 30, No. 8, pp. 217–223.)

The four parameters of the two linear quadripole equations (giving the primary voltage and current of a quadripole in terms of secondary voltage and current) can be grouped into a matrix, the "network matrix". In an earlier work (3269 of 1941) the writer has shown what conditions the network parameters contained in the matrix must satisfy, as functions of frequency, in order that such a matrix may be realised in the form of a reactance quadripole. These conditions were put into the form of two "practicability laws", the first of which was based on a rule obtained in a previous paper (959 of 1940), while the second was proved in the paper cited above. "The great importance of the two 'practicability laws' for the construction of reactance quadripoles with predetermined properties appears to me to justify a setting of them on the most solid basis possible": the present paper is therefore devoted to this, the opportunity being taken to correct an error in the first law (pointed out by Cocci) by presenting a new and improved formulation of it. Further, it is shown that each of the two laws is derivable from the other. The practical advantages over Cauer's reactance theorem (*see* for example 3017 of 1941) is discussed.

1934. Corrections to Typographical Errors in the Papers "Wave Filters . . . with Predetermined Performance" and "Canonical Network Circuits for Reactance Quadripoles with Predetermined Characteristics".—H. Piloty. (*T.F.T.*, Sept. 1941, Vol. 30, No. 9, pp. 272–274.) *See* 959 of 1940 and 3269 of 1941.

1935. Characteristic Impedance, Transmission Equivalent, and Network Matrix [in the Calculation of Iterative Networks].—R. Feldtkeller. (*T.F.T.*, Sept. 1941, Vol. 30, No. 9, pp. 265–266.)

This type of filter has been developed particularly by Zobel. Weizel (2715 of 1939) has pointed out certain simple relations between the network parameters and the elements of the network matrix, obtaining these relations by splitting the matrix into three matrices in such a way that the middle one has elements only in the principal diagonal ("principal axis transformation"). Now it is recognised that the network parameters are theoretically and practically of much less importance than the wave parameters, so that the solution of the problem by the demonstration of a simple relationship of network matrix to network parameters is not completely satisfactory. The writer, however, extends Weizel's procedure and splits the matrix into the product of three matrices in such a way that the middle one contains only the transmission equivalent and has only elements of the principal diagonal. Thus in eqn. 2 the first matrix contains only the first characteristic impedance, and represents the input circuit; the second contains only the two transmission factors; the third only the second characteristic impedance, and represents the output circuit; so that the wave parameters are conveniently separated instead of being interwoven as in the original matrix of eqn. 1. This "product" representation is then applied to the practically important case of a recurrent network composed of two (or more) quadripoles whose right-hand characteristic impedance is the same as the left-hand impedance of the following section, but which otherwise can be arbitrary. It is clearly seen how, in such networks, the characteristic impedances of the end sections appear as the characteristic impedances of the network, and how the transmission equivalents add in both directions. Finally this result from eqn. 7 can be applied to the original eqn. 1, to yield the elements of the network matrix of the quadripole system.

1936. "Transformed" Iterative Networks [used (*e.g.*) as Band-Pass Filters: Uneconomical & Unpractical Values of Recurrent-Network Components avoided by "Transformation," involving Single Tapping on Coils: No Change to Filter Properties].—H. J. Griese. (*T.F.T.*, Sept. 1941, Vol. 30, No. 9, pp. 263–264.) A full translation will appear in an early issue of *Wireless Engineer*.

1937. Design Criteria of Smoothing Filters for Radio Transmitters.—Mariani. (*See* 1945.)

TRANSMISSION

1938. The Overtones in a Magnetron Generator of Decimetric Waves.—Grekhova & Gapanov. (*See* 1970.)

1939. A Method of Indirect Modulation of a Magnetron Generator of Decimetric Waves.—Kalinin. (*See* paper dealt with in 1921, above.)

1940. Certain New Principles of Frequency Modulation.—G. A. Levin & Yu. M. Gadiev. (*Journ. of Tech. Phys.* [in Russian], No. 10, Vol. 10, 1940, pp. 813–829.)

It is shown that if the output voltages U_1 and U_2 of two oscillators C_1 and C_2 (Fig. 1), tuned to frequencies f_1 and f_2 respectively, are applied to an amplitude limiter "O", then the output voltage u of the limiter will be of a variable frequency depending on $f_2 - f_1$ and U_1/U_2 (equation 3). Thus the required modulation can be effected by varying either the amplitude or the frequency of the oscillations from one of the oscillators. The operation of the system is discussed in detail and it is shown that considerable frequency swings are obtained without recourse to frequency multipliers. The adaptation of existing frequency-modulation systems (Armstrong's and Zeitlenok-Kamenski's, Figs. 10a and 10b respectively) to the principles proposed is also discussed, and the advantages gained thereby are pointed out. Reception of the oscillations produced by the new system will be discussed in a separate paper, but it is indicated that the receivers required will not differ much from those employed at present for frequency-modulated oscillations.

1941. Non-Linear Distortion, with Particular Reference to the Theory of Frequency-Modulated Waves: Part II.—Cherry & Rivlin. (*See* 1917.)

1942. Frequency Modulation: Parts I–VI [General Survey].—Sturley. (*See* 2145.)

1943. Improving the Pierce Crystal Oscillator [Reduction of Excessive Crystal R. F. Current by Use of Coil resonant to Frequency rather below Crystal Frequency, in place of Usual Plate Choke].—E. Preston. (*QST*, Feb. 1942, Vol. 26, No. 2, p. 44.)

1944. A Note on the Use of Small Power Pentodes as Negative-Resistance Oscillators [Stable Circuit giving Good Wave-Form].—E. Lawrence. (*Electronic Eng:g*, Oct. 1941, Vol. 14, No. 164, p. 456.)

1945. DESIGN CRITERIA OF SMOOTHING FILTERS FOR RADIO TRANSMITTERS [Characteristics of the Rectified Voltage from Usual Monophase & Polyphase Supplies: Generally Accepted Ratios of Ripple after & before Smoothing, for Various Types of Transmitter: Consequent Attenuation required, and Its Calculation (Formulae & Nomograms, for 1, 2, & 3 Stages): Calculation of *L*, *C* Values: Capacitance of Output Condenser: Examples].—M. Mariani. (*Alta Frequenza*, Feb. 1942, Vol. 11, No. 2, pp. 67–79.)

1946. THE NEW DUTCH 125 kW TRANSMITTER [Defects of the Doherty System: Variation adopted which uses a Final Stage with Four Valves having Their Anode Circuits paralleled through Three Quarter-Wave Transformers: Reduced Distortion].—K. Posthumus. (*Alta Frequenza*, Feb. 1942, Vol. 11, No. 2, pp. 111–112: summary, from *Philips Transmitting News*, Nov. 1940.)

RECEPTION

1947. THE MAGNETRON AS A RECEIVER FOR CENTIMETRIC WAVES.—H. Schmersow. (*E.T.Z.*, 31st Dec. 1941, Vol. 62, No. 52/53, p. 1006: summary only.) Already dealt with in 1874 of 1941.

1948. "DAS GROSSE KURZWELLEN- UND ULTRAKURZWELLEN - EMPFÄNGER - SCHALTUNGS - BUCH" [Book Review].—W. W. Diefenbach. (*Zeitschr. f. tech. Phys.*, No. 5, Vol. 21, 1940, p. 115.)

1949. ON CERTAIN COMBINED RESONANCE PHENOMENA IN SUPER-REGENERATIVE RECEIVERS.—N. V. Osipov. (*Journ. of Tech. Phys.* [in Russian], No. 10, Vol. 10, 1940, pp. 843–850.)

It was discovered by the author (565 of 1940) that it is possible to receive short and even long waves on an ultra-short-wave super-regenerative receiver, provided that a heterodyne oscillator also tuned to an ultra-short wave is operating near the receiver. In the present paper a mathematical investigation of the phenomenon is given. A super-regenerator subjected to the action of two e.m.fs (Fig. 1) is considered, and the characteristic of the valve is approximated by a polynomial of the third order. This leads to a non-linear equation (7) with a periodically varying coefficient of the first derivative. A detailed analysis of this equation is given, using the van der Pol method extended by Gorelik (2694 [and 3141] of 1938) for systems with periodically varying parameters.

1950. THE DETECTION EFFECT IN ELECTRON-BEAM VALVES.—Grekhova & Vasil'ev. (*See* 1972.)

1951. HOMODYNE RECEPTION: POSSIBILITIES OF THE SYSTEM AS AN AID TO SELECTIVITY.—(*Wireless World*, April 1942, Vol. 48, No. 4, pp. 87–89.) ". . . it does not seem unduly optimistic to say that the difficulties inherent in the homodyne system of reception could be overcome in a commercial design."

1952. THE ADDITION OF NEGATIVE FEEDBACK [for Improvement of Quality of Reproduction] TO AN EXISTING RECEIVER WITHOUT EXTENSION OF THE CHASSIS.—E. W. Stockhusen. (*Funk*, 15th Dec. 1941, No. 24, p. 368.)

1953. DESCRIPTION OF THE RECEIVING INSTALLATION IN THE TEST AEROPLANE OF THE RESEARCH ESTABLISHMENT OF THE GERMAN STATE POST OFFICE (RPF).—G. Rösseler & K. Vogt. (*T.F.T.*, Sept. 1941, Vol. 30, No. 9, pp. 247–251.)

In addition to its use in the determination of the radiation characteristics of aerials, applications of such an aeroplane include propagation measurements on ultra-short waves, the development and testing of d.f. systems free from night error (Gothe & Wächtler, 2608 of 1940, and Keen's book), and of anti-fading aerial systems; and also, recently, the investigation of the space-wave received field (the reference given here is to the Doppler-effect short-wave investigations dealt with in 2963 of 1941). The receiver ($350 \times 210 \times 187$ mm³) covers, with interchangeable coils, the wave-range 18–1800 m.

1954. NOISE FROM TRANSMITTER [Interference traced to Meter with Two Turns of Internal Shunt touching].—J. P. Gilliam. (*QST*, Feb. 1942, Vol. 26, No. 2, p. 45.)

1955. STREAMERING IN NEGATIVE CORONA [Abruptly Introduced Higher-Current Régime, causing Much More Intense Radio Interference: Investigation into Factors governing Value of Transition Current].—W. H. Bennett. (*Journ. Applied Phys.*, March 1942, Vol. 13, No. 3, pp. 199–200.)

1956. MUTUAL INTERFERENCE BETWEEN WIRED AND WIRELESS RADIO SERVICES [between Power Companies' Carrier Systems on Their H.T. Lines and Long-Wave Wireless Broadcasting, between Carrier Systems on Overhead Telephone Networks and Wireless Broadcasting, & between Different Carrier Systems].—R. Moebes. (*E.T.Z.*, 12th March 1942, Vol. 63, No. 9/10, pp. 113–116.)

With the usual energies employed in carrier working (telemetering, etc.) on power lines, the field strength at a 100 m distance normal to the line is some mv/m; at 3 km distance it is only about 1 μV/m, and becomes negligible in view of the higher atmospheric noise level on these frequencies. Actually the only cases of interference encountered were for distances under 500–600 m: and if the frequencies differ by as much as 10 kc/s, interference is only noticed at distances under 100 m, and then only on small receivers. Various other results are given, and recommendations made as to the prohibition of higher powers (such as are employed sometimes abroad), the allocation of frequencies, etc. Things will become even more difficult now that the medium-tension power systems are taking up carrier-frequency working.

1957. Effect of the Cabinet Material on the Performance of a Radio Receiver [Tests on Oak, Pine, Sandal-Wood, Teak, etc., indicate that Wooden Cabinets (especially Plywood) give Better Signal/Noise Ratio than those of Synthetic Material, owing to Increased Absorption of Higher Frequencies].—R. D. Joshi. (*Sci. & Culture* [Calcutta], April 1941, Vol. 6, No. 10, p. 615.)

1958. Non-Interfering Vibrators [primarily for Communication-Type Receivers].—Masteradio. (*Electronic Eng:g*, Nov. 1941, Vol. 14, No. 165, p. 510.) For other recent work *see* 1492 of May.

1959. A New Portable Communications Receiver: the Hallicrafters "Sky Traveller."—(*Electronic Eng:g*, Dec. 1941, Vol. 14, No. 166, pp. 550–554.)

1960. The Requirements of Radio Receivers for Export [Design Considerations for Subtropical Conditions].—R. O. Lambert. (*Electronic Eng:g*, Sept. 1941, Vol. 14, No. 163, pp. 396–397.) Incidentally, the author mentions the excellent overseas market awaiting a receiver working from a 6 v accumulator and vibrator.

1961. Band Spread in Broadcast Receivers [at the 1941 Leipzig Autumn Fair].—(*Funk*, 1st Dec. 1941, No. 23, p. 360.)

1962. Grid Bias by the Cathode-Resistance Method, and the Reproduction of the Low Frequencies [including a Circuit dispensing with the Large Bridging Condenser].—K. Breuer. (*Funk*, 1st Dec. 1941, No. 23, pp. 347–350.)

1963. A Modern Two-Circuit "Straight" Receiver using Steel Valves [with Constructional Details].—W. Dieck. (*Funk*, 15th Dec. 1941, No. 24, pp. 361–363.)

1964. Technical Details of Foreign [French] Broadcast Receivers.—E. Bottke. (*Funk*, 15th Nov. 1941, No. 22, pp. 339–340.)

1965. Developmental Tendencies in Broadcasting [including Some Data on Listener Densities in Germany & U.S.A.].—(*E.T.Z.*, 26th Feb. 1942, Vol. 63, No. 7/8, p. 97: summary only.)

AERIALS AND AERIAL SYSTEMS

1966. On the Theory of the Cylindrical-Parabolic Reflector.—W. Magnus. (*Zeitschr. f. Phys.*, No. 5/6, Vol. 118, 1941, pp. 343–356.)

For other recent work by the same writer *see* 2079 & 2121 of 1941. "The rigorous treatment of the problems of diffraction and reflection of electromagnetic waves has hitherto been successful only in those cases where the diffracting surface is a surface of the second order or a degenerate form of such, since the wave equation is only separable into elliptic coordinates. But the separation of the variables in each special case requires further investigations. For the case of two-dimensional (*i.e.* independent of one coordinate) waves in the interior of a parabolic cylinder, the general foundations have been given elsewhere [ref. "1"] by an integral representation of the solution of the relevant boundary-value problem. In the present paper a series representation of the solution will be derived from this integral form, for a special case of practical interest [electric field, in a parabolic cylinder of perfect electrical conductivity, under the influence of an emitting ("luminous") focal line; the focal length and wavelength being of the same order of magnitude] with the help of a procedure previously employed in a similar form" [Watson, ref. "2," and Buchholz, 2402 of 1941].

In section 2 the integral representation of the solution is given, and then transformed into a series representation: this is discussed in section 3 and yields, in particular, a formula for the radiation resistance per unit length of the focal line. Section 4 contains some contributions to the numerical evaluation of the results: thus with a focal-length/wavelength ratio of 0.318 it is found that the ratio (rad. resistance per unit length of focal line)/(rad. resistance per unit length of emitting line in empty space) is rather more than 0.8. Finally, section 5 contains a study of the "functions of the parabolic cylinder," in which the most important formulae are collected and (if not already known) briefly derived. This also yields a representation of the Hertzian vector of an (infinitely short) dipole, in empty space, by functions of the parabolic cylinder: this formula is to be considered as the starting point for a treatment of the radiation emitted by a Hertzian dipole situated in the focal line of a cylindrical parabolic reflector.

1967. Antennas for 112-Mc. Mobile Work: Suggestions for Ultra-High-Frequency Automobile Antennas [including a Beam Type].—B. Goodman. (*QST*, Feb. 1942, Vol. 26, No. 2, pp. 14–16 and 78, 80.)

1968. Multicoupler Antenna System [for Blocks of Flats, etc.] includes Frequency-Modulation Reception.—Amy, Aceves & King Inc. (*Review Scient. Instr.*, Feb. 1942, Vol. 13, No. 2, p. 86.) *Cf.* 98 of January.

1969. A Three-Direction Double-Pitchfork Antenna.—G. Nelson. (*QST*, Feb. 1942, Vol. 26, No. 2, p. 45.) Modification of the aerial described by Lynch, 3848 of 1940.

VALVES AND THERMIONICS

1970. The Overtones in a Magnetron Generator of Decimetric Waves.—M. Grekhova & V. Gaponov. (*Journ. of Tech. Phys.* [in Russian], No. 10, Vol. 10, 1940, pp. 855–858.)

It is known that a magnetron employing two anode segments to which a small loop of wire or ribbon is attached possesses a number of overtones of the non-harmonic type. The present paper reports on experiments made to investigate the excitation of these overtones. Magnetrons with a ribbon frame in the anode circuit (Fig. 1) were used in these experiments, and overtones up to the fourth order were excited by varying the anode voltage and the magnetic field. It appears that the system can be excited over a comparatively wide frequency range (change in frequency up to 40%), although it is not possible to ensure a continuous frequency variation. The efficiency of the magnetron at various overtones was determined, and the effect of the end-plates (Linder, 2611 of 1936) on the power output was investigated. Experimental curves are shown and a theoretical interpretation of the results obtained is given.

1971. New Transmitting Tube: HY 1269 Beam Tetrode (Max. Plate Dissipation 40 Watts].—Hytron. (*QST*, Feb. 1942, Vol. 26, No. 2, p. 76.) Max. ratings may be used up to 60 Mc/s.

1972. The Detection Effect in Electron-Beam Valves.—M. T. Grekhova & P. P. Vasil'ev. (*Journ. of Tech. Phys.* [in Russian], No. 11, Vol. 10, 1940, pp. 908–913.)

The effect of an alternating field on the electron beam (modulation) has been investigated by a number of authors. The alternating voltage is applied to a modulating electrode (grid) interposed between the cathode and the anode of the tube. It is pointed out that as a result of this the anode current varies as if an alternating voltage were applied between the grid and the anode, *i.e.* a detection effect is taking place. This variation of the anode current depends on the static characteristic of the tube and the position of the working point on it, as well as on the construction of the grid. Valves with grids of various types were experimented with and a number of detection curves are shown.

1973. The Augetron Multi-Stage Electron Multiplier [Augetron: Photo-Augetron: Thermionic Grid-Controlled Augetron: Special Augetrons: Stability: Testing: Power Supplies: Some Applications: etc.].—F. J. G. van den Bosch. (*Journ. Television Soc.*, No. 7, Vol. 3, pp. 175–196.)

For previous work on the Augetron *see* 1359 of May. For an extract from the present paper (which was read before the Television Society) dealing with the stability of electron multipliers, see *Electronic Eng:g*, Nov. 1941, Vol. 14, No. 165, pp. 502 and 517.

1974. On the Behaviour of the Output and Energy Distribution of Secondary Electrons from Sublimated Layers of Increasing Thickness [Non-conducting Films of MgF_2 & NaCl, on Nickel Plates, of Thickness varying from 1–300 (1000 for NaCl) Times the Lattice-Plane Spacing].—K. H. Geyer.* (*Ann. der Phys.*, 25th Feb. 1942, Vol. 41, No. 2, pp. 117–143.)

The s.e. output increases steadily below 10–30*d*, without any change in the position of the maximum of the output curve. This behaviour is explained by the velocity-loss of the primary electrons in the sublimated layer, the secondary electrons coming predominantly from the nickel base. Between 10 and 30*d* the output maximum is displaced towards higher voltages, and strong field emission occurs: "Layers under 10*d* have a structure imposed on them by the base, those above 30*d* an amorphous structure." Above 30*d* the secondary emission comes more and more from the sublimated layer. Infra-red irradiation causes an increase in output for layers of about 300*d*, owing to the improved conductivity produced by the irradiation. At 1000*d* no such increase of output is observed. "The path of the primary electrons in the layer has therefore a length of 300–1000*d*". As regards energy distribution, at 10*d* the slowest secondary electrons are represented at their greatest intensity, and the back-diffused primary electrons and the faster 30-volt secondary electrons at their lowest. Energy distributions for 600 and 1000*d* thicknesses show a series of maxima, which are connected with the presumed selectivities in the passage of slow electrons through periodic potential lattices.

1975. Electron Emission of Metals in Electric Fields: III—The Transition from Thermionic to Cold Emission [Investigation to bridge Gap between High-Temperature/Low-Field & Low-Temperature/High-Field Theories: Extension of Theory of Periodic Deviations from Schottky Line: Effect of Patches: etc.].—E. Guth & C. J. Mullin. (*Phys. Review*, 1st/15th March 1942, Vol. 61, No. 5/6, pp. 339–348.) For this theory *see* 1909 of 1941 [and 453 of February].

1976. Theoretical and Experimental Contributions to the Schottky Diffusion Column [in the Low-Pressure Mercury Plasmas].—H. Fetz. (*Ann. der Phys.*, No. 8, Vol. 40, 1941, pp. 579–600.)

For previous work *see* second paragraph of 410 of February. "For many cases, especially for discharges in high gas pressures (above 1 mm Hg) the boundary condition already employed by Schottky, namely zero plasma density at the wall, can be considered a good approximation. Now, however, that discharges at very low pressures, discharges influenced by Langmuir layers, are attracting increasing attention, this boundary problem must be investigated thoroughly again, since it is just in this field of application that the sectional distribution has a decisive influence on the course of the control process". The present theoretical investigations, confirmed by a special c.r. oscillographic probe-measuring technique, lead to a new boundary condition based on the assumption that the ion velocities in the wall zone are predominantly *directed* (towards the wall), as contrasted to their unordered state over the rest of the cross section. A plausible relation between the wall velocity and the mean ion temperature of the column is found.

1977. Diffusion of Heat through a Rectangular Bar, and the Cooling Effect of Fins: I—The Steady State [Exact Solutions yielding New Results not contained in Approximate Formulae hitherto employed], *and* Application of an Electric Model to the Study of Two-Dimensional Heat Flow.—M. Avrami & J. B.

Little: Avrami & Paschkis. (*Phys. Review*, 1st/15th March 1942, Vol. 61, No. 5/6, p. 392: p. 394: summaries only.)

1978. COLLOIDAL-GRAPHITE ELECTROSTATIC SHIELDING [for Valves & Ground Connections, Shield Partitions, etc.].—B. H. Porter. (*Review Scient. Instr.*, March 1942, Vol. 13, No. 3, pp. 129–130.)

"With research workers currently forced to devise metal substitutes, suggestions presented earlier (1927 of 1936 [*see* also 1530 of May]) become worthy of further elaboration. . ."

1979. PAPERS ON INDUCTION HEATING [*cf.* Kirkpatrick, 1695 of June].—Babat: Wall. (*See* 2199/2201.)

1980. TUBE CONSERVATION ["Leave Filaments On" Advice does Not apply to Thoriated-Tungsten Filaments].—R. A. Reinhart. (*QST*, Feb. 1942, Vol. 26, No. 2, p. 84.)

1981. PRODUCTION OF TUNGSTEN: ELECTRO-THERMAL METHODS REVIEWED.—(*Electrician*, 15th May 1942, Vol. 128, pp. 472–475.)

1982. "PHILIPS BÜCHERREIHE ÜBER ELECTRONENRÖHREN" [Vol. I—Fundamentals: Vol. II—Data & Circuits, Modern Receiving & Power-Amplifier Valves: Book Review].—Philips Company. (*Zeitschr. f. Fernmeldetech.*, 16th Dec. 1941, Vol. 22, No. 12, p. 192.)

1983. THE TYPE NAMES AND DISTINGUISHING PROPERTIES OF RECEIVING VALVES [Standard German Convention].—W. Götze. (*Funk*, 1st Dec. 1941, No. 23, pp. 354–356.)

DIRECTIONAL WIRELESS

1984. THE AUTOMATIC RADIO COMPASS [including Combination with Remotely Indicating Magnetic Compass].—W. L. Webb & G. O. Essex. (*Journ. Roy. Aeron. Soc.*, May 1942, Vol. 46, No. 377, p. 158: abstract only.)

1985. POSITION FINDING BY WAVES [Acoustic and Electric: Short Survey of Principles (including Fresnel's Law of Optimum Wavelength) & Development].—(*Engineer*, 1st May 1942, Vol. 173, pp. 360–361.)

1986. DIRECTION-FINDING DEVELOPMENTS: BEARING INDICATOR FOR GROUND STATIONS.—(*Wireless World*, April 1942, Vol. 48, No. 4, p. 97.) *See* Budenbom, 721 of March.

ACOUSTICS AND AUDIO-FREQUENCIES

1987. THE SCATTERING OF THE VALUES OF TRANSMITTING AND RECEIVING TRANSMISSION EQUIVALENTS IN TELEPHONE APPARATUS [Tests on Numerous Microphone Insets & Receivers (the Latter worse than the Former): Need for Very Rigorous Acceptance Tests, etc.].—K. Braun. (*T.F.T.*, Aug. 1941, Vol. 30, No. 8, pp. 229–231.) Using the meter dealt with in 3371 of 1941. For a further paper *see* issue for September, No. 9, pp. 253–257.

1988. THE DIRECTIONAL PROPERTIES OF ELLIPTICAL (SOUND) RADIATORS.—M. I. Karnovski. (*Journ. of Tech. Phys.* [in Russian], No. 10, Vol. 10, 1940, pp. 839–842.)

In providing sound equipment for open and enclosed spaces it is often necessary to include sound radiators with sharp directional properties which remain constant over a wide frequency range. In the present paper elliptical radiators are considered, and the directional properties are defined as the relationship between the velocity potential and the angle of radiation. This relationship can be represented by the Lamé function of the *n*th order (for an ellipsoid of the *n*th order) and it is shown that in general the directional properties of such a radiator depend on the frequency used as well as on the dimensions and shape of the radiator. Only when the ellipsoid degenerates into a sphere do the directional properties become independent of the frequency.

1989. ELASTIC WAVES FROM A POINT IN AN ISOTROPIC HETEROGENEOUS SPHERE: III, *and* TRANSMISSION OF ARBITRARY ELASTIC WAVES FROM A SPHERICAL SOURCE, SOLVED WITH OPERATIONAL CALCULUS: I.—R. Yosiyama: I. Sezawa & K. Kanai. (*Sci. Abstracts*, Sec. A, March 1942, Vol. 45, No. 531, p. 81: p. 81.)

1990. LAUE PHOTOGRAPHS OF ROCHELLE SALT POWDER COMPRESSED UNDER HIGH PRESSURES [Clear Indications of Asterism].—K. Deutsch. (*Zeitschr. f. tech. Phys.*, No. 6, Vol. 21, 1940, p. 134.)

1991. THE THERMOREGENERATION OF SOUND.—K. Teodorchik. (*Journ. of Tech. Phys.* [in Russian], No. 11, Vol. 10, 1940, pp. 914–917.)

See also 460 of February. Using the principles of thermoacoustic oscillations as formulated by Rayleigh, and the modern theory of auto-oscillations, the simplest case of thermoregeneration, auto-oscillations in a Helmholtz resonator, is considered. It is shown that the condition of self-excitation (9), amplitude of stable oscillations (10), and frequency correction (11) can be determined on the basis of the linear theory of the resonator, taking into account the non-linearity of the thermal characteristic.

1992. SOUND-LAG CALCULATOR FOR LISTENING EQUIPMENT FOR AIRCRAFT NOISE: EXTENSION AND CORRECTIONS.—E. Kutzscher. (*Zeitschr. V.D.I.*, 18th April 1942, Vol. 86, No. 15/16, p. 230.)

The original paper was in Vol. 84, 1940, pp. 845–851. The corrections in no way affect the writer's assertion that "it is better in practice to estimate the speed rather than the height."

1993. THE MECHANISM OF THE INFLUENCE OF MOVEMENTS OF THE HEAD ON THE LOCALISATION OF SOUNDS: PRELIMINARY NOTE.—A. Gemelli. (*La Ricerca Scient.*, Jan. 1942, Vol. 13, No. 1, pp. 5–10.)

1994. ELECTRICALLY IMPROVED AUDITORIUM ACOUSTICS [Acoustics of Unter den Linden State Opera House, designed for Opera, unsuitable for Symphony Concerts: Successful Modification by Electroacoustical Methods].—O. Vierling. (*E.T.Z.*, 26th March 1942, Vol. 63, No. 11/12, p. 145: summary, from *Akust. Zeitschr.*, Vol. 6, 1941, p. 86 onwards.)

1995. PROBLEMS OF TRANSATLANTIC TELEPHONY [Kelvin Lecture: particularly the Prospects of Multi-Channel Working on Broad-Band Cable, and the Problem of the Necessary Repeaters on the Ocean Bed].—O. E. Buckley. (*Electrician*, 1st May 1942, Vol. 128, pp. 415–418.)

1996. REVISED STANDARD-FREQUENCY BROADCASTS [Inclusion of 15 Mc/s Carrier Frequency: the Complete Procedure of WWV's Transmissions].—Bureau of Standards. (*Tech. News Bull. Nat. Bur. of Stds.*, Feb. 1942, No. 298, pp. 9–10.) See also 2082.

1997. THE "AXIS SOUND" OF BODIES ROTATING AT HIGH SPEED: A NEW STANDARD NOTE SOURCE [Free from Harmonics: up to Supersonic Frequencies: High Power (Several Hundred Watts radiated): Uniform All-Round Radiation].—E. Huguenard. (*Comptes Rendus* [Paris], 10th Nov. 1941, Vol. 213, No. 19, pp. 648–650.)

1998. A PUSH-PULL OSCILLATOR FOR VERY LOW FREQUENCIES [1–10 & 10–100 c/s], *and* A NOTE GENERATOR WITHOUT OSCILLATORY CIRCUIT [50–5000 c/s].—Gauger & Berrang: Willoner & Tihelka. (See 2025 & 2026.)

1999. THE NIVOC ACE BEAT-FREQUENCY OSCILLATOR [50–10 000 c/s: One Tuning Control].—(*Journ. of Scient. Instr.*, March 1942, Vol. 19, No. 3, p. 46.)

2000. VACUUM-TUBE-DRIVEN TUNING-FORK OSCILLATOR [Type 723: Operation More Stable than Microphone-Button Type, and Better Wave Form].—General Radio Company. (*Review Scient. Instr.*, Feb. 1942, Vol. 13, No. 2, p. 84.)

2001. COLOUR IN SOUND: A STUDY FROM THE PSYCHOLOGICAL VIEWPOINT.—E. L. Trist. (*Electronic Eng:g*, Dec. 1941, Vol. 14, No. 166, pp. 547–548.) *Cf.* p. 546, and 2313 of 1941.

2002. ARTISTIC DEVIATION AS AN AESTHETIC PRINCIPLE IN MUSIC.—C. E. Seashore. (*Scientific Monthly*, Feb. 1942, Vol. 54, No. 2, pp. 99–109.)

2003. MODERN SCIENCE AND MUSICAL THEORY.—Ll. S. Lloyd. (*Nature*, 4th April 1942, Vol. 149, pp. 389–390.) Summary of Royal Society of Arts paper.

2004. ON THE REACTION OF THE SOUNDBOARD TO THE VIBRATION OF STRINGS.—A. I. Belov. (*Journ. of Tech. Phys.* [in Russian], No. 10, Vol. 10, 1940, pp. 807–812.)

The transmission of oscillatory energy from the string to the soundboard is considered theoretically. Constructional peculiarities of the soundboard necessary for the coordination of its parameters with those of the string are discussed. An interpretation is given of certain defects in musical instruments of inferior quality.

2005. DYNAMICS OF THE PIANOFORTE STRING AND THE HAMMER: PART VI—DISPLACEMENT AFTER IMPACT: PART VII—ENERGY OF THE STRING.—M. Ghosh. (*Indian Journ. of Phys.*, Feb. 1941, Vol. 15, Part 1, pp. 1–10: pp. 11–14.)

2006. A MORE CORRECT THEORY OF THE ARRANGEMENT OF FRETS ON THE FINGER-BOARD OF PLUCKED INSTRUMENTS, *and* A THEORY OF THE SIMULTANEOUS ARRANGEMENT OF FRETS FOR TWO SMOOTH STRINGS OF PLUCKED INSTRUMENTS.—N. Jakovlev. (*Journ. of Tech. Phys.* [in Russian], No. 11, Vol. 10, 1940, pp. 936–940: No. 7, Vol. 11, 1941, pp. 654–667.)

2007. ON VIBRATIONS OF TWISTED STRINGS [Effect of Static Twist is to produce Vibration-Curve with Cyclic Changes: Oscillographic Results with Strings having One, Two, & Three Complete Turns].—G. Suryan. (*Sci. & Culture* [Calcutta], July 1941, Vol. 7, No. 1, p. 55.)

2008. ISOLATION OF AN ULTRASONIC CRYSTAL RADIATOR FROM CONDUCTING LIQUIDS.—J. W. McGrath & A. R. Kurtz. (*Review Scient. Instr.*, March 1942, Vol. 13, No. 3, pp. 128–129.)

2009. MAGNETOSTRICTION PHENOMENA [Effects & Applications].—Williams. (See 2139.)

PHOTOTELEGRAPHY AND TELEVISION

2010. THE RESPONSE OF A NETWORK TO AN ARBITRARY PERIODIC DRIVING FORCE [with Application to Television Circuits].—Hamlin. (See 1918.)

2011. THE QUANTUM OUTPUT OF PHOTOCELLS OF VARIOUS TYPES.—A. M. Gurevich. (*Journ. of Tech. Phys.* [in Russian], No. 11, Vol. 10, 1940, pp. 943–944.)

A comparison is made, as regards the quantum output, between the modern antimony–caesium and sulphur–thallium photocells, possessing high spectral sensitivity, and older cells of the silver-oxide–caesium and selenium types. As a result of experiments a table is prepared which shows that sulphur–thallium cells with a positive photoeffect in the barrier layer give the highest quantum output (30%), while that of the silver-oxide–caesium type is surprisingly low (only 0.3%). The relationship between the quantum output of photocells and their spectral sensitivity curves is also discussed.

2012. THE SPECTRAL SENSITIVITY DISTRIBUTION OF SELENIUM BARRIER-LAYER CELLS [and the Influence of Cadmium Admixtures].—F. Eckart & A. Schmidt. (*Zeitschr. f. Phys.*, No. 3/4, Vol. 118, 1941, pp. 199–206.)

A small addition of Cd results in a flattening of the long-wave drop in the selenium characteristic; in larger quantities the Cd produces (as Görlich found : 3251 of 1939) a second maximum at 0.7 μm, but the absolute output decreases (Fig. 2, "Mitte"). Not only the properties of the metal semiconductor boundary layer, but also the measured spectral distributions of CdSe barrier-layer and resistance photocells, indicate that CdSe domains are built into the otherwise unaltered selenium layer. These domains are also photoelectrically active, and the sensitivity-distribution due to them is superposed on that due to the selenium. Debye-Scherrer photographs show also that on heat treatment heterogeneous CdSe domains are formed.

2013. THE SELENIUM BARRIER-LAYER PHOTOCELL [Action: High Quality of British-made Cells: Sensitivity & Dark Current to be expected of Good Cells: etc.].—G. A. Veszi. (*Electronic Eng:g*, Oct. 1941, Vol. 14, No. 164, pp. 436–437.) From Evans Electroselenium, Ltd.

MEASUREMENTS AND STANDARDS

2014. ABSORPTION MEASUREMENTS ON BIOLOGICAL LIQUIDS (BLOOD) IN THE 50–100 cm WAVE-RANGE.—G. Gsell. (*Physik. Zeitschr.*, 20th March 1942, Vol. 43, No. 5/6, pp. 101–107.)

The special interest of this investigation, in more than one way, is pointed out. The method adopted was the Zahn-Rieckhoff "damping" method (1930 Abstracts, p. 111), suitably modified to work with decimetric waves. The 50–100 cm generator (triode with retroaction) followed the three-point connection given by Döhler (3896 of 1938), in which the leads to the cathode and to the feed-point in the oscillatory circuit are built as a Lecher system, so that all chokes are eliminated and the transmitter is very symmetrical. Another Lecher system couples the generator circuit to the actual measuring circuit, and serves to filter out any harmonics. The measuring circuit is itself a Lecher pair, with the test vessel at its closed end and a sliding bridge near the other; a diode voltmeter, with its loop coupled to the Lecher pair in the neighbourhood of the bridge, acts as resonance indicator. Details are mentioned, such as the conical shape of the holes through the wall of the container, for the passage of the ends of the two wires: in this way the electrical homogeneity of the pair is very little upset. The accuracy of the measurements was within 1.8–2%. Results are given, and discussed in relation to the increase in conductivity due to dipole relaxation.

2015. HIGH-FREQUENCY CURRENT MEASUREMENT: METHODS FOR FREQUENCIES UP TO 1500 Mc/s. —M. J. O. Strutt. (*Archiv f. Tech. Messen*, March 1941, No. 117, V324-4, Sheets T33–34.)

I.—Thermal methods. For thermojunctions of modern design the sources of error at frequencies above 60 Mc/s are (a) self and mutual inductances of the various conductors, (b) capacitance between the various conductors, and (c) skin effect in the heating wire. The last source can be nullified to a great extent, at any rate for small currents, by the use of sufficiently thin wire of suitable material (such as 20μ diam. constantan: the error at 1500 Mc/s for this would be about 2% in the value of resistance. For larger currents, such as 1 A, the skin-effect error can be reduced by the use of thin-walled heater tubing, self-supporting or carried on insulating material. Vacuum thermojunctions of the first kind are on the market (for currents up to about 50 mA: Fig. 1) but none of the latter kind. An approximate equivalent circuit for the thermojunctions shown in Fig. 1 is given in Fig. 2, with rough values for the circuit elements. From this circuit it can be estimated that the errors due to causes (a) and (b) would be between 2 and 10% at 300 Mc/s and 50% or more at 1500 Mc/s. It is mentioned that by a suitable dimensioning of the length of each wire from the earthing point to the heating point it is possible to introduce, for a particular frequency, a high a.c. resistance between these points, which will reduce the error, but only for frequencies in a small region about the chosen frequency. This plan is referred to again in section 12, where the absolute calibration of thermojunctions, up to 1500 Mc/s, is described: the method (circuit Fig. 4, equipment Fig. 5) is based on the differential hot-wire air thermometer (1527 of 1940 and back reference). Finally, Straubel's optical double-refraction devices (1440 of May and back reference) are mentioned: "hitherto little used in practice."

II.—Electrodynamic methods. Gundlach's magnetodynamometer (2473 of 1941) is discussed. At 2000 Mc/s the max. error, according to theoretical considerations, would be about 8%. "A comparative calibration against other types of instrument was not carried out. When this has been done, and if the results are satisfactory, there will be nothing to prevent its general use in suitable conditions."

III.—Methods depending on the measurement of voltage and resistance (diode voltmeter): *see* 2485 of 1938 and 1527 of 1940. Fig. 10 shows an arrangement for the absolute comparison of a diode voltmeter and a thermojunction, at 400 Mc/s, using the special coaxial Lecher system with split outer conductor (Fig. 11) to act as two d.c. leads but as one a.c. conductor. This device of splitting can be extended, if desired, so as to supply several diodes. The small, symmetrically arranged variable condensers C in Fig. 10, used to balance out the self-inductance of the heating wire, present certain difficulties on these very short waves, and can well be replaced by short Lecher pairs with a fine screw adjustment.

2016. SURVEY OF THE SKIN-EFFECT ERROR OF THERMAL MEASURING DEVICES [Definition: the Resistance Ratios (Effective-Resistance/D.C.-Resistance) for Circular-Section Wire, Circular-Section Tube, Rectangular Parallel Strips with Small Spacing, & Single Conductor with Elliptical Cross-Section: the Case of a Conductor wound into a Cylindrical Coil].—J. Fischer. (*Zeitschr. f. tech. Phys.*, No. 11, Vol. 22, 1941, pp. 280–283.)

2017. THERMOELECTRIC FORCE OF BISMUTH THIN FILMS [prepared by Vaporisation or Sputtering: for Thermocouples, etc.].—Z. Yamaguti. (*Electrotech. Journ.* [Tokyo], March 1941, Vol. 5, No. 3, pp. 52–55.)

2018. A MIXING VALVE INSTEAD OF AN ELECTRODYNAMOMETER [or Thermo-Wattmeter] for the Selective Measurement of Very Small Alternating Voltages [0.01 μV].—S. Singer: Schäfer. (*Zeitschr. f. tech. Phys.*, No. 8, Vol. 21, 1940, p. 175.)

Description of a modification of Schäfer's method (1544 of 1940), an ordinary microammeter being used and the whole method becoming more flexible, since the width of the rectified band can be varied at will.

2019. THE MEASUREMENT OF CAPACITY AND INDUCTANCE OF CONCENTRIC CABLES [and the Correction of Errors due to Residual Inductance of Measuring Condenser & to Cable End Effects: using the Hartshorn-Ward Dielectric Test Set: New Short Method of evaluating Cable Constants from Closed & Open Impedance Measurements].—F. Jones. (*Journ. of Scient. Instr.*, April 1942, Vol. 19, No. 4, pp. 53–58.)

2020. THE PURE R–C AMPLIFIER AS A WIDE-BAND TEST AMPLIFIER.—Wunderlich. (*See* 1926.)

2021. CONTRIBUTION TO THE THEORY OF THE SO-CALLED "ELLIPSOID" METHOD OF MEASURING DIELECTRIC CONSTANTS [of Liquids].—Y. Björnståhl. (*Zeitschr f. Phys.*, No. 3/4, Vol. 118, 1941, pp. 257–263.)

Fürth's 1924 theory has been used by various workers who have employed his method, depending on the measurement of the torque produced by an electric field on an ellipsoid of solid dielectric immersed in the liquid whose dielectric constant is required (Lin, 3525 of 1936: Shutt & Rogan, 652 of 1937). Results have been rather peculiar, and the present writer explains this by an examination of the original theory and the development of a new one, which states that the torque is *not* independent of the ϵ of the ellipsoid material (as maintained by Fürth) except when its conductivity is very large. The question of torque dependence on frequency, and the formation of waves in the liquid (under the action of the electric field) which affect the torque, are also examined.

2022. THE MEASUREMENT OF VERY SMALL LOSS ANGLES [Description of Bridge for Measurements with Absolute Accuracy within 3×10^{-8}, using a Special Standard Condenser].—C. G. Koops. (*E.T.Z.*, 20th Nov. 1941, Vol. 62, No. 46/47, pp. 930–931: summary, from *Philips tech. Rundschau*, Vol. 5, 1940, p. 307 onwards.)

The air condenser has an over-all loss angle of only a few times 10^{-8}, which can be neglected in measurements up to 8000 c/s when an accuracy within 10^{-6} is required. The plates are of aluminium coated with a very low-loss oxide layer only a few microns thick. Philite insulation is used. The bridge circuit is such that only the capacitances between the plates, and not the parallel capacitances to the metal cover, come into the measurements.

2023. THERMOCHROME TEMPERATURE-MEASURING CRAYONS.—F. Penzig. (*Journ. Roy. Aeron. Soc.*, May 1942, Vol. 46, No. 377, p. 159.)

For one possible use *see* 1792 of June, on u.h.f. measurements on insulating materials.

2024. A NOTE ON THE USE OF SMALL POWER PENTODES AS NEGATIVE-RESISTANCE OSCILLATORS [Stable Circuit giving Good Wave-Form].—E. Lawrence. (*Electronic Eng:g*, Oct. 1941, Vol. 14, No. 164, p. 456.)

2025. A PUSH-PULL OSCILLATOR FOR CONTINUOUSLY VARIABLE, VERY LOW FREQUENCIES [1–10 and 10–100 c/s].—R. Gauger & B. Berrang. (*T.F.T.*, Sept. 1941, Vol. 30, No. 9, pp. 257–260.)

Authors' summary:—"A valve generator without any oscillatory circuit is described which gives a constant output voltage of about 5 v_{eff} at 600 ohms over the frequency range 1–10 c/s and 10–100 c/s, continuously varied by a single knob in the same simple way as in a heterodyne note generator. The generating stage has two valves and a voltage divider (which governs the frequency) consisting of fixed condensers and variable resistances. The self-exciting voltage is so stabilised by an automatic level control that no grid current flows. From the anode circuits of these two valves, equal and opposite alternating voltages are taken for the control of a push-pull output stage. An output transformer matches the oscillator with resistances from 10 to 600 ohms." The particular circuit employed is based on that developed by Fehér, who replaced the phase-shifting section or phase-reversing valve (hitherto employed in relaxation-oscillation circuits required to give a good wave-form) by the voltage divider mentioned above: *see* also Willoner & Tihelka, 2026, below.

2026. A NOTE GENERATOR WITHOUT OSCILLATORY CIRCUIT [Range 50–5000 c/s].—G. Willoner & F. Tihelka. (*Arch. f. Tech. Messen*, March 1941, Part 117, Z42-4, Sheet T44.)

"A note generator working on a new principle is described [*cf.* 2025, above], in which the low frequency is generated directly, negative feedback being introduced. The generator contains no oscillatory circuit: it consists essentially of an a.f. amplifier in which a [positive] back-coupling is provided by a type of bridge circuit [left-hand edge of Fig. 2] made up simply of capacitances and resistances, so that the self-excitation conditions are fulfilled for one single frequency only. The direct generation of the note frequency leads to high constancy of frequency, freedom from distortion, and simple construction." The strong negative feedback voltage, which stabilises the amplification and ensures phase equality between input and output, is obtained from the voltage divider R_7–R_8 (Fig. 2).

2027. VACUUM-TUBE-DRIVEN TUNING-FORK OSCILLATOR [Type 723: Operation More Stable than Microphone-Button Type, and Better Wave Form].—General Radio Company. (*Review Scient. Instr.*, Feb. 1942, Vol. 13, No. 2, p. 84.)

2028. REVISED STANDARD-FREQUENCY BROADCASTS [Inclusion of 15 Mc/s Carrier Frequency: the Complete Procedure of WWV's

Transmissions.—Bureau of Standards. (*Tech. News Bull. Nat. Bur. of Stds.*, Feb. 1942, No. 298, pp. 9–10.) See also *Journ. Franklin Inst.*, March 1942, Vol. 233, No. 3, pp. 271–273.

2029. HALLICRAFTER HT-7 FREQUENCY STANDARD: A CORRECTION.—(*Electronic Eng'g*, Sept. 1941, Vol. 14, No. 163, p. 417.) This journal's article referred to in 1454 of May included a wrong specification: the frequency range mentioned in the abstract has therefore nothing to do with the instrument in question.

2030. HIGH-PRECISION FREQUENCY COMPARISONS [Measurement of Long-Time Stabilities of Standard-Frequency Oscillators, by Spark Chronograph (1537 of 1940): of Short-Time Stabilities, by Method employing Two (or more) Similar but Independent Oscillators adjusted to Differ in Frequency by 0.1 c/s. and firing a Thyratron (causing Light Flash from Mercury-Vapour Lamp) at Each Beat Cycle].—L. A. Meacham. (*Bell Lab. Record*, March 1942, Vol. 20, No. 7, pp. 179–182.)

2031. METHOD OF MEASURING THE SERIES CAPACITANCE AND THE INDUCTANCE OF OSCILLATING CRYSTALS.—W. Herzog. (*T.F.T.*, Sept. 1941, Vol. 30, No. 9, pp. 260–263.)

From the Telefunken laboratories. The procedure described involves a signal generator (adequately stabilised, with a fine-adjustment condenser giving a frequency change of about 1×10^{-5} per scale degree, with a very exact relative calibration), a crystal oscillator circuit (preferably one where the crystal, oscillating in its series resonance, acts as a coupling between two valves), and a receiver. The exact tuning of the crystal circuit is important: this can be carried out by adjusting the anode circuit until the anode current of the first valve is at its minimum. A more accurate method is as follows:—a largish variable condenser (a few hundred picofarads) is connected in parallel to the crystal. When the circuit is in tune, the rotation of this condenser should cause, according to eqn. 1, a frequency change of only a few c/s, due to the term $\omega C R_k^2$ (R_k being the resistance of the crystal equivalent circuit, Fig. 1).

The circuit is illustrated in Fig. 4, the various steps of the measuring process being shown by the numerals. First, the pure series resonance of the crystal is determined: for this, the inductance coil is short-circuited by a bar (step "1") so that the crystal has only its own parallel capacitance, including connection capacitances C_1. The generated pure series-resonance frequency is passed on to the receiver. On this frequency is then superposed the frequency of the calibrated signal generator, whose condenser is adjusted till the beat-note vanishes, when the condenser reading, ϵ_0, is taken. For step "2" the short-circuiting bar is removed, so that the coil is now in series with the crystal, the parallel capacitance remaining unchanged. The resulting frequency-shift τ_1 is measured by readjusting the signal generator till the beat-note again vanishes, the condenser reading being now ϵ_1: then $\tau_1 = -F(\epsilon_1 - \epsilon_0)$, where F is the calibration factor of the condenser. Now (step "3") the known fixed condenser C' is connected in parallel with the crystal, and the signal generator adjusted again (ϵ_2) to zero beat: the detuning (from the pure series-resonance frequency) is now $\tau_2 = -F(\epsilon_2 - \epsilon_0)$. As to the signs of τ_1 and τ_2, it is pointed out that they can be negative or positive, according to whether the circuit is oscillating in the first or second series-resonance. For instance, while ϵ_1 is being taken the first mode may be involved, in which case τ_1 will be negative, while on paralleling the condenser the second series-resonance may be excited, with τ_2 positive.

The required value C_k is given by eqn. 14, involving C', F, C_1, and the three ϵ values. If the differences τ_1 and τ_2 are kept fairly small, or if an error above about 1% is considered admissible, this equation can be simplified (*cf.* eqn. 9, simplified from eqn. 8) to the formula $C_k = 2C'F \cdot (\epsilon_2 - \epsilon_0)(\epsilon_1 - \epsilon_0)/(\epsilon_2 - \epsilon_1)$. The accuracy with which C_k can be determined depends, therefore, chiefly on the accuracy of the measurement of the ϵ differences, and the series inductance and parallel condenser C' should be chosen so that these differences are large enough to be accurately measured. A good value for C' is 15–30 pF, while the series coil should be of the order of 10^{-4}–10^{-3} henry, depending (but by no means critically) on the crystal inductance to be measured. If the calibration curve of the signal generator is not sufficiently linear, as in the case of the specimen tests described at the end of the paper, two calibration factors F_1 and F_2 must be brought in, and the full and approximate formulae for C_k are then given by eqns. 16 and 17 respectively. It was found that the greatest discrepancy between the results obtained by the two formulae was only 0.7%.

2032. DATA SHEETS XII TO XVII: THE INDUCTANCE OF SINGLE-LAYER SOLENOIDS.—(*Electronic Eng'g*, Oct. & Nov. 1941, Vol. 14, Nos. 164 & 165, pp. 447–450 & 495–498.)

2033. A NEW DESIGN OF SATORI ELECTRIC PENDULUM DRIVE.—K. Novak. (*Zeitschr. f. Instr:kunde*, Jan. 1942, Vol. 62, No. 1, pp. 18–20.)

2034. RESISTANCE MATERIALS FOR STANDARD RESISTANCES [Survey, including Manganin, Isabellin, Novokonstant, "A" Alloy (Therlo), & Gold-Chromium Alloys (3130 of 1940)].—A. Schulze. (*Zeitschr. f. tech. Phys.*, No. 6, Vol. 21, 1940, pp. 117–128.)

2035. SILVER ALLOYS AS RESISTANCE MATERIALS, *and* RESISTANCE MATERIALS WITH LITTLE OR NO NICKEL CONTENT [for War Economy].—Schulze: Hessenbruch. (See 2134 & 2135.)

2036. THE UNITED STATES STANDARDS OF MEASUREMENTS.—L. J. Briggs. (*Engineering*, 17th & 24th April 1942, Vol. 153, pp. 304–305 & 334–335.) Excerpt from *The Smithsonian Report for 1940*.

2037. A NEW D.C. MEASURING METHOD FOR DETERMINING THE POSITION OF AN "ALL-WIRES" INSULATION FAULT [*i.e.* Arbitrary Combination of Short Circuits & Earthings: applicable only to Cables of at least Four Wires].—H. Poleck. (*Wiss. Veröff. a. d.*

Siemens-Werken, No. 2, Vol. 18, 1939, pp. 1–8.)

2038. ATTENUATION AND AMPLIFICATION MEASUREMENTS IN COMMUNICATION TECHNIQUE [Definitions & Expressions for Quadripole Characteristic Quantities: Short Survey of Measuring Methods].—H. Koschel. (*Arch. f. Tech. Messen*, March 1941, Part 117, V3713-3, Sheets T35–36.)

2039. NEW METHOD OF MEASURING THE MAGNETIC DECLINATION AND DIP [Rapid Method using Ferromagnetic-Saturation Frequency-Doubling Principle: Mean & Max. Errors ± 5" & 16"].—M. Tenani. (*La Ricerca Scient.*, Nov. 1941, Vol. 12, No. 11, pp. 1135–1140.)

2040. DESCRIPTION OF THE RECEIVING INSTALLATION IN THE TEST AEROPLANE OF THE RESEARCH ESTABLISHMENT OF THE GERMAN STATE POST OFFICE.—Rösseler & Vogt. (See 1953.)

2041. MEASURING APPARATUS IN THE AMERICAN BROADCAST-RECEIVER REPAIR WORKSHOP.—G. Keinath. (*E.T.Z.*, 31st Dec. 1941, Vol. 62, No. 52/53, pp. 1009–1010: summary only.)

2042. A TYPE OF THREAD ELECTROMETER [Design giving High Sensitivity (1000 mm/V) and Good Stability & Linearity].—G. C. Trabacchi. (*La Ricerca Scient.*, Jan. 1942, Vol. 13, No. 1, pp. 15–20.)

2043. THE POINT-DISCHARGE RECORDER—RECORDING MICROAMMETER.—Candler. (See 1014.)

2044. A DIODE SLIDE-BACK PEAK VOLTMETER [Surprising Neglect in Spite of Advantages: Probe-Valve Instrument for A.C. Supply, No Meter ("Magic Eye" Indicator), Television-Type Diode: Range 0.1 to 65 V or over].—C. E. Cooper. (*Electronic Eng:g*, Sept. 1941, Vol. 14, No. 163, pp. 395 and 417.)

2045. A RECORDING PEAK-VOLTAGE METER FOR COMMERCIAL ALTERNATING AND DIRECT CURRENT [Peaks up to 1000 V: Resolving Power 7×10^{-4} s for a Minimum Spacing around 1 s].—J Kühne. (*E.T.Z.*, 31st Dec. 1941, Vol. 62, No. 52/53, pp. 1003–1005.) Portable instrument based on the same principle as the electroacoustic "tonemeter" of Thilo & Bidlingmaier, 3457 of 1936.

2046. ON A METHOD OF MEASURING VERY HIGH POTENTIALS [Certain Defects of Previous "Generating Voltmeters" avoided by Spherical Design, with Driving Motor enclosed in Rotating Divided Sphere: Applications].—O. Yadoff. (*Comptes Rendus* [Paris], 6th Oct. 1941, Vol. 213, No. 14, pp. 453–455.)

2047. A HIGH-FREQUENCY HIGH-TENSION TESTING PLANT OF HIGH POWER [20–40 kW: for Tests on Insulators, Bushings, & Condensers at Frequencies 300 kc/s and 1 & 10 Mc/s, and Voltages 500, 300, & 80 kV respectively].—L. Rohde & others. (*E.T.Z.*, 26th March 1942, Vol. 63, No. 11/12, pp. 129–133.)

2048. MEASUREMENTS ON IMPULSE VOLTAGES WITH A BALLISTIC GALVANOMETER [Summary of I.E.E. Paper & Discussion].—G. W. Bowdler. (*Electrician*, 15th May 1942, Vol. 128, pp. 487–488.)

2049. THE MEASUREMENT OF IMPULSE VOLTAGES BY MEANS OF SMALL SPHERE GAPS [and the Obtaining of Greater Consistency of Breakdown by remedying the Ion Deficiency by Radioactive Substances or Ultra-Violet Irradiation, etc.].—D. E. M. Garfitt. (*Proc. Phys. Soc.*, 1st March 1942, Vol. 54, Part 2, No. 302, pp. 109–120.) *Cf.* Mochizuki & Takeda, 2088, below.

2050. ERRORS IN THE MEASUREMENT OF HIGH SURGE CURRENTS WITH THE HELP OF LOW-INDUCTANCE TEST RESISTANCES AND THE CATHODE-RAY OSCILLOGRAPH.—W. Siemer. (*E.T.Z.*, 16th Jan. 1941, Vol. 62, No. 3, pp. 45–47.)

SUBSIDIARY APPARATUS AND MATERIALS

2051. GIANT DEMONSTRATION OSCILLOGRAPH [using Type 2532 A20 Intensifier "Oscillotron" with 20" Screen, 6 kV Final Accelerating Voltage].—DuMont Laboratories. (*Review Scient. Instr.*, Feb. 1942, Vol. 13, No. 2, pp. 85–86.) In *Gen. Elec. Review*, April 1942, p. 249, the tube is named a "teletron."

2052. THE MEMORY OSCILLOGRAPH.—Hull & Elder. (In paper dealt with in 2082, below.)

2053. A NEW INSTRUMENT FOR ANALYSING ELECTRIC TRANSIENTS [Single Instrument combining Low-Voltage Surge Generator, Sweep Circuit, & C.R. Oscillograph].—Rohats. (*Gen. Elec. Review*, Feb. 1942, Vol. 45, No. 2, pp. 121–122.)

2054. AN IONISATION AMPLIFIER FOR THE RECORDING OF COINCIDENCES [with Electronic Commutator (10 000 Alternations per Second) giving Signals from Two Ionisation Chambers at Same Point on C.R.O. Screen, for Comparison of Energies].—Magnan. (*Comptes Rendus* [Paris], 13th Oct. 1941, Vol. 213, No. 15, pp. 476–479.)

2055. LOW-FREQUENCY LINEAR TIME-BASE GENERATOR FOR OSCILLOGRAPHY [Type 215: Frequency Range 0.2 to 125 c/s: for Vibration Studies, Physiological Applications, etc.].—DuMont Laboratories. (*Review Scient. Instr.*, March 1942, Vol. 13, No. 3, p. 132.)

2056. DIRECT-WRITING OSCILLOGRAPH [the Garceau Velograph].—Electro-Medical Laboratory. (See 2261.)

2057. PEDAL-OPERATED SWITCH primarily for C.R. Recording Apparatus].—Burns. (*Journ. of Scient. Instr.*, April 1942, Vol. 19, No. 4, p. 63.)

2058. ON THE WINDING DENSITY [Number of Turns per Unit Length] OF A CIRCULAR SECTION COIL TO PRODUCE A GIVEN MAGNETIC FIELD [for Electron-Optical Apparatus].—Glaser. (*Zeitschr. f. Phys.*, No. 3/4, Vol. 118, 1941, pp. 264–268.)

The question is, how must the number of turns per unit length, $n(\zeta)$, be chosen in order that the coil may produce, along its axis, a magnetic field of the form $H(z)$. "Analogous to this is the electrostatic problem, to design a series of coaxial charged circular rings of equal radius in such a way that the electrical potential $\Phi(z)$ excited along the axis may have a given course. Obvious and elementary as the question may appear, to the best of our knowledge it has never been tackled. The problem leads to an integral equation of the first class of a quite definite type. Since we give a general solution for this whole class of integral equation, the fundamental solution of various other problems, leading to the same type, is thus provided": since the integral equation 5, $f(x) = \int_{-\infty}^{+\infty} K(x-\xi)\,\phi(\xi)d\xi$, applies whenever any magnitude produces, at a point in space, an effect which depends on the distance r in a definite manner $K(r)$, and which is proportional to the value of the magnitude producing the effect. In spite of its importance, the writer has been unable to find the solution of this eqn. 5 in any work on integral equations. In the present problem the x and ξ in eqn. 5 represent z/a and ζ/a respectively, where a is the coil radius; and $\phi(\xi) = \frac{1}{2}I\,n(\xi)$. To solve the equation with respect to the wanted unknown $\phi(\xi)$, the writer uses two reciprocity formulae 8a & b, derived directly from the Fourier integral theorem, and obtains ultimately eqn. 11 for $\phi(\xi)$, which, in conjunction with eqn. 12, allows all the integrals involved to be evaluated for a given field course $H(z)$ or $\Phi(z)$.

2059. SUPPLEMENT TO THE PAPER "ON THE OPTICAL CONSTANTS OF STRONG ELECTRON LENSES", *and* SUPPLEMENT TO THE PAPERS "ON THE TESTING OF SHORT-FOCUS ELECTRON LENSES" AND "ON A 200 kV UNIVERSAL ELECTRON MICROSCOPE WITH OBJECT-SHADOWING DEVICE".—Dosse: von Ardenne. (*Zeitschr. f. Phys.*, No. 5/6, Vol. 118, 1941, pp. 375–383: pp. 384–388.)

(i) While Dosse's paper (516 of February) was in the press, von Ardenne's two papers appeared (515 of February and 3490 of 1941), in which various problems identical with or similar to those dealt with in Dosse's work were treated, with some discrepancies in the results. Since on pp. 723–727 of Dosse's survey the various results known up to that time were discussed, the present supplement considers von Ardenne's two papers in order that the methods and results described in the three papers may be compared. Five main points in von Ardenne's work are contested, the first in connection with his "shadow image" method of measuring focal length (which, Dosse maintains, gives too *long* focal lengths and not too short, as stated by von Ardenne): the second his use of wire gauze as the test object: the third with regard to the distortion of shadow images: the fourth his statement that the minimum focal length is proportional to the accelerating voltage: and the fifth his conclusion that, contrary to previous ideas, the resolving power deteriorates with increasing voltage.

(ii) Von Ardenne's supplement is prompted by (i) and by a subsequent discussion between the two workers, and is a clarification and an extension of certain points in his two papers. He sticks to his conviction that for voltages above 60 kv his approximate relation that f_{min} is proportional to U conforms better with practical experience than, for instance, the $\sqrt{U}$ relation. Regarding resolving power, the best he has been able to get with 180 kv is 4 mμ, compared with 2.2 mμ with 60 kv: this may partly be due to the decreased contrast given by the smallest particles at the higher voltage.

2060. THE LOWER LIMITS OF THE FOCAL LENGTH AND CHROMATIC ABERRATION OF MAGNETIC ELECTRON-LENSES.—Scherzer. (*Zeitschr. f. Phys.*, No. 7/8, Vol. 118, 1941, pp. 461–466.)

In seeking conclusions as to the practicability of a lens it is helpful to assume that the steepness of field change (on which the reduction of focal length and chromatic aberration both depend) has an upper limit for all practical lenses. This steepness is represented by $s = -H'/H$, where H is the field strength at the optical (z) axis and the minute stroke denotes differentiation with respect to z. Representing the upper limit of s by $1/l$, then $l/100$ is the distance over which, in the region of max. relative field change, the field strength at the axis alters by 1%. The length l should be of the same order of magnitude as the smallest stop diameter and thickness attainable by the mechanic without detracting from the centering: it is, therefore, a measure of the precision of workmanship. The writer shows that the focal length of a magnetic objective cannot go below the value of $0.8l$, and that the lower limit for chromatic aberration is that df/dU is not less than $l/2U$.

2061. CATHODE AND CONTROL-ELECTRODE ASSEMBLY FOR CATHODE-RAY TUBES.—R.C.A. Laboratories.—(*Electronic Eng:g*, Oct. 1941, Vol. 14, No. 164, p. 456.)

2062. CERTAIN DIFFICULTIES IN THE USE OF CATHODE-RAY OSCILLOGRAPHS FOR STUDYING ELECTRICAL PROCESSES.—Balygin. (*Journ. of Tech. Phys.* [in Russian], No. 10, Vol. 10, 1940, pp. 859–863.)

The following difficulties met with in practice are discussed:—(1) The use of cathode-ray oscillographs for studying processes of low frequencies (down to 50 c/s): suitable circuits are suggested, obviating the necessity of additional complicated devices such as rotating cameras, etc. (2) The initial wandering of the spot, which often precludes the possibility of obtaining a suitable oscillogram: practical measures are suggested for overcoming this difficulty. (3) Distortion of wave-form introduced by the oscillograph equipment, including the supply leads: examples of distorted impulse waves are shown, but it is pointed out that in some cases the distortion may be caused by the breakdown process in the spark gap.

2063. FILM-CONTRACTION ERRORS IN LATTICE-SPACING MEASUREMENTS.—Lipson: Hume-Rothery & others. (*Journ. of Scient. Instr.*, April 1942, Vol. 19, No. 4, pp. 63–64.) Letter prompted by 806 of March.

2064. Atomic Images with the Electron Microscope [and the Improvement of Contrast by inclining Axis of Condenser Lens with respect to That of Remainder of Microscope, so that Undeviated Beam just Misses the Objective Aperture].—Schiff. (*Phys. Review*, 1st/15th March 1942, Vol. 61, No. 5/6, p. 391: summary only.)

2065. Electron-Microscopic Examination of Surfaces by the Impression Process.—Mahl. (*Naturwiss.*, 3rd April 1942, Vol. 30, No. 14/15, pp. 207–217.) For the writer's original account of this process *see* 2933 of 1941; and *cf.* 2215, below.

2066. Phase-Contrast [Optical] Microscopy [Advantages, & Its Neglect in Industry: Technique & Examples].—Burch & Stock. (*Journ. of Scient. Instr.*, May 1942, Vol. 19, No. 5, pp. 71–75.) *Cf.* 1741 of 1941 and 798 of March.

2067. A New Ion-Source System with Mass Monochromator for Neutron Generators.—von Ardenne. (*Physik. Zeitschr.*, 20th March 1942, Vol. 43, No. 5/6, pp. 91–101.)

"In the writer's laboratory, during 1940/41, a van de Graaff neutron generator of one million volts potential was built for investigations (in an extension to electron-microscopic researches) by the method of radioactive indicators [no further information is given]. For this apparatus an ion source was developed whose construction an properties should be of a more general interest." It was required to produce a deuteron beam of about 100 μA, with as small a consumption as possible both of the heavy hydrogen and of power; and the desire to embody a mass monochromator (to weed out the deuteron stream from the unwanted ions) limited the choice of ion source to a type with low scattering of velocities. The principle adopted was the oscillating-electron principle of Finkelstein (2411/2 of 1940), modified by Heil (unpublished paper) so that the magnetic field and the swinging of the electrons were *perpendicular* to the ion-beam direction, and further modified by the writer to take advantage, in the design of electrodes, etc., of his decimetric-wave technique, so that with electrode dimensions of only a few centimetres the total path length of an electron in the ionising space reached a value of 10 m or over. A combination of electrostatic and magnetic (permanent-magnet) electron focusing was used, and among other features described and illustrated is a special vacuum lock for replacement of the ray-producing system in the event of damage to the cathode (but the system is specially designed to avoid the shortening of cathode life by ion bombardment). For early work by the writer on ionic probes *see* 1567 of 1940.

2068. On the Phosphorescence Centres [Experiments on Blue-Luminescent CaSBi*x* Phosphor confirm Lenard's Statement of Existence of Centres with Different Persistencies in the Same Phosphor, contrary to Riehl's Conclusions].—Bandow. (*Ann. der Phys.*, 25th Feb. 1942, Vol. 41, No. 2, pp. 172–176.) *See* Riehl's book, 805 of March.

2069. The Fluorescence of Phosphors in the Rare Gases [Measurements, including Improved Output from Zinc Silicate by Removal of Free Silica, Estimate of Quantum Efficiency (near Unity in Neon), etc.].—Fonda & Huthsteiner. (*Journ. Opt. Soc. Am.*, March 1942, Vol. 32, No. 3, pp. 156–160).

2070. The Yellow Fluorescent Form of Zinc Silicate.—Rooksby & McKeag. (*G.E.C. Journal*, Feb. 1942, Vol. 12, No. 1, p. 59: short summary.)

2071. Better Vacuum [Use of Kovar for Seals].—Westinghouse. (*Review Scient. Instr.*, March 1942, Vol. 13, No. 3, p. 134.) *See* also 2647 of 1936 and back reference.

2072. A Stabilised Ionisation-Gauge Circuit with Vacuum-Tube Voltmeter [with Increased Stability, Ruggedness, & Simplicity].—Rainwater. (*Review Scient. Instr.*, March 1942, Vol. 13, No. 3, pp. 118–122.)

2073. Regulated Voltage Supplies [for the Magnetic Electron Microscope: Very High Requirements: Possibility of using Non-Regulated Supply for Acceleration to Almost Full Value, with Additional Stage of Acceleration compensating Fluctuations of Previous Stages (*e.g.* by Use of Magnetic Analyser, combined with Amplifier, to control Last Stage)].—Marton. (*Phys. Review*, 1st/15th Feb. 1942, Vol. 61, No. 3/4, p. 204: summary only.)

2074. Regulated Power Supplies [using Negative Feedback].—Marton & Hutter. (*See* 1929.)

2075. Heavy-Duty Regulated H.T. Supply Unit [consisting essentially of Parallel Combination of Regulated Unit with Unregulated Unit operating at a Higher Voltage].—R.C.A. Laboratories. (*Electronic Eng:g*, Dec. 1941, Vol. 14, No. 166, p. 556.)

2076. Voltage Regulator for a Densitometer Lamp [requiring a Constancy within about 0.03%].—Parsons. (*Journ. Opt. Soc. Am.*, March 1942, Vol. 32, No. 3, pp. 153–155.) Modification by Hygrade Sylvania of the Coombs-Nims circuit (*Electronics*, Vol. 13, 1940).

2077. The Stabilisation of D.C. Voltages with the Help of Amplifier Valves.—Schad: Lindenhovius & Rinia. (*Funk*, 15th Dec. 1941, No. 24, pp. 365–367.) Abbreviated version of the paper dealt with in 817 of March.

2078. Voltage Control of D.C. Generators by Flux-Diversion.—Davies & Crawford. (*G.E.C. Journal*, Feb. 1942, Vol. 12, No. 1, pp. 27–37.)

2079. Rectifiers for Telecommunication [including the "Noregg" & "Westat" Constant-Voltage Systems, etc.].—(*Overseas Engineer*, April 1942, Vol. 15, No. 175, pp. 139–145.) *See* 2939 of 1940 and back reference.

2080. The Compounding of Grid-Controlled Rectifiers to give a Voltage independent of Current, over Whole Range of Adjustment of No-Load Voltage: Derivation of Theoretical Conditions: Practical Example.—Kong. (*E.T.Z.*, 31st Dec. 1941, Vol. 62, No. 52/53, pp. 993–997.)

2081. The Electrical Strength of High-Voltage Electrical Apparatus.—Rakov. (*Journ. of Tech. Phys.*, in Russian, No. 10, Vol. 10, 1940, pp. 864–870.)

High-vacuum electrical apparatus such as X-ray tubes, kenotrons, etc., operating at voltages of the order of 100 kV or more are often disabled temporarily or permanently by sharp discharges which may take place inside the apparatus. Every care should therefore be taken to prevent these discharges, and this necessitates the fulfilment of the following conditions:—(1) Sufficient degree of vacuum; (2) absence of cold emission of electrons, and (3) correct distribution of electron streams in the apparatus, especially in view of the appearance of secondary electrons. Each of the above conditions is discussed separately, and practical suggestions are made.

2082. The Phase of Arc-Back [Measurements on Thyratrons, interpreted by Kingdon & Lawton's Theory (803 of 1940): Use of the "Memory Oscillograph"].—Hull & Elder. (*Journ. Applied Phys.*, March 1942, Vol. 13, No. 3, pp. 171–178.) For an early paper on "memory" equipments *see* Pakala 723 of 1930.

2083. Theoretical and Experimental Contributions to the Schottky Diffusion Column [in the Low-Pressure Mercury Plasma].—Fetz. (*See* 1970.)

2084. "Gaseous Conductors, Theory and Engineering Applications" [Book Review].—Cobine. (*Journ. Franklin Inst.*, March 1942, Vol. 233, No. 3, p. 292: *Review Scient. Instr.*, April 1942, Vol. 13, pp. 163–164.)

2085. Grid-Controlled Corona [Development of a Corona "Triode", for (e.g.) Stabilisation of Voltage on a High-Potential Electrode].—Ashby & Hanson. (*Review Scient. Instr.*, March 1942, Vol. 13, No. 3, p. 128.)

2086. Streamering in Negative Corona.—Bennett. (*See* 1955.)

2087. Threshold Field Studies of Various Positive Corona Phenomena.—Fitzsimmons. (*See* 1900.)

2088. On the Discharge Characteristics of the Combined Gaps [Corona-Discharge Needle Gap to reduce Time Lag of Main Gap: the Use of a Steep Impulse Voltage to improve Corona-Production: Occasional Hindering Action of a Three-Point Gap: etc.].—Mochizuki & Takeda. (*Electrotech. Journ. Tokyo*, March 1941, Vol. 5, pp. 55–57.)

2089. "Electric-Discharge Lamps" [Book Review].—Francis & Jenkins. (*Electronic Eng'g*, Nov. 1941, Vol. 14, No. 165, p. 500.) From the General Electric Company.

2090. Diffusion of Heat through a Rectangular Bar and the Cooling Effect of Fins, and Application of an Electric Model to the Study of Two-Dimensional Heat Flow.—Avrami & Little: Avrami & Paschkis. (*See* 1977.)

2091. Semiconducting Materials: Short Survey, including Important Applications (Protecting Devices in Receivers, etc.: Rectifiers)].—Mutschke. (*Zeitschr. f. Fernmeldetech.*, 16th Dec. 1941, Vol. 22, No. 12, pp. 182–185.)

2092. Simplified and Extended Theory of the Boundary-Layer Rectifier.—Schottky. (*Zeitschr. f. Phys.*, 1st Feb. 1942, Vol. 118, No. 9/10, pp. 539–592: Corrections p. 592.)

"The more exact study of the cuprous-oxide and selenium rectifiers (2076 of 1940) has led to the recognition of the fact that in these two rectifiers, which may be regarded as the most important technically up to the present, a full ionisation is to be assumed for the defect points ['gaps', Störstellen], yielding defect electrons in a layer of semiconductor about 10^{-5} cm thick immediately adjacent to the rectifier metal. It was also established that the d.c. and a.c. behaviour of these rectifiers is quite predominantly determined by the properties of this 'exhaustion boundary layer,' while those layers in which there is only an imperfect ionisation of the defect points or a partial compensation of the defect-point charges by defect-electron charges play only a minor rôle. This discovery is not only of physical and technical interest but also makes possible a greatly simplified mathematical representation of the processes governing the behaviour of these types of rectifier. Since moreover, in the framework of this theory a complete representation of the current/voltage relations for d.c. and a.c. becomes possible, the most important results of this simplified theory will be set out in the following pages and compared with experimental results."

The theory developed in §§ 1–5 is first applied, in § 6, to a discussion of Schmidt's capacitance measurements on selenium rectifiers [826 of March]: "it not only allows the case of homogeneous distribution of the defect points to be dealt with, but also makes it possible to determine, for the case of a distribution varying in space, the defect-point density at various distances from the metal electrode. The discussion of the observed d.c. behaviour of selenium rectifiers with low defect-electron work function for the covering material gives at the higher temperatures an excellent agreement with the theory, and decides against the applicability of the characteristic-curve calculation recently given by Davydov [footnote 3, p. 565: for the original Russian paper *see* 2545 of 1941]: §§ 7 and 8. To interpret the discrepancies still existing, particularly at low temperatures and for high work functions, § 9 first discusses the influence, on the characteristic curve, of a reduction of the work function produced by the boundary field (in a generalisation of a calculation carried out by Mott, 4136 of 1939). It is found, however, that these effects, except at high temperatures and for low work functions, are always of a smaller order of magnitude than certain structural effects, bound up with the discrete distribution of the defect-point charges, which are discussed in § 10. Finally, in §§ 11 and 12 the theory is applied also to rectifiers with incomplete defect-point dissociation in the interior of the semiconductor, but nevertheless having an 'exhaustion boundary layer' close to the metal; for the copper-oxide rectifier, which belongs to this type, the defect-point distribution in the neighbourhood of the mother copper is determined."

2093. ON THE TEMPERATURE COMPENSATION OF CUPROUS-OXIDE RECTIFIERS.—Manovski & Sharavski. (*Journ. of Tech. Phys.* [in Russian], No. 11, Vol. 10, 1940, pp. 941–942.)

It is shown that with the fall of temperature the output power of a cuprous-oxide rectifier is considerably decreased and at − 60° C is equal only to 40% of that at room temperature. This variation in the power output can be made very small within wide temperature limits (curve 2 as against curve 1 in Fig. 3) if a power-supply transformer having large leakage (for example with a magnetic shunt) is used.

2094. NON-INTERFERING VIBRATORS [primarily for Communication-Type Receivers].—Masteradio. (*Electronic Eng:g*, Nov. 1941, Vol. 14, No. 165, p. 510.) For other recent work *see* 1492 of May.

2095. DRY CELL MANUFACTURE [and the Use of Materials indigenous to India].—(*Nature*, 4th April 1942, Vol. 149, pp. 381–382: summary only.)

2096. SALVAGING ACCUMULATORS [Regeneration of Sulphated Cells: Experience over Past Six Months].—Hickling. (*Wireless World*, April 1942, Vol. 48, No. 4, p. 78.) *See* 830 of March.

2097. THE SILVER-ZINC ACCUMULATOR [New Light-Weight Alkali Accumulator]. — André. (*E.T.Z.*, 26th March 1942, Vol. 63, No. 11/12, pp. 145–146: summary only.)

2098. LARGE-SCALE EXTRACTION OF POLONIUM FROM ACTIVE LEAD, AND THE FORMATION OF RADIOACTIVE ELECTRODE ALLOYS.—Dillon & Street. (*Journ. Applied Phys.*, March 1942, Vol. 13, No. 3, pp. 186–198.) Leading out of the work on sparking plugs referred to in 2746 of 1940.

2099. PRODUCTION OF TUNGSTEN: ELECTRO-THERMAL METHODS REVIEWED.—(*Electrician*, 15th May 1942, Vol. 128, pp. 472–475.)

2100. CLEANING FINE COPPER WIRE [Litz Wire of Very Small Section].—Bell. (*Journ. of Scient. Instr.*, May 1942, Vol. 19, No. 5, p. 79.)

2101. A DEVICE FOR WINDING SMALL TOROIDAL INDUCTANCES.—Wass. (*Journ. of Scient. Instr.*, May 1942, Vol. 19, No. 5, pp. 78–79.)

2102. A GENERAL-PURPOSE COIL-TURNS MEASURING EQUIPMENT.—Snelson & Brailsford. (*Met.-Vickers Gazette*, April 1942, Vol. 20, No. 336, pp. 51–53.)

2103. COLLOIDAL-GRAPHITE ELECTROSTATIC SHIELDING.—Porter. (*See* 1978.)

2104. ELECTROSTATIC SCREENING AT VERY HIGH FREQUENCIES [Note on Method of passing Control Shaft into Screening Box, etc.].—E.M.I. (*Electronic Eng:g*, Sept. 1941, Vol. 14, No. 163, p. 410.)

2105. SOIL-CORROSION STUDIES, 1939: COATINGS FOR THE PROTECTION OF METALS UNDERGROUND.—Logan. (*Journ. of Res. of Nat. Bur. of Stds.*, Jan. 1942, Vol. 28, No. 1, pp. 57–71.)

2106. ECONOMY IN BRASS [to extent of 60%] IN SCREW TERMINALS, BY NEW DESIGN.—Schulz & Wägele. (*Zeitschr. V.D.I.*, 18th April 1942, Vol. 86, No. 15/16, p. 250.) An example taken from a long paper in *Siemens-Zeitschrift*.

2107. ELECTRIC SOLDERING IRONS: A WARTIME ECONOMY [Re-tinning Technique avoiding Heavy Filing].—(*Wireless World*, April 1942, Vol. 48, No. 4, p. 97.)

2108. TIN-LESS SOLDERING FOR WIRE JOINTING.—A.E.G. (*E.T.Z.*, 20th Nov. 1941, Vol. 62, No. 46/47, Advt. p. 9.)

2109. FLUXES FOR SOFT SOLDERS. — Watkins (*Engineering*, 24th April 1942, Vol. 153, p. 328: summary of report from Tin Research Institute.)

2110. FLUX FOR SOLDERING PHOSPHOR-BRONZE HAIR-SPRINGS.—Homer & Watkins. (*Journ. of Scient. Instr.*, March 1942, Vol. 19, No. 3, p. 45.) For correspondence on the chance of corrosion by the lactic acid component *see* May issue, No. 5, pp. 79–80.

2111. VERNIER CONDENSER [Compact Unit having Two Ranges of Capacitance-Variation with Single Control: Two Spacings, located by Ball in Annular Groove].—R. C. A. (*Electronic Eng.g*, Oct. 1941, Vol. 14, No. 164, p. 467.)

2112. NOTE ON THE PREPARATION AND PROPERTIES OF METAL-COATED MICA CONDENSERS [Technique of Sputtering & Evaporation Methods: Measurements].—Craggs. (*Journ. of Scient. Instr.*, March 1942, Vol. 19, No. 3, pp. 40–43.) For a letter from Coursey, and the reply, *see* May issue, No. 5, p. 80.

2113. ULTRA-HIGH-FREQUENCY ALUMINIUM-CASE TRANSMITTING CAPACITORS [Highly Refined Sulphur Compound as Dielectric: Corona eliminated]. — Aerovox. (*Review Scient. Instr.*, Feb. 1942, Vol. 13, No. 2, p. 86.)

2114. OIL-FILLED PLUG-IN CAPACITORS [Type 72: "Ideal where Prompt Servicing of Single Units is Absolutely Essential"].—Aerovox. (*Review Scient. Instr.*, March 1942, Vol. 13, No. 3, p. 132.)

2115. BERYLLIUM OXIDE AND ITS APPLICATIONS [including the Good Electrical Insulating & Thermal Conducting Properties of Highly

Sintered Beryllia].—David. (*Engineering*, 1st May 1942, Vol. 153, p. 344: summary only.)

2116. FUSED ALUMINA CEMENTS [for Securing & Covering Heating Elements wound on Vitreosil, Alumina, etc.].—(*Journ. of Scient. Instr.*, March 1942, Vol. 19, No. 3, p. 46.)

2117. EXPANSIVITY OF A VYCOR BRAND GLASS [96% Silica, Glass No. 790: Comparison with Fused Quartz].—Saunders. (*Journ. of Res. of Nat. Bur. of Stds.*, Jan. 1942, Vol. 28, No. 1, pp. 51–55.)

2118. FIBRONISED KOROSEAL TUBING [for Insulation].—(*Journ. Applied Phys.*, March 1942, Vol. 13, No. 3, p. 208.) Developed from Koroseal (3132 of 1941 and back reference).

2119. THERMOPLASTIC SARAN [as Alternative for Copper & Other Metal Tubings, etc.].—(*Gen. Elec. Review*, Feb. 1942, Vol. 45, No. 2, p. 137.)

2120. NEW ROSIN [" Polypale Resin ", with High Melting-Point].—Hercules Powder. (*Review Scient. Instr.*, March 1942, Vol. 13, No. 3, p. 134.)

2121. WATER ABSORPTION OF RESINS.—Irany. (*Sci. Abstracts*, Sec. A, March 1942, Vol. 45, No. 531, p. 97.)

2122. PLASTICS: A NEW MATERIAL OF CONSTRUCTION [with Table of Non-Electrical Properties of the Various Types].—Chapman. (*Engineer*, 24th April 1942, Vol. 173, pp. 353–355: long summary.)

2123. THE DEPENDENCE ON TEMPERATURE OF VISCOSITY AND DIELECTRIC RELAXATION IN AMORPHOUS SOLID BODIES AND LIQUIDS, FROM CONSIDERATIONS OF PLACE-CHANGE PROCESSES.—Holzmüller. (*Physik. Zeitschr.*, 15th Sept. 1941, Vol. 42, No. 15/16, pp. 273–281.)

2124. DIELECTRIC LOSSES IN HIGH-POLYMER SOLIDS [Measurements of Loss Angles & Dielectric Constants, at 500, 10^4, & 10^6 c/s and Temperatures between 10 & 160°C, of Polyvinyl Acetate, Polystyrol, Thiokol, Novolak, etc.].—Holzmüller. (*Physik. Zeitschr.*, 15th Sept. 1941, Vol. 42, No. 15/16, pp. 281–293.)

For previous work, including the bridge now used for the 1 Mc/s measurements, *see* 3513 of 1941 and back references. The present results showed "a displacement of the loss-angle maximum towards higher temperatures when the frequency was increased, and an anomalous dispersion of the dielectric-constant values. The renewed rise in dielectric loss observed at high temperatures and low frequencies is attributed to ionic conductivity. The rise of the loss-angle maximum at higher temperatures and high frequencies confirms the theoretical expectations. The measurements also allow the temperature-dependence of the relaxation times to be obtained, showing a linear increase of log τ with respect to the reciprocal of the absolute temperature. From the width of the loss-angle curves the existence in all cases of a number of closely adjacent relaxation times can be deduced."

2125. THE STORY OF LAC.—Gibson. (*Journ. Roy. Soc. Arts*, 17th April 1942, Vol. 90, pp. 319–332: Discussion pp. 332–335.)

2126. SYNTHETIC RUBBER.—Bridgewater. (*Journ. Franklin Inst.*, March 1942, Vol. 233, No. 3, pp. 225–234.)

2127. ON THE THEORY OF THE ELECTRICAL BREAKDOWN IN LIQUIDS OF SIMPLE STRUCTURE [Arguments in Favour of Application of Zener's Quantum-Mechanical Theory (of Breakdown in Solid Insulators) to Insulating Liquids of Simple Structure: illustrated by Discussion of Conditions in Liquid Argon].—Kronig. (*Zeitschr. f. Phys.*, No. 7/8, Vol. 118, 1941, pp. 452–454.) Zener's theory (ref. " 1 ") was based on the Bloch electron theory of metallic conduction.

2128. AN EFFECTIVE VIBRATION-FREE SUSPENSION [primarily] FOR LIQUID MIRRORS [where All Three Motional Components have to be considered].—Becker. (*Zeitschr. f. tech. Phys.*, No. 9, Vol. 21, 1940, pp. 195–199.)

2129. TIME-DELAY RELAY [Circuit for Complete A.C. Operation: closes 10 s after Energising Contact is made, opens automatically after Predetermined (5–90 s) Interval].—Krebs & Kersten. (*Review Scient. Instr.*, Feb. 1942, Vol. 13, No. 2, pp. 83–84.)

2130. AN INEXPENSIVE SENSITIVE RELAY [primarily for Wireless Control of Model Aircraft, etc.].—Worthington. (*Electronic Eng'g*, Nov. 1941, Vol. 14, No. 165, p. 504.)

2131. RHODIUM CONTACTS: A NEW METAL FOR USE IN RADIO APPARATUS.—Laister. (*Electronic Eng'g*, Nov. 1941, Vol. 14, No. 165, pp. 490–491.)

2132. PLATINUM-NICKEL, A NEW NOBLE-METAL CONTACT MATERIAL FOR COMMUNICATION TECHNIQUE [including Comparison with Platinum & Platinum-Iridium].—Döring. (*E.T.Z.*, 4th Dec. 1941, Vol. 62, No. 48/49, pp. 953–955.)

2133. ELECTRICAL CONTACTS FOR INSTRUMENTS [and the Selection of Material for a Given Application].—Chaston. (*Journ. of Scient. Instr.*, April 1942, Vol. 19, No. 4, pp. 50–53.)

2134. SILVER ALLOYS AS RESISTANCE MATERIALS [particularly the Tin-free and Low-Tin Silver-Manganese Alloys].—Schulze. (*E.T.Z.*, 26th Feb. 1942, Vol. 63, No. 7/8, pp. 99–100: summary, from *Physik. Zeitschr.*, No. 12, Vol. 42, 1941, pp. 385–389.) For previous work *see* 1721 of 1941.

2135. RESISTANCE MATERIALS WITH LITTLE OR NO NICKEL CONTENT [for War Economy: Copper-Manganese Alloys for Precision Resistances: Chrome-Nickel Alloys with Reduced Nickel & Increased Iron, or Chrome-Aluminium-Iron Alloys, for High Resistances in Communication Engineering: Heating Resistances: etc.].—Hessenbruch. (*E.T.Z.*, 26th Feb. 1942, Vol. 63, No. 7/8, pp. 89–92.)

2136. PROPERTIES OF MONEL METAL AT LOW TEMPERATURES [including Special "K" Monel, completely Non-Magnetic even at These Temperatures, unlike Ordinary Types].—Wiggin & Company. (*Engineering*, 24th April 1942, Vol. 153, p. 340: summary only.)

2137. ERRATUM: A SIMPLE TYPE OF FLAT INDUCTION COIL.—Benedikt. (*Review Scient. Instr.*, March 1942, Vol. 13, No. 3, p. 130.) *See* 1537 of May.

2138. NEW STEELS OF HIGH MAGNETIC POWER [particularly for M.C. Loudspeakers].—Jonas & van Embden. (*Alta Frequenza*, Feb. 1942, Vol. 11, No. 2, pp. 104–105: summary, from *Rev. tech. Philips*, Jan. 1941, Vol. 6, No. 1, p. 8 onwards.)

New steels of the "ticonal" series, and some in which the titanium is replaced by copper, such as Fe 51.5%, Al 8.5%, Ni 14%, Co 23%, and Cu 3%. The weight of a given magnet using the new materials can be reduced to 300 gms instead of 700 for the earlier "ticonal" steels and over 1300 for cobalt steels.

2139. MAGNETOSTRICTION PHENOMENA [Short Survey of Joule, Villari, Barrett, Nagaoka-Honda, Guillemin, Wiedemann, & Wertheim Effects: Applications].—Williams. (*Gen. Elec. Review*, March 1942, Vol. 45, No. 3, pp. 161–163.)

2140. THE MAGNETOSTRICTION OF ALLOYS.—Mes'kin & others. (*Journ. of Tech. Phys.* [in Russian], No. 10, Vol. 11, 1941, pp. 918–935.)

A sensitive device developed by the authors for measuring magnetostriction is described and a detailed report presented on an investigation carried out with the following alloys: Ni-Be, Fe-Mo, Fe-W, Fe-P, Fe-Ti, Fe-Al, and Fe-Si.

STATIONS, DESIGN AND OPERATION

2141. WIRELESS TELEPHONY WITH MOVING MOTOR-CARS [Complete U.S.W. Equipment for Police & Fire Services, etc.].—von Lindern. (*E.T.Z.*, 4th Dec. 1941, Vol. 62, No. 48/49, p. 957; summary, from *Philips tech. Rundschau*, Vol. 5, 1940, p. 323 onwards.)

2142. MORE GEAR FOR CIVILIAN DEFENCE: ALTERNATIVE MODULATORS AND A CARRY-ALL OPERATING TABLE [for 112 Mc/s Equipment].—Grammer. (*QST*, Feb. 1942, Vol. 26, No. 2, pp. 17–20 and 80, 82.) Further development of 1025 & 1159 of April, and back references.

2143. DEFENCE NETWORK CONTROL STATION: 112-MC. EQUIPMENT IN NEW ROCHELLE NET.—Stiles. (*QST*, Feb. 1942, Vol. 26, No. 2, pp. 21–23.)

2144. WESTCHESTER COUNTY'S HAMS ARE PREPARED [for Defence Activities].—Taylor. (*QST*, Feb. 1942, Vol. 26, No. 2, pp. 34–36 and 70.)

2145. FREQUENCY MODULATION: PARTS I–VI [General Nature of System: Advantages & Disadvantages of Frequency- and Phase-Modulated Transmission: Methods of Modulating the Frequency or Phase of a Carrier: the F.M. Receiver: F.M. Reception].—Sturley. (*Electronic Eng:g*, Nov. & Dec. 1941, Jan., Feb., March, & April 1942, Vol. 14, Nos. 165/170.)

2146. ECKERSLEY REPLIES TO CRITICS OF HIS WIRE-BROADCASTING SCHEME.—Eckersley. (*Wireless World*, April 1942, Vol. 48, No. 4, p. 96.) *See* 545 of February and 1547 of May, and back reference.

2147. PROGRAMME SWITCHING AND PRE-SELECTION.—Murphy. (*Bell Lab. Record*, Feb. 1942, Vol. 20, No. 6, pp. 142–148.)

2148. WIRELESS CAPE COD: ALL THAT NOW REMAINS—MEMORIES AND FOUNDATIONS.—Vermilya. (*QST*, Feb. 1942, Vol. 26, No. 2, pp. 32–33.)

GENERAL PHYSICAL ARTICLES

2149. ELECTRON POLARISATION [Positive Result in Attempt to find Polarisation predicted by Mott in Doubly-Scattered Beam of Fast Electrons].—Shull. (*Phys. Review*, 1st/15th Feb. 1942, Vol. 61, No. 3/4, p. 198.) *Cf.* Massey & Mohr, 1524 of 1941, and back reference.

2150. EXTENDED THEORÉMS IN DYNAMICS.—Kasner & Mittleman. (*Science*, 6th March 1942, Vol. 95, pp. 249–250.) With "applications, direct and indirect, in physical situations dealing with interacting particles. . . ." *See* also 1824 of June.

2151. DERIVATION OF THE FREQUENCY RELATION $E_{phot} = h\nu$.—Gruber. (*Ann. der Phys.*, 25th Feb. 1942, Vol. 41, No. 2, pp. 167–171.)

"The hitherto isolated relation between frequency and energy of a photon is derived from simple, securely based fundamental assumptions, and at the same time a hitherto unknown correction is introduced into the relation between absorbed or emitted frequency and the change in the repose energy of the absorbing or emitting atom."

2152. INTERNAL DIAMAGNETIC FIELDS [Calculation of Value, at Nucleus, of Magnetic Field produced by Diamagnetism of Atomic Electrons: in connection with Rabi's Molecular-Beam Measurements].—Lamb. (*Phys. Review*, 1st Dec. 1941, Vol. 60, No. 11, pp. 817–819.)

2153. ELECTROSTATIC CHARGE AS A PROBLEM OF THE ELECTRONIC THEORY OF METALS [Usual Assumption of "Surface Charges" only an Approximation, since Every Charge must extend into Interior of Conductor: Calculation of Charge Distribution for Solid Sphere: Effect of Reducing the Thickness of a Metallic Layer: etc.].—Wolf. (*Ann. der Phys.*, 25th Feb. 1942, Vol. 41, No. 2, pp. 103–116.)

2154. EXPERIMENTS ON CURRENT BRANCHING AND SKIN EFFECT IN SUPERCONDUCTORS [Quantitative Confirmation of von Laue's Theory of

Current Division in Parallel Conductors when Ohmic Resistance has Disappeared].—Justi & Zickner. (*Physik. Zeitschr.*, 15th Sept. 1941, Vol. 42, No. 15/16, pp. 257–273.) For von Laue's paper on the theoretical significance of these results see *Zeitschr. f. Phys.*, No. 7/8, Vol. 118, 1941, pp. 455–460.

2155. REMARKS ON THE THEORY OF SUPERCONDUCTIVITY [Welkers' Theory: Gorter & Casimir's Thermodynamic Relation and Its Application by Kok: New Threshold-Value Measurements].—Sommerfeld. (*Zeitschr. f. Phys.*, No. 7/8, Vol. 118, 1941, pp. 467–472.)

2156. PHOTOPHORESIS AND ITS INTERPRETATION BY ELECTRIC AND MAGNETIC IONS.—Ehrenhaft. (*See* 1889.)

MISCELLANEOUS

2157. THE SOLUTION OF AN INTEGRAL EQUATION OF WIDE APPLICATION in Electron Optics, etc.].—Glaser. (In paper dealt with in 2058, above.)

2158. A NUMERICAL METHOD OF SOLVING INTEGRAL EQUATIONS OF THE LAPLACE TYPE.—Keck & Colby. (In paper dealt with in 2242, below.) For Pipes's paper, referred to here, *see* 3381 of 1939.

2159. OPERATIONAL METHODS OF DEALING WITH CIRCUITS EXCITED BY SINUSOIDAL IMPULSES.—Coulthard. (*See* 1919.)

2160. RELAXATION OSCILLATIONS [Survey].—Graffi. (*See* 1931.)

2161. GENERAL EQUATIONS OF RELAXATION OSCILLATIONS [applicable to Many Mechanical & Other Problems, such as Tacoma Narrows Bridge].—Levinson. (*Science*, 6th March 1942, Vol. 95, Supp. p. 10: summary only.)

2162. "THE CALCULUS OF EXTENSION" [Book Review].—Forder. (*Journ. Franklin Inst.*, Feb. 1942, Vol. 233, No. 2, p. 200.)

2163. THE SUMMATION OF INFINITE HARMONIC SERIES.—Soddy. (*Proc. Roy. Soc.*, Ser. A, 27th Feb. 1942, Vol. 179, No. 979, pp. 377–386.)

2164. FURTHER STUDIES ON SOLVING EIGENVALUE PROBLEMS BY FACTORISATION.—Schrödinger. (*Sci. Abstracts*, Sec. A, Dec. 1941, Vol. 44, No. 528, pp. 365–366.)

2165. "HIGHER MATHEMATICS FOR ENGINEERS AND PHYSICISTS: SECOND EDITION" [Book Review].—Sokolnikoff & Sokolnikoff. (*Journ. Franklin Inst.*, Feb. 1942, Vol. 233, No. 2, pp. 200–201.)

2166. COMMITTEE DECISIONS AND MATHEMATICAL STATISTICS.—Nicol. (*Nature*, 25th April 1942, Vol. 149, p. 473.)

"Much scorn has been poured on Hitler's 'intuition,' but it is not clear that the Allies have used any sounder method of attacking many of their problems . . ."

2167. STATISTICAL CONTROL OF REPETITION WORK.—(*Engineering*, 24th April 1942, Vol. 153, pp. 332–333.) *See* also 2168, below, and for notice of quality-control charts see *Electrician*, 8th May 1942, p. 458: also *see* Rissik, *BEAMA Journ.*, May 1942, pp. 130–133.

2168. STATISTICAL QUALITY CONTROL [the Joint Meeting of 15th April].—(*Engineer*, 24th April & 1st May 1942, Vol. 173, pp. 346–347 and 374–376.) *See* also 1835/6 of June: and for a critical letter *see* p. 370, followed by a reply by Rissik in issue of 8th May, p. 389. *See* also 2167, above.

2169. "STATISTICAL METHODS FOR RESEARCH WORKERS" [Eighth Edition, Revised & Enlarged: Book Review.]—Fisher. (*Nature*, 25th April 1942, Vol. 149, p. 451.)

2170. "ELEMENTS OF STATISTICAL REASONING" [Book Review].—Treloar. (*Science*, 13th Feb. 1942, Vol. 95, p. 172.)

2171. "THE SECOND YEARBOOK OF RESEARCH AND STATISTICAL METHODOLOGY BOOKS AND REVIEWS" [Book Review].—Buros (Edited by).—(*Science*, 27th Feb. 1942, pp. 225–227.)

2172. "THE VARIATE DIFFERENCE METHOD" [of investigating the Random Element in Time Series: Book Review].—Tintner. (*Nature*, 4th April 1942, Vol. 149, pp. 369–370.)

2173. APPLICATIONS OF THE MULTIHARMONOGRAPH TO THE GRAPHICAL SOLUTION OF PHYSICAL AND MATHEMATICAL EQUATIONS, *and* MECHANICAL MEANS FOR THE GRAPHICAL REPRESENTATION AND SOLUTION OF TRANSCENDENTAL FUNCTIONS [with the 30-Element Harmonic Synthesiser].—Brown: Wheeler & Brown. (*Phys. Review*, 1st/15th Feb. 1942, Vol. 61, No. 3/4, p. 205: 1st/15th March, No. 5/6, p. 383: summaries only.)

2174. ELECTRONIC DIFFERENTIATION [Mutual-Inductance Method: Simple Condenser Method: Condenser-with-Feedback Method: Applications for Each Method].—Schmitt & Tolles. (*Review Scient. Instr.*, March 1942, Vol. 13, No. 3, pp. 115–118.)

Among the applications mentioned are automatic computing systems, nerve-impulse transmission research, cathode-ray-tube automatic brilliancy control, galvanometer-damping and loudspeaker-transient control, and automatic machine-tool control. For another recent use of a differentiating circuit *see* Vetterlein, 1710 of June. For previous papers by Schmitt *see* 606 of March and 3734 of 1938.

2175. "PRACTICAL PHYSICS" for Workers in U.S.A. Defence Industries], *and* "PRACTICAL MATHEMATICS" [for Preparation for Technical Branches of the Services: Book Reviews].—(*Nature*, 18th April 1942, Vol. 149, p. 424: 2nd May 1942, p. 486.) The second book is by C. V. Durell.

2176. INVENTION FOR DEFENCE [Hints for Engineers].—Lent. (*Journ. Franklin Inst.*, March 1942, Vol. 233, No. 3, pp. 208–209: summary only.) From the National Inventors' Council, Washington. *Cf.* 1218 of April.

2177. SCIENCE AND THE WAR [Need for Facilities & Encouragement for the Private Inventor].—Hoare. (*Electrician*, 8th May 1942, Vol. 128, p. 446.)

2178. METHOD IN INVENTION: PART III.—Turnbull. (*Distribution of Electricity*, April 1942, Vol. 14, No. 146, pp. 540–541.) Continued from 1221 of April.

2179. THE MOBILISATION OF SCIENCE IN NATIONAL DEFENCE.—Jewett. (*Science*, 6th March 1942, Vol. 95, pp. 235–241.) Delivered at I.R.E. Winter Convention.

2180. ADVISORY COMMITTEE ON SCIENTIFIC PUBLICATIONS [Defence Aspect].—Jewett & others. (*Science*, 13th Feb. 1942, Vol. 95, p. 166.)

2181. EDUCATION AND TRAINING: FURTHER DISCUSSION OF POST-WAR PROBLEM.—Fleming & others. (*Electrician*, 15th May 1942, Vol. 128, pp. 476–479.) Contd. from 1848 of June.

2182. PROGRESS IN ENGINEERING KNOWLEDGE DURING 1941 [Materials, Design, & Application Engineering].—Alger. (*Gen. Elec. Review*, Feb. 1942, Vol. 45, No. 2, pp. 82–110.)

2183. INDUSTRIAL ELECTRONICS [Formation of Electronics Group of Institute of Physics].—Cockcroft & others. (*Journ. of Scient. Instr.*, March 1942, Vol. 19, No. 3, p. 48.) Later news on 1566 of May.

2184. INDUSTRIAL RESEARCH IN THE U.S.S.R. DURING 1941 and IN GERMANY DURING 1941.—(*Journ. Roy. Aeron. Soc.*, May 1942, Vol. 46, No. 377, p. 166 : p. 166 : abstracts only.)

2185. STALIN PRIZES FOR SCIENTIFIC STUDIES for 1941.—(*Nature*, 25th April 1942, Vol. 149, pp. 475–476.)

In "Physics and Mathematics" one of the three first prizes goes to Mandelstam & Papalexi "for studies on the theory of the oscillation and spread of radio waves" (*cf.* 1703 of June and back references).

2186. RUSSIAN FOR SCIENTIFIC WORKERS [Invitation to Groups wishing to learn].—Russell. (*Nature*, 2nd May 1942, Vol. 149, p. 502.) From the Ministry of Information.

2187. CLIMATE IN THE SOVIET UNION.—Wegener. (*Zeitschr. V.D.I.*, 4th April 1942, Vol. 86, No. 13/14, p. 223: summary only.)

2188. WHEREFORE THE AIR ARM SIGNAL CORPS SOLDIER? and FROM AIR SIGNALLER TO COMMUNICATIONS ENGINEER OF THE LUFTWAFFE.—Arndt: Fruh. (*E.T.Z.*, 26th March 1942, Vol. 63, No. 11/12, p. 146: summary only: *T.F.T.*, Sept. 1941, Vol. 30, No. 9, pp. 206–207.)

2189. A SIMPLE AIR-RAID ALARM [Valve Note-Oscillator Unit with Wail controlled by Operator: particularly for Buildings equipped with P.A.].—Hatt. (*Science*, 20th March 1942, Vol. 95, pp. 301–302.)

2190. ENGLISH IN THE SCIENCE COURSE.—Lyon. (*Nature*, 25th April 1942, Vol. 149, pp. 454–456.)

". . . It is not that science is in itself a narrowing study; but it demands so much time, and the standard required for success in examinations is so high, that literary, political, ethical, historical, philosophical and cultural interests all have to give way." *See* also pp. 456–460 and 447–449.

2191. "DEZIMAL-KLASSIFIKATION": Second, Enlarged Edition [Book Review].—(*E.T.Z.*, 20th Nov. 1941, Vol. 62, No. 46/47, p. 944.)

2192. "THE COMPLETE EDITION OF THE WRITINGS OF GUGLIELMO MARCONI" in the Original Italian or translated into Italian: Book Review.—(*La Ricerca Scient.*, Jan. 1942, Vol. 13, No. 1, p. 76.)

2193. "SHORT WAVE WIRELESS COMMUNICATION: FOURTH EDITION," and "SHORT-WAVE RADIO" [Book Reviews].—Ladner & Stoner: Reyner. (*Electrician*, 22nd May 1942, Vol. 128, p. 511 : p. 511.)

2194. "RADIO ENGINEERING HANDBOOK: THIRD EDITION" [Book Review].—Henny (Edited by). (*Proc. I.R.E.*, Nov. 1941, Vol. 29, No. 11, p. 606.)

2195. "STANDARD HANDBOOK FOR ELECTRICAL ENGINEERS: SEVENTH EDITION" [Book Review].—Knowlton (Edited by). (*Journ. Franklin Inst.*, Feb. 1942, Vol. 233, p. 201.)

2196. ON THE READING OF SCIENTIFIC PAPERS [Audience-Enemies Nos. I to VI and Their Elimination].—DuBois. (*Science*, 13th March 1942, Vol. 95, pp. 273–274.)

2197. SQUARE RULED PAPER PROJECTION [Very Simple Way of making Projection Drawings with Ease & Accuracy: including a Suggestion to the Commissioner for Patents].—Boys. (*Journ. of Scient. Instr.*, May 1942, Vol. 19, No. 5, pp. 65–71.)

2198. IS THE WATER COMPARISON ADMISSIBLE? [Failures of the Analogy between Electric & Hydraulic Processes].—Moeller. (*E.T.Z.*, 26th March 1942, Vol. 63, pp. 139–140.)

2199. THE MODEL METHOD FOR INVESTIGATING THE ELECTROMAGNETIC FIELDS OF INDUCTION HEATING SYSTEMS.—Babat. (*Journ. of Tech. Phys.* [in Russian], No. 5, Vol. 11, 1941, pp. 443–455.)

In dealing with h.f. (above 10^4 c/s) induction heating of metallic objects it is important to know the distribution of the electromagnetic field around the object. It is proposed to achieve this by studying the currents distribution in an electrolytic bath into which models of the inductor and the object, made of a dielectric material, are immersed.

2200. THE OPTIMUM FREQUENCY FOR THE TOTAL HEATING OF HOLLOW CYLINDERS IN AN INDUCTION FURNACE.—Babat. (*Journ. of Tech. Phys.* [in Russian], No. 5, Vol. 11, 1941, pp. 486–490.)

It is pointed out that in the paper by Rodigin (*ibid.*, Vol. 10, 1940, p. 1128), in all other papers on the subject, and also in the original patent itself (by Dr. Erich Huth), it is assumed that the frequency of the heating current should satisfy the condition $R = \omega L$, where R and L are the resistance and inductance respectively of the cylinder. It is shown, however, that this condition should be $\sqrt{3} . R = \omega L$.

2201. THE HIGH-FREQUENCY INDUCTION FURNACE [including Spark & Valve Generators and the Proposed Use of the "Arc Valve," Variant of Poulsen Arc, burning in Inert Gas: Powers up to 50 kw, Frequencies to 100 kc/s].—Wall. (*Engineer*, 20th March 1942, Vol. 173, pp. 242–243.) No. III of a series.

2202. MEASUREMENT OF THE REFRACTIVE INDEX OF WATER TREATED WITH POLARISED DI-ELECTRICS [in connection with Piccardi's Explanation of Action of Abbot-Close "Electronic Bulb" for Prevention of Boiler Scale].—Frongia. (*La Ricerca Scient.*, Nov. 1941, Vol. 12, No. 11, pp. 1161–1168.)

2203. COLOUR IN SOUND: A STUDY FROM THE PSYCHOLOGICAL VIEWPOINT.—Trist. (*Electronic Eng:g*, Dec. 1941, Vol. 14, No. 166, pp. 547–548.) *Cf.* p. 546, and 2313 of 1941.

2204. "ELEKTROPHYSIOLOGIE" [Vol. I: Book Review].—Schaefer. (*Naturwiss.*, 3rd April 1942, Vol. 30, No. 14/15, p. 228.)

2205. BIOELECTRIC RESEARCH APPARATUS [Complete Amplifying & Three-Trace Cathode-Ray-Tube System].—Goldberg. (*Proc. I.R.E.*, Dec. 1941, Vol. 29, No. 12, pp. 664–665: summary only.)

2206. ABSORPTION MEASUREMENTS ON BIOLOGICAL LIQUIDS (BLOOD) IN THE 50–100 CM WAVE-RANGE.—Gsell. (*See* 2014.)

2207. ON ACTIVATION WAVES ALONG PASSIVE IRON WIRES [immersed in Nitric Acid, and taken as a Physical-Chemical Model for the Study of Action-Current Propagation along Nerves: Action Currents as Origin, Not Accompaniment, of Nervous Impulses: New Results removing Difficulties in Theory].—Bonhoeffer & Renneberg. (*Zeitschr. f. Phys.*, No. 7/8, Vol. 118, 1941, pp. 389–400.)

2208. NERVE FIBRE IMPEDANCE [and the Calculation of Its Characteristics by Submarine-Cable Theory, from End Measurements: an Approximate Equivalent Circuit].—Cole. (*Phys. Review*, 1st/15th March 1942, Vol. 61, No. 5/6, p. 391: summary only.)

2209. NEW EXPERIMENTS ON SEMICONDUCTORS AND ON THEIR RÔLE IN ELECTROPHYSIOLOGY [Oscillographic Investigation of Two or More Semiconductors in Contact suggests Physical Interpretation of Nerve & Muscle Fibre].—Reboul. (*Comptes Rendus* [Paris], 8th Sept. 1941, Vol. 213, No. 10, pp. 344–346.)

2210. THE UNIT QUANTITIES OF VISION AND TOUCH SENSATIONS.—Lifshits. (*Journ. of Tech. Phys.* [in Russian], No. 6, Vol. 11, 1941, pp. 555–560.)

Continuing previous work (2445 of 1941, and the present journal, Vol. 10, 1940, p. 1630), in which the minimum change in hearing sensation was determined, a similar investigation is carried out for vision and touch sensations (*see* also 2314 of 1941). The main conclusion reached is that these sensations (and probably all other sensations) grow in equal steps, which on a decibel scale are equal to 2 db.

2211. "OPTISCHE MESSUNGEN DES CHEMIKERS UND DES MEDIZINERS" [Third Edition: Book Review].—Löwe. (*Zeitschr. f. tech. Phys.*, No. 1, Vol. 23, 1942, p. 27.)

2212. MITOGENETIC RAYS [Survey of 18 Years' Work in U.S.S.R.: Importance in Cancer Diagnosis & in Treatment of Certain Mental Disorders].—Mariinsky. (*Sci. & Culture* [Calcutta], June 1941, Vol. 6, No. 12, pp. 690–693.) For work in other countries *see*, for example, 376 & 1335 of 1936 and 745/6 of 1938.

2213. STATISTICAL DISTRIBUTION OF IMPEDANCE ELEMENTS IN BIOLOGICAL SYSTEMS.—Weinberg & Householder. (*Phys. Review*, 1st/15th Jan. 1942, Vol. 61, No. 1/2, p. 102: summary only.)

2214. THE FINE STRUCTURE OF DIATOMS ACCORDING TO OBSERVATIONS AND STEREOSCOPIC RECORDINGS BY THE ELECTRON MICROSCOPE.—Müller & Pasewaldt. (*Naturwiss.*, 23rd Jan. 1942, Vol. 30, No. 4, pp. 55–60.) Müller's paper on the stereoscopic technique here employed will be published shortly.

2215. NEW ELECTRON-MICROSCOPE TECHNIQUE BROADENS STUDIES OF GRAIN STRUCTURE OF METALS [by Use of Exact Replica of Metal's Grain Structure in Collodion].—R.C.A. Laboratories. (*Journ. Franklin Inst.*, Feb. 1942, Vol. 233, No. 2, p. 180.) *Cf.* 2933 & 3594 of 1941, and 2216, below.

2216. ELECTRON-MICROSCOPIC EXAMINATION OF SURFACES BY THE IMPRESSION PROCESS.—Mahl. (*See* 2065.)

2217. "DAS ÜBERMIKROSKOP ALS FORSCHUNGSMITTEL" [Supermicroscope as Research Tool: Book Review].—Siemens & Halske. (*Zeitschr. V.D.I.*, 18th April 1942, Vol. 86, No. 15/16, p. 256.) Particularly biological-medical and dust research.

2218. THE X-RAY MICROSCOPE.—Bragg. (*Nature*, 25th April 1942, Vol. 149, pp. 470–471.)

2219. X-RAY ABSORPTION STRUCTURE AS A TOOL IN PHYSICS AND CHEMISTRY.—Stephenson. (*Journ. Applied Phys.*, March 1942, Vol. 13, No. 3, pp. 142–146.)

2220. THE DETERMINATION OF RADIUM DEPOSITS WITH COUNTER-TUBE DEVICES [and the Design of Highly Sensitive, Directive, & Portable Counters].—Dreblow. (*Zeitschr. f. Instr:kunde*, Feb. 1942, Vol. 62, No. 2, pp. 60–66: to be contd.)

2221. A PRECISION METHOD OF MEASURING GEIGER COUNTER RESOLVING TIMES [primarily developed for Argon-Alcohol Counters with Small (10^{-4} s) Resolving Times, where Usual Methods are Unsatisfactory], *and* A MODIFICATION OF THE BARNES GEIGER-MÜLLER COUNTER.—Beers. Wang & others. (*Review Scient. Instr.*, Feb. 1942, Vol. 13, No. 2, pp. 72–76: p. 81.)

2222. COUNTER-TUBE AMPLIFIERS [Short Survey].—Jullfs. (*E.T.Z.*, 20th Nov. 1941, Vol. 62, No. 46/47, p. 928.) Particularly the work of Trost (2301 & 2016 of 1941) and Kolhörster & Weber (1021 of 1941). The bibliography in Johnson's paper (1105 of 1939) is specially mentioned.

2223. THE BEHAVIOUR OF PROPORTIONAL COUNTER AMPLIFICATION AT LOW VOLTAGES.—Rose & Ramsey. (*Phys. Review*, 1st/15th Feb. 1942, Vol. 61, No. 3/4, pp. 198–199.)

2224. SELF-QUENCHING GEIGER-MÜLLER COUNTERS.—Weisz. (*Phys. Review*, 1st/15th March 1942, Vol. 61, No. 5/6, p. 392: summary only.) Cf. Ramsey, Stever, 1850 of June.

2225. TEMPERATURE COEFFICIENTS IN SELF-QUENCHING COUNTERS: Trouble avoided by Use of Suitable Gases.—Korff & others. (*Review Scient. Instr.*, March 1942, Vol. 13, No. 3, p. 127.)

2226. THE QUANTUM OUTPUT OF PHOTOCELLS OF VARIOUS TYPES.—Gurevich. (*See* 2011.)

2227. THE AUGETRON MULTI-STAGE ELECTRON MULTIPLIER and Applications.—van den Bosch. (*See* 1973.)

2228. THE SPECTRAL SENSITIVITY DISTRIBUTION OF SELENIUM BARRIER-LAYER CELLS, and the Influence of Cadmium Admixtures.—Eckart & Schmidt. (*See* 2012.)

2229. THE SELENIUM BARRIER-LAYER PHOTOCELL.—Veszi. (*See* 2013.)

2230. ON PHOTOMETRY WITH THE PHOTOELECTRIC CELL: Expression for Steady Current passed by Cells, yielding 1 Lumen Values within a Very Few Percent of Measured Values.—Rogers. (*Phys. Review*, 1st/15th March 1942, Vol. 61, No. 5/6, pp. 394–395: summary only.)

2231. THE "LIGHT WATCHMAN" Photocell Device for Shops, etc., focused on Street Lights (which are turned off at Air-Raid Warning).—(*Gen. Elec. Review*, March 1942, Vol. 45, No. 3, p. 186.)

2232. THE ELECTRIC EYE: Some Examples of Photocell Control, including the Westinghouse "Phantocycle" & the Application of the Same Principle to Control of Giant Searchlights, etc.—Lion. (*Sci. & Culture*, Calcutta, April 1941, Vol. 6, No. 10, pp. 566–569.)

2233. CONTINUOUSLY-ACTING CRATER-FOCUSING ADJUSTMENT FOR ARC LAMPS or Solar Reflectors required to follow Movement of Sun: Use of Urdox Temperature-Dependent Resistance directly controlling Driving Motor.—Straubel. (*Zeitschr. f. tech. Phys.*, No. 11, Vol. 22, 1941, pp. 283–287.)

2234. RÔLE OF PHOTOGRAPHY IN THE DETECTION AND MEASUREMENT OF RADIATION.—Davies. (*Nature*, 18th April 1942, Vol. 149, pp. 430–432.) By the Director of Research, Kodak Ltd.

2235. "PHOTOGRAPHIC EMULSION TECHNIQUE" [Book Review].—Thorne Baker. (*Journ. Franklin Inst.*, March 1942, Vol. 233, No. 3, pp. 289–290.)

2236. "KODAK DATA BOOKS OF APPLIED PHOTOGRAPHY" [Book Review].—(*Journ. of Scient. Instr.*, March 1942, Vol. 19, No. 3, p. 47.)

2237. THE "DIFFUSING" EFFECT OF FOG.—Middleton. (*Journ. Opt. Soc. Am.*, March 1942, Vol. 32, No. 3, pp. 139–143.)

2238. THE RANGE OF LIGHT SIGNALS IN DAYLIGHT.—Schonwald. (*Zeitschr. f. Instr.kunde*, Jan. 1942, Vol. 62, No. 1, pp. 35–36: summary only.)

2239. ON THE OPTICAL TRANSPARENCY OF QUARTZ GLASS [like Crystalline Quartz down to 200 mμ, but Strongly Absorbent below this Wavelength: Practical Consequences].—Schraub. (*Physik. Zeitschr.*, 20th Feb. 1942, Vol. 43, No. 3/4, pp. 64–69.)

2240. GROUND INVESTIGATION AND EARTHING MEASUREMENT [Survey, including the Question of "Lightning Nests," the Use of the Siemens Earthing Meter, Abnormal Geological Conditions, etc.].—Pfiffner & Marsch. (*E.T.Z.*, 20th Nov. & 4th Dec. 1941, Vol. 62, Nos. 46/47 & 48/49, pp. 919–923 & 950–953.)

2241. DIFFERENTIAL METHOD OF ELECTRICAL PROSPECTING OF THE SUBSOIL.—Diénert. (*Comptes Rendus*, Paris, 3rd Nov. 1941, Vol. 213, No. 18, pp. 625–627.)

2242. THE DEPTH DEPENDENCE OF EARTH CONDUCTIVITY UPON SURFACE POTENTIAL DATA treated by Perturbation Method.—Keck & Colby. (*Journ. Applied Phys.*, March 1942, Vol. 13, No. 3, pp. 179–188.) Cf. 2158.

2243. ON THE POSSIBILITY OF SUBSOIL PROSPECTING BY THE DEVIATIONS OF THE VERTICAL.—Aquilina. (*La Ricerca Scient.*, Nov. 1941, Vol. 12, No. 11, pp. 1126–1131.)

2244. A DISPERSION CONCENTRATOR TO IMPROVE OIL DEPOSIT LOCATION BY THE SEISMIC METHOD [corresponding to Correction for Chromatic Aberration in a Lens].—Hoover. (*Sci. News Letter*, 7th March 1942, Vol. 41, No. 10, p. 148.)

2245. THE ENERGY PROBLEM IN COMMUNICATION TRANSMISSIONS by Wire & Wireless [Energy Distribution in Space (e.g. along a Transatlantic Telephone Cable): Variations in Time (1 : 2500 for Different Telephone Users, 1 : 10^6 for Symphony Orchestra): Interference by External Sources, etc.].—Waldow. (*E.T.Z.*, 20th Nov. 1941, Vol. 62, No. 46/47, pp. 913–919.)

2246. MUTUAL INTERFERENCE BETWEEN WIRED AND WIRELESS RADIO SERVICES.—Moebes. (See 1056.)

2247. INTERFERENCE IN LONG-DISTANCE CABLES DUE TO A.C. RAILWAY SYSTEMS.—Wild & Ochem. (E.T.Z., 4th Dec. 1941, Vol. 62, No. 48/49, p. 962: summary only.)

2248. MULTI-BAND CARRIER-FREQUENCY TELEPHONY OVER OVERHEAD LINES [Contrast between European & American Development: the German MG System and Its Belgrade/Germany Service].—Cornelsen. (E.T.Z., 30th Jan. 1941, Vol. 62, No. 5, pp. 85–92.) Cf. 1386 of May.

2249. 12-CHANNEL CARRIER EQUIPMENT IN THE GÖTEBORG-MALMÖ CABLE.—Nordström. (Elec. Communication, No. 2, Vol. 20, 1941, pp. 80–87.)

2250. TELEMETERING OF TEMPERATURE AND VACUUM VALUES FOR THE CENTRAL SUPERVISION OF UNATTENDED TRANSFORMER AND RECTIFIER STATIONS.—Klinker. (E.T.Z., 26th Feb. 1942, Vol. 63, No. 7/8, p. 96: summary, from Siemens-Zeitschrift.)

2251. GETTING THE MOST FROM AUTOMATIC CONTROL [with Examples in Temperature & p_H Control].—Peters. (Sci. Abstracts, Sec. B, Dec. 1941, Vol. 44, No. 528, p. 242.)

2252. ELECTRONIC CONTROL OF THE VOLTAGE AND FREQUENCY OF AN ALTERNATOR DRIVEN BY A D.C. MOTOR [with Tests on a 1 kVA Set: ultimately for a 150 kVA Set for Supply of Galileo Ferraris Institute].—Pinciroli & Francini. (Alta Frequenza, Oct. 1941, Vol. 10, No. 10, pp. 581–588.)

2253. TWO BRIDGE-CONTROLLED THYRATRON THERMOSTATS.—Bancroft. (Review Scient. Instr., Jan. 1942, Vol. 13, No. 1, pp. 24–27.) For corrections see March issue, p. 114.

2254. "TEMPERATURE MEASUREMENT AND CONTROL" [Book Review].—Weber. (Journ. Franklin Inst., Feb. 1942, Vol. 233, No. 2, pp. 199–200.)

2255. THE APPLICATION OF ELECTRONICS TO INDUSTRY: I—SAFETY DEVICES: II—CONTROL DEVICES: III—MEASUREMENT [with Bibliographies in Each Part].—(Electronic Eng'g, Sept., Oct., & Nov. 1941, Vol. 14, Nos. 163, 164, & 165, pp. 303–304, 444–445, & 492–493.) For lift controls by photocells see Nov. issue, No. 165, p. 500.

2256. ELECTRICAL MEASUREMENT OF SHORT TIMES WITH CONDENSER AND THYRATRON [Accuracy within ± 10% for Times down to 50 μs: for Investigations on Projectiles, Blasting, etc.].—Püschel. (Arch. f. Tech. Messen, April 1941, Part 118, V142-5, Sheet T47: summary in E.T.Z., 12th March 1942, Vol. 63, No. 9/10, p. 119.)

2257. APPLICATION OF THE METHOD OF DEGASSING BY ELECTRON BOMBARDMENT TO THE ESTIMATION OF THE AMOUNTS OF THE GASES CONTAINED IN NICKEL-CHROMIUM STEELS.—Moreau. (Comptes Rendus [Paris], 24th Nov. 1941, Vol. 213, No. 21, pp. 732–734.)

2258. THE DETERMINATION OF THE THICKNESS OF GALVANICALLY DEPOSITED COATINGS BY SPECTRUM ANALYSIS.—Lauenstein & Passer. —(E.T.Z., 26th March 1942, Vol. 63, No. 11/12, p. 164: summary only.) Cf. 1842 of June.

2259. EFFECT OF MAGNETIC-FIELD DISTRIBUTION IN MAGNETIC INSPECTION [Method avoiding Saturation, using Two Search Coils, each with Integrating Valve Amplifier, feeding Two-Element Oscillograph].—Fuller. (Journ. Roy. Aeron. Soc., May 1942, Vol. 46, No. 46, No. 377, p. 151: abstract only.)

2260. DETERMINATION OF THE STRAINS IN MATERIALS AND INVESTIGATION OF MECHANICAL VIBRATION PROCESSES WITH STRIP- AND RING-TYPE [Resistance-Variation] GAUGES. —Theis. (Zeitschr. f. tech. Phys., No. 11, Vol. 22, 1941, pp. 273–280.)

2261. DIRECT-WRITING OSCILLOGRAPH [with from 1 to 20 Recording Elements: for Aeroplane-Vibration Analysis, etc.: the Garceau Velograph].—Electro-Medical Laboratory. (Review Scient. Instr., March 1942, Vol. 13, No. 3, p. 131.) See also 3601 of 1941 and 704 of March.

2262. KNOCK RATING BY ACOUSTICAL METHODS [Piezoelectric Pick-up & C.-R. Oscillograph]. —Funk. (Journ. Roy. Aeron. Soc., May 1942, Vol. 46, No. 377, pp. 157–158: abstract only.)

2263. KNOCK INDICATOR USING THE PRESSURE-ACCELERATION PROCESS [developed by DVL, with Their Special Quartz Indicator].—Lichtenberger. (Zeitschr. V.D.I., 21st March 1942, Vol. 86, No. 11/12, pp. 181–183.)

2264. THE REMOTE RECORDING OF INDICATOR DIAGRAMS FOR INTERNAL-COMBUSTION MOTORS [so that One Fixed Central Plant can be actuated by Cable from Numerous & Dispersed Testing Shops].—Lichtenberger. (E.T.Z., 26th March 1942, Vol. 63, No. 11/12, pp. 134–139.) [From the DVL: for their knock indicator see 2263, above.]

2265. IGNITION-DELAY MEASUREMENT in connection with Diesel-Engine Fuels WITH PHOTOCELLS IN VARIOUS REGIONS OF THE SPECTRUM and Comparison with Piezoelectric-Indicator Results.—Bisang & Stallechner. (Zeitschr. V.D.I., 18th April 1942, Vol. 86, No. 15/16, pp. 241–244.)

2266. PORTABLE DYNAMIC BALANCING UNIT [for Rotating Machines assembled by Mass Production Methods].—Westinghouse. (Review Scient. Instr., March 1942, Vol. 13, No. 3, p. 132.) Cf. 1876 of June, from the same firm.