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Editorial

The Propagation of Electromagnetic Waves in Water

ALTHOUGH not a very hopeful line of research, the possibility of discovering some unsuspected property of water whereby ultra-short waves of some critical length might be transmitted over considerable distances was sufficient justification for a careful exploration of the problem such as was recently described in *Hochfrequenztechnik*.* It is well known that water has a very different absorption coefficient for light of different wavelengths, the absorption of green light being almost negligible compared with that of either red or violet. It can be said at once that the results of all the experiments confirmed the conclusion that at no wavelength is there any possibility of obtaining a reasonable range of transmission. Even green light, to which water is so strikingly transparent, experiences a so much greater absorption than in air that a ray which would be visible over 6 kilometres in air has a range in water of only 300 metres.

The experiments with ultra-short waves were made in the public swimming bath in Jena after preliminary tests had been made in troughs and tanks. The wavelengths employed were 16 cm., 1.3 m., and 7.2 m.; these are the equivalent wavelengths in air, those in the water being only a ninth of these ($\lambda \propto 1/\sqrt{K}$), viz. 1.78 cm., 14 cm., and 80 cm. For the shortest waves the generator was a 4-sector magnetron; for the others ordinary valve generators were employed, the power being transmitted to the radiating dipole by a concentric line. The receiving dipole was similarly connected to the detector and amplifier, the output of which was measured on a Weston outputmeter. Great care had to be taken to ensure that the receiver was not affected by waves transmitted through the air; elaborate screening was necessary and as much as possible of the apparatus was immersed in the water in watertight metal cases. If the experiments had held out any promise of a reasonable range of transmission, trouble would undoubtedly have been experienced due to reflection from the walls, floor, and water surface, but as it was, the absorption was always so rapid that little or no trouble was experienced from this cause. For the same reason little improvement was found to result from the use of metal reflectors, even a properly focused parabolic mirror giving little increase in the range; no more in fact than a plane sheet reflector. Tests showed that the outer parts of any reflector were useless because the waves were so attenuated before reaching them. The best distance between the transmitting dipole

* K. Brüne, September, 1937, p. 73.

and the reflector was always found to be 0.2 of the wavelength in water.

As examples of the results obtained, assuming the water to have a specific resistance of 1,000 ohms per cm. cube, the distance for a reduction of the intensity (power) to 10^{-6} is 8.74 cm. if $\lambda = 100$ cm.; 8.2 metres if $\lambda = 1$ m.; 250 m. if $\lambda = 10$ m.; 667 m. if $\lambda = 100$ m.; all the wavelengths being those in air. With such rapid attenuation little is gained by increasing the sensitivity of the receiver, an increase of a thousandfold only doubling the range.

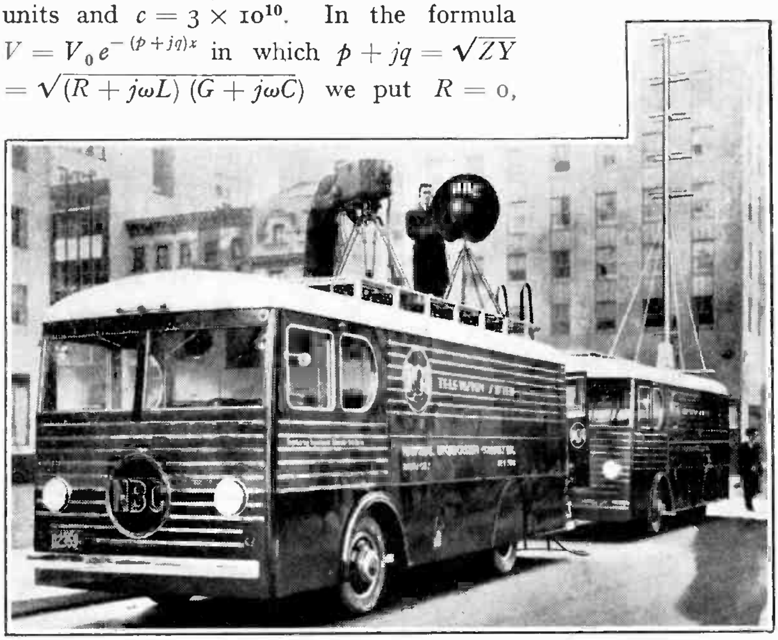
As we have previously shown, the attenuation of such spherically radiated waves can be calculated very simply from the ordinary telephone transmission formulae by assuming the "line" to consist of two very obtuse cones placed apex to apex with the generator between the apices. The currents will be radial and the magnetic flux will be in concentric circles, the length of path being $2\pi x$ where x is the distance from the source. If the angle between the cones is θ, it is easily seen that the inductance per cm. $L=2\theta$, the capacitance $C = \frac{K}{2\theta}\cdot\frac{1}{c^2}$ and the leakance $G = \frac{2\pi}{\theta}\sigma$, all in e.m. units, where K is the dielectric constant, σ the conductance in e.m. units and $c = 3 \times 10^{10}$. In the formula $V = V_0 e^{-(p+jq)x}$ in which $p + jq = \sqrt{ZY} = \sqrt{(R+j\omega L)(G+j\omega C)}$ we put $R = 0$, since we assume our "lines" to be perfect conductors, and we then find that $p=\sqrt{\left(\frac{\omega L}{2}\sqrt{\omega^2C^2+G^2}-\frac{\omega^2LC}{2}\right)}$. If we consider the attenuation of the power and not of the voltage, the index will be $2p$, and substituting the above values for L, C and G we have

$$2p=\frac{4\pi}{\lambda}\sqrt{\tfrac{1}{2}\{\sqrt{1+\gamma^2}-1\}} \text{ where } \gamma=2c\lambda\sigma/\sqrt{K}$$

and λ is the wavelength in the water or other medium in cm. The results of the experiments agree with the values calculated by this formula for frequencies below about 30×10^6, i.e., for wavelengths in air exceeding 10 metres. At higher frequencies the absorption is greater than that calculated by this formula owing to an additional type of conductivity known as dipole-conductivity which becomes important at these frequencies. The index $2p$ calculated above has to be increased by an amount independent of σ but proportional to the square of the frequency. For water this additional term is equal to $1.58/\lambda^2$ where λ is the wavelength in air in metres.† As λ is progressively decreased this new term becomes increasingly important as compared with the term $2p$ calculated above. This was confirmed by the experiments made at Jena the results of which were in close agreement with the calculated values.

G. W. O. H.

† M. Wien, *Physik. Zeitschr*, 37, (1936), p. 869.



Two vans are used in America by the National Broadcasting Company for experimental television outside broadcasts and are connected by a coaxial cable. One van contains a transmitter with a "trolley" aerial, and the other the camera equipment with the necessary cameras and microphones.

Design of Audio-Frequency Input and Intervalve Transformers*

By J. G. Story

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1. Introduction

IT is not intended in the present article to discuss all the theoretical considerations governing the performance of audio-frequency input and intervalve transformers. Several writers, notably Messrs. Willans[1], Koehler[2], and the late Dr. Dye[3] have already dealt with this aspect of the subject fairly conclusively.

Rather is it intended to deal with a method of practical design which reduces the labour of calculations to a minimum and takes account of the introduction of modern core materials. Furthermore, although much of the matter dealt with is applicable to the design of transformers carrying direct current, no attempt is made to consider specifically the design of this class of transformer.

For a given performance the problems which beset the audio-frequency transformer designer are, first, the calculation of the constants of the transformer which are necessary to fulfil the requirements of performance and, secondly, the determination of the method by which these constants are to be realised in practice.

In general the design of an audio-frequency transformer may be approached from two angles, namely, from the point of view of the performance at the lower frequencies, that is, from, say, 50 to 1,000 c/s, and from the standpoint of the operation over the upper audio-frequency band of 1 to about 10 kc/s; it remains for the designer to correlate the two designs which satisfy the conditions of performance in the two frequency bands.

In the lower frequency band some of the constants have a negligible effect upon the operation of the transformer, and can therefore be neglected. Notable amongst these are, of course, the leakage inductance, winding and mutual capacitances; whereas at the higher frequencies it is well known that these constants are all important.

2. The Performance over the Upper Frequency Band

Let the performance of an input or intervalve transformer over the higher frequency band be considered first.

It is generally recognised that for all practical purposes the transformer may be replaced at these frequencies by the circuit shown in Fig. 1. In this figure E represents the source e.m.f., R_1—the source impedance plus the transformer copper losses, both E and R_1 being transferred to the secondary, L_{LS} the secondary leakage inductance, C—the effective secondary capacitance of the transformer plus the input capacitance of the following valve, R_2—the secondary load resistance including the core and dielectric losses and V_2—the voltage developed across the secondary terminals.

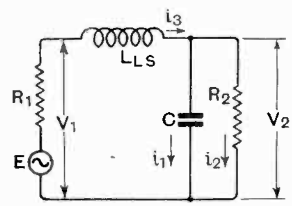


Fig. 1.

The capacitance C may also include a condenser to represent the effect of mutual capacitance, although the present tendency is to incorporate electrostatic screening between the primary and secondary windings,

* MS. accepted by the Editor, June, 1937.

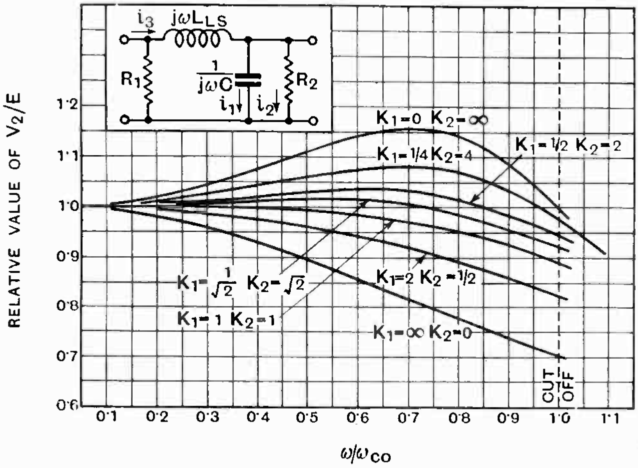
[1] "Low Frequency Intervalve Transformers." P. W. Willans, M.A. *Journ.* (*Wireless Section*), *I.E.E.*, September, 1926.

[2] "The Design of Transformers for Audio-frequency Amplifiers with Pre-assigned Characteristics." C. Koehler. *Proc. Inst. Rad. Eng.*, December, 1928.

[3] "The Performance and Properties of Telephonic Frequency Intervalve Transformers." D. W. Dye. *Wireless Engineer*, Vol. I, page 691 *et seq.*

which will reduce the mutual capacitance to negligible proportions.

In an actual transformer, the winding and



mutual capacitances, leakage inductance and dielectric and copper losses are, of course, all inextricably bound up together. The separation of these constants is not therefore rigorously correct. However, the theory becomes too involved if consideration is given to the strict distribution of the transformer constants.

Referring then to Fig. 1, it is desired to know the ratio of V_2/E at any frequency for which the network is applicable.

Now $i_3 = i_1 + i_2 = j\omega C V_2 + \frac{V_2}{R_2}$

or $$\frac{E}{V_2}\cdot\frac{1}{R_1} = \frac{1}{R_1} + \frac{1}{R_2} - \frac{\omega^2 L_{LS}\,.\,C}{R_1} + j\omega\left(C + \frac{L_{LS}}{R_1 R_2}\right) \quad .. \quad (1)$$

Fig. 2.—*If* $j\omega_{co}L_{LS} = \frac{1}{j\omega_{co}C} = R_2 = R_1/K_1$.

Then $V_2/E \propto$

$$\sqrt{\left[\frac{1}{1 + \frac{(\omega/\omega_{co})^4 + (\omega/\omega_{co})^2(K_1^2 - 1)}{(K_1 + 1)^2}}\right]}.$$

If $j\omega_{co}L_{LS} = \frac{1}{j\omega_{co}C} = R_1 = R_2/K_2$.

Then $V_2/E \propto$

$$\sqrt{\left[\frac{1}{1 + \frac{(\omega/\omega_{co})^4 + (\omega/\omega_{co})^2(1/K_2^2 - 1)}{(1/K_2 + 1)^2}}\right]}.$$

Squaring both sides of equation (1) :—

$$\left(\frac{E}{V_2}\cdot\frac{1}{R_1}\right)^2 = \left(\frac{1}{R_1} + \frac{1}{R_2}\right)^2 + \frac{\omega^4 L_{LS}^2 C^2}{R_1^2} - \frac{2\omega^2 L_{LS} C}{R_1}\left(\frac{1}{R_1} + \frac{1}{R_2}\right) + \omega^2 C^2 + \ldots \ldots \frac{\omega^2 L_{LS}^2}{R_1^2 R_2^2} + \frac{2\omega^2 L_{LS} C}{R_1 R_2}.$$

If $\omega = 0$

$$\left(\frac{E}{V_2}\cdot\frac{1}{R_1}\right)^2 = \left(\frac{1}{R_1} + \frac{1}{R_2}\right)^2$$

So if $\omega \neq 0$,

$$\frac{V_2}{E} = \frac{1}{R_1}\sqrt{\frac{1}{1 + \frac{\omega^4 L_{LS}^2 C^2}{\left(\frac{1}{R_1} + \frac{1}{R_2}\right)^2}\cdot\frac{1}{R_1^2} + \frac{\omega^2}{\left(\frac{1}{R_1} + \frac{1}{R_2}\right)^2}\left\{C^2 + \frac{L_{LS}^2}{R_1^2 R_2^2} - \frac{2L_{LS}C}{R_1^2}\right\}}} \quad .. \quad .. \quad (2)$$

and the voltage across L_{LS}

$$= j\omega L_{LS} V_2\left(j\omega C + \frac{1}{R_2}\right)$$

so that $V_1 = j\omega L_{LS} V_2\left(j\omega C + \frac{1}{R_2}\right) + V_2$

and $$E = V_1 + V_2 R_1\left(j\omega C + \frac{1}{R_2}\right) = j\omega L_{LS} V_2\left(j\omega C + \frac{1}{R_2}\right) + V_2 + V_2 R_1\left(j\omega C + \frac{1}{R_2}\right)$$

Obviously equation (2) is too cumbersome for practical design purposes and means must be sought to simplify the operation of substitution. A convenient way of accomplishing this is to fix arbitrarily the relationship of two or three of the four adjustable constants L_{LS}, C, R_1 and R_2 to one another and observe the effect of varying the remaining constant or constants.

Suppose, for instance, it is assumed that the reactances of L_{LS} and C are equal and numerically identical with the value of the resistance R_1. Then if the angular frequency at which these assumptions occur is denoted by ω_{co},

$$\omega_{co}L_{LS} = \frac{1}{\omega_{co}C} = R_1$$

Let $R_2/R_1 = K_2$

It follows that, if R_1 and R_2 are independent of frequency, at any frequency $\omega/2\pi$

$$\frac{V_2}{E} = \frac{1}{R_1}\sqrt{\frac{1}{1 + \frac{(\omega/\omega_{co})^4 + (\omega/\omega_{co})^2(1/K_2{}^2 - 1)}{(1/K_2 + 1)^2}}} \quad \ldots \quad \ldots \quad (3)$$

Similarly, if

$$\omega_{co}L_{LS} = \frac{1}{\omega_{co}C} = R_2 \text{ and } R_1/R_2 = K_1,$$

$$\frac{V_2}{E} = \frac{1}{R_1}\sqrt{\frac{1}{1 + \frac{(\omega/\omega_{co})^4 + (\omega/\omega_{co})^2(K_1{}^2 - 1)}{(K_1 + 1)^2}}} \quad \ldots \quad \ldots \quad (4)$$

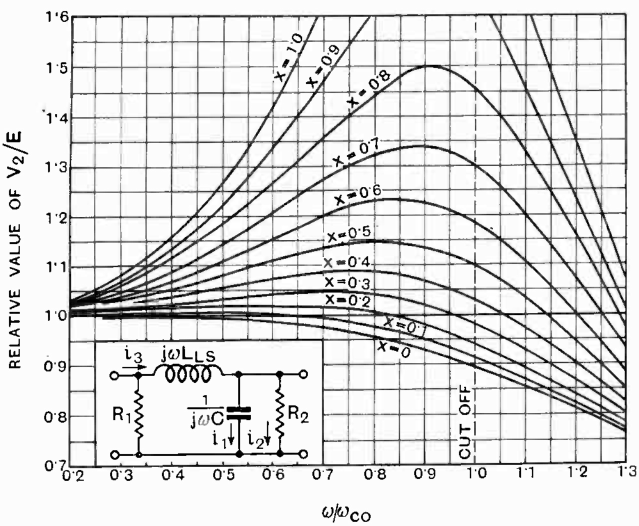


Fig. 3.—*If* $j\omega_{co}L_{LS} = \frac{1}{j\omega_{co}C} = 2R_1R_2/R_1 + R_2$

and $\frac{R_1}{R_2} = \frac{K_1}{K_2} = \frac{1 - x}{1 + x}$

Then $V_2/E \propto$

$$\sqrt{\left[\frac{1}{1 + \left(\frac{\omega}{\omega_{co}}\right)^4\left(\frac{1+x}{2}\right)^2 + \left(\frac{\omega}{\omega_{co}}\right)^2\left(\frac{x^4}{4} - x^2 - x\right)}\right]}$$

When x =	*then* K_1 =	*and* K_2 =
0	1.0	1.0
0.1	0.91	1.11
0.2	0.833	1.25
0.3	0.77	1.43
0.4	0.715	1.67
0.5	0.667	2.0
0.6	0.625	2.5
0.7	0.588	3.33
0.8	0.555	5.0
0.9	0.526	10.0
1.0	0.5	∞

The relationships (3) and (4) present the variation of V_2/E with frequency in a much more workable form than equation (2) and a set of curves may readily be plotted for the assumed relationships between the transformer constants, assigning various values to K_1 and K_2.

Since the relationship of equation (4) may be obtained by substituting K_1 for $1/K_2$ in equation (3) only one set of curves is necessary for the two conditions. These are shown in Fig. 2.

An infinite number of other equations giving the solution of V_2/E may be written in a similar manner, taking different relationships between the four transformer constants each time, but it is found in practice that five or six sets of curves are sufficient to satisfy most of the conditions met with in design.

Some sets of curves which have been found to be most used in practice are shown in Figs. 3, 4, 5, 6 and 7.

Given a suitable set of curves and assuming that the constants of a transformer can be accurately forecasted, it is possible to predetermine the frequency response of the transformer in conjunction with its terminating impedances to within ± 0.25 db. in normal cases.

As an illustration of the application of the curves that have been derived, suppose that for a tentative design of a transformer to work between 500 and 50,000 ohms matched impedances the secondary leakage inductance is calculated to be 1 henry and the total secondary capacitance is estimated as 100 picofarads.

The cut-off frequency, $\omega_{co}/2\pi$, is given by :—

$$f_{co} = \frac{10^6}{2\pi\sqrt{100}} = 16{,}000 \text{ c/s.}$$

At this frequency $\omega L_{LS} = 1/\omega C = 2\pi \times 16{,}000 = 100{,}000$ ohms. Since the transformer is to work under conditions of matched impedance, $R_1 = R_2 = 50{,}000$ ohms, and, referring to Fig. 4, $K = 50{,}000/100{,}000 = \frac{1}{2}$.

Neglecting copper, core and dielectric losses, which may be made comparatively small in this case, the relative response of the transformer at various frequencies for this value of K may now be tabulated as is shown in Table 1.

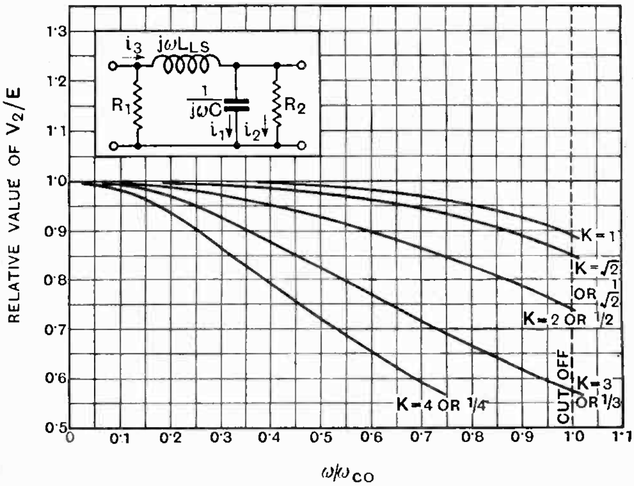


Fig. 4.—*If* $j\omega_{co}L_{LS} = \dfrac{1}{j\omega_{co}C} = R_1/K = R_2/K.$

Then $V_2/E \propto$

$$\sqrt{\left[\frac{1}{1 + \dfrac{(\omega/\omega_{co})^4 + (\omega/\omega_{co})^2(K - 1/K)^2}{4}}\right]}$$

It is seen that such a transformer will have a falling frequency characteristic. The loss in amplification at 9,600 c/s amounts to about 1 db. referred to the amplification at 1,600 c/s.

If the loss at the higher audio-frequencies was considered to be too great, it would either be necessary to reduce the leakage inductance or, what would probably be easier, to increase the value of R_2 and simultaneously decrease the value of R_1 so that the input impedance of 500 ohms is preserved. This may readily be accomplished by loading the primary of the transformer with a resistance.

This is best exemplified by assuming that R_2 is now increased to 100,000 ohms. In order to maintain the same value of input impedance as before, the primary must be loaded with a resistance of 1,000 ohms, and R_1 now becomes :—

$$R_1 = \frac{50{,}000}{500} \times \frac{500 \times 1{,}000}{1{,}500} = 33{,}333 \text{ ohms,}$$

or, referring to Fig. 2, $K_1 = 0.333$.

The approximate frequency characteristic of the transformer has now become that given in Table 2.

3. The Performance over the Low Frequency Band

In the lower frequency band it is convenient to represent the transformer by the simple circuit shown in Fig. 8, where r_1 r_2 and e have the significance shown in the figure and L_p is the primary inductance.

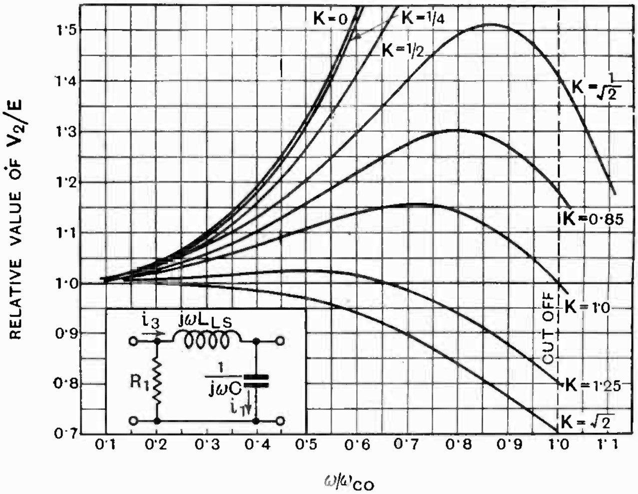
TABLE 1.

ω/ω_{co}	Frequency c/s	Relative value of $\frac{V_2}{E}$
1	16,000	0.74
0.9	14,400	0.785
0.8	12,800	0.83
0.7	11,200	0.866
0.6	9,600	0.90
0.5	8,000	0.93
0.4	6,400	0.955
0.3	4,800	0.975
0.2	3,200	0.99
0.1	1,600	1.0

TABLE 2.

ω/ω_{co}	Frequency c/s	Relative value of $\frac{V_2}{E}$
1	16,000	0.965
0.9	14,400	1.01
0.8	12,800	1.045
0.7	11,200	1.06
0.6	9,600	1.05
0.5	8,000	1.04
0.4	6,400	1.03
0.3	4,800	1.015
0.2	3,200	1.005
0.1	1,600	1.00

The primary inductance, L_p, is, of course, a variable quantity, depending on the effective permeability which, in turn, is a



function of the magnetising force and frequency of the e.m.f. applied to the transformer.

For design purposes it is usual to base L_p on the minimum initial value of the effective permeability of the core material at a frequency of 50 c/s.

It is obvious that L_p must be large compared to the resistive elements of the circuit

Fig. 6.—*If* $j\omega_{co}L_{LS} = \dfrac{1}{j\omega_{co}C} = 3R_1R_2/R_1 + R_2$

and $R_1/R_2 = K_1/K_2 = \left(\dfrac{1.5 - x}{1.5 + x}\right)$

Then $V_2/E \propto$

$$\frac{1}{\sqrt{\left[1 + \left(\frac{\omega}{\omega_{co}}\right)^4\left(\frac{1.5 + x}{\sqrt{3}}\right)^2 + \left(\frac{\omega}{\omega_{co}}\right)^2\left\{\frac{(3.25 - x^2)^2}{3} - \frac{2(1.5 + x)}{3}\right\}\right]}}$$

When $x =$	*then* $K_1 =$	*and* $K_2 =$
0	0.6667	0.6667
0.1	0.625	0.715
0.2	0.588	0.77
0.3	0.555	0.833
0.4	0.527	0.908
0.5	0.5	1.0
0.6	0.476	1.11
0.7	0.454	1.25
0.8	0.435	1.43
0.9	0.417	1,67
1.0	0.4	2.0

if a flat frequency characteristic is to be maintained throughout the pertinent range of frequencies, the response being given by :—

$$\frac{v_2}{e} = \frac{\omega L_p}{\sqrt{R^2 + \omega^2 L_p^2}} \quad \ldots \quad \ldots \quad (5)$$

where $R = \dfrac{r_1 r_2}{r_1 + r_2}$.

There is another, and often overlooked, reason for making L_p large compared with R, namely, in order to reduce the harmonic distortion as much as is consistent with economical design. This is illustrated by

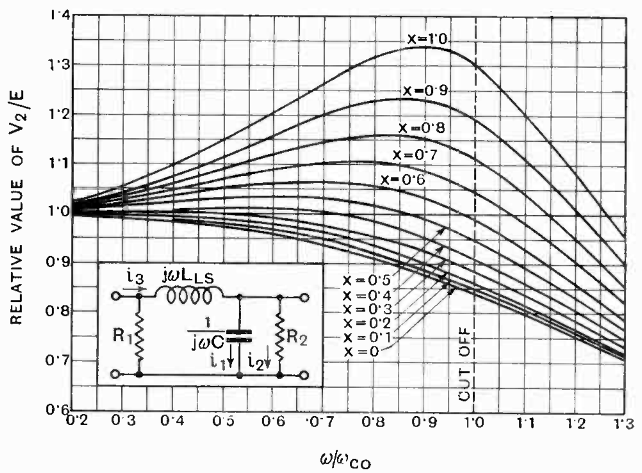
Fig. 5.—*If* $j\omega_{co}L_{LS} = \dfrac{1}{j\omega_{co}C} = R_1/K$.

Then $V_2/E \propto$

$$\sqrt{\left[\frac{1}{1 + (\omega/\omega_{co})^4 + (\omega/\omega_{co})^2(K^2 - 2)}\right]}$$

Figs. 9 10 and where the variation of the total percentage harmonic distortion with flux density is shown for several ratios of $\omega L_p/R$ for assembled cores of Mumetal and Permalloy C respectively.

These curves were constructed from measurements made at a frequency of 50 c/s on cores made up from T and U 0.015in. stampings, a special filter being designed



to ensure that the voltage applied to the test circuit was itself free from harmonics.

The harmonic content referred to in the

figures is the square root of the sum of the squared amplitudes of all the measurable harmonics expressed as a percentage of the amplitude of the fundamental. Furthermore in order to facilitate the extraction of relevant data for design purposes, the flux density has been calculated as if the core was a homogeneous mass of the same substance. In other words, no account has been taken of the space factor and the effect of butt joints, so that the actual flux densities in the stampings will be higher.

It should also be explained that the value of L_p was based on the inductance pertaining when the magnetising force approaches zero. In short, if use is made of the curves, the primary inductance should be evaluated from the initial effective permeability of the core.

The point on the curves where the harmonic content commences to rise steeply corresponds roughly to the point where the effective permeability of the core commenced to fall with increasing flux density.

From the foregoing it will be clear that it is preferable to design the transformer so that the primary reactance at a frequency of 50 c/s is numerically greater than three times R for input and intervalve transformers. In output transformers it is often necessary to make $L_p > 4R$ if the harmonic distortion is to be kept within reasonable bounds—even with stalloy cores.

4. Predetermination of the Constants

The foregoing assumes that some means exist for predetermining the constants of a transformer.

Of the losses the dielectric loss alone defies accurate estimation as, apart from varying with frequency it varies with atmospheric humidity and temperature, and the form of winding adopted.

Fortunately, this loss is generally insignificant for transformers working into impedances not exceeding 150,000 ohms and having normal types of winding. Special precautions have, however, to be taken in the winding for transformers working into higher impedances. These may take the form of interleaving each layer of the secondary winding with some reliable insulating material, such as varnished paper, or baking the winding and impregnating in a moisture-proof compound.

The copper losses can, of course, be calculated in the usual manner.

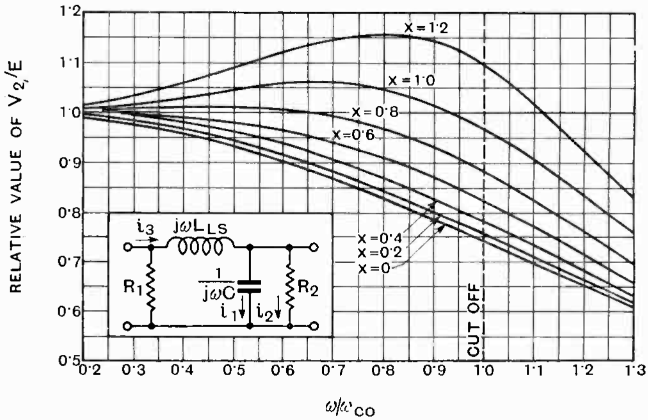


Fig. 7.—*If* $j\omega_{co}L_{LS} = \dfrac{1}{j\omega_{co}C} = 4R_1R_2/R_1 + R_2$ *and* $R_1/R_2 = K_1/K_2 = \dfrac{(2-x)}{(2+x)}$

Then $V_2/E \propto$

$$\frac{1}{\sqrt{\left[1 + \left(\frac{\omega}{\omega_{co}}\right)^4\left(\frac{2+x}{4}\right)^2 + \left(\frac{\omega}{\omega_{co}}\right)^2\frac{(9 - 8x - 10x^2 + x^4)}{16}\right]}}$$

When $x =$	then $K_1 =$	and $K_2 =$
0	0.5	0.5
0.2	0.455	0.556
0.4	0.417	0.625
0.6	0.385	0.715
0.8	0.357	0.833
1.0	0.333	1.0
1.2	0.312	1.25

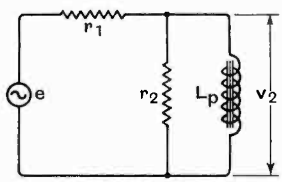


Fig. 8.—e = source e.m.f.; r_1 = source impedance; r_2 = load impedance transferred to primary.

As the makers of stampings are not usually able to supply data concerning the iron losses at the high frequencies involved, it is necessary to construct curves based on experimental evidence before these losses can be estimated. A convenient set of curves for the purpose is obtained by plotting the loss in milliwatts per cubic inch of core against frequency for various voltages corresponding to arbitrarily determined flux densities at a frequency of 50 c/s, the voltages applied to the test transformer being constant at all frequencies. Such a set of curves is shown in Fig. 11.

Both the last mentioned losses vary with frequency, a fact that would be very disconcerting if they were allowed to affect appreciably the response of the transformer

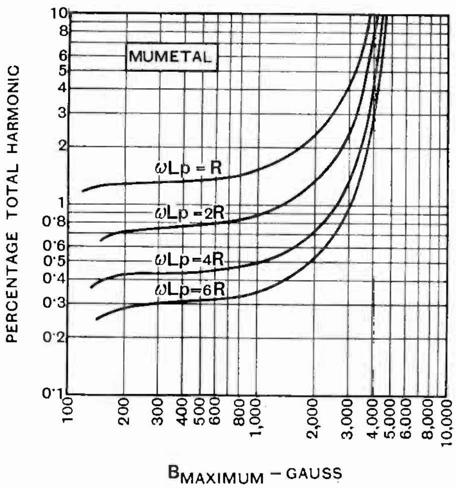


Fig. 9.

in the audio-frequency band. For normal designs, however, the effect of these last two losses is seldom more than to change the frequency characteristic by 1 per cent. and, at the higher frequencies, most of this change is generally accounted for by the copper losses alone. A rough calculation of the copper losses will therefore suffice in practical design if a greater accuracy than 1 per cent. is desired, but they may usually be neglected.

The minimum open circuit inductance of the windings is given by

$$L = \frac{1.257 \cdot T^2 \cdot A \cdot \mu_e}{l \times 10} \quad \ldots \quad \ldots \quad (6)$$

where T = the number of turns.

A = the effective cross sectional area of the core in sq. cms.

l = the length of the mean flux path in cms.

and μ_e = the initial effective permeability of the core.

There remains the estimation of leakage inductance and capacitance.

5. Estimation of the Leakage Inductance

It often occurs that it is required to explore the merits of a new shape of core and in such a case no empirical data exists. Under these circumstances it is necessary to revert to some formula which will yield the leakage inductance in terms of the core and winding dimensions.

Consider a transformer having the dimensions in cms., and the form of construction shown in Fig. 12(a), and in which the primary and secondary current is denoted by I_p and I_s respectively. Then considering the reluctance of the leakage path through the core to be negligible compared with the reluctance of the air path, most of the leakage flux will be in a direction normal to the coils inside the core window. Furthermore, the leakage flux will be a maximum between the primary and secondary windings and steadily fall across the coils.

The maximum leakage $MMF = \sqrt{2}\, I_p\, T_p$ and, if the efficiency be assumed to be 100 per cent., $\sqrt{2}\, I_p\, T_p = \sqrt{2}\, I_s\, T_s$.

Given the above assumption the length of the leakage flux path in air is l cms., and the maximum leakage flux density is $\frac{0.4\pi\sqrt{2}\, I_p\, T_p}{l}$ gauss.

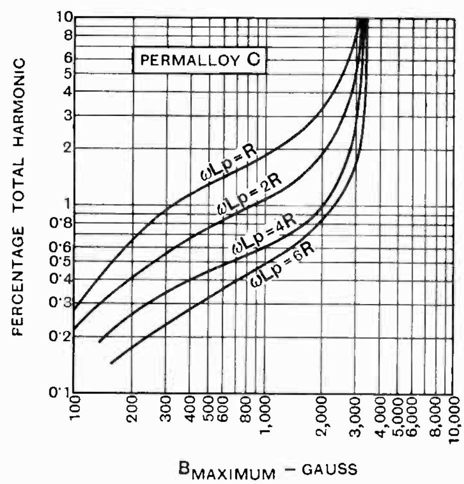


Fig. 10.

Now, as has been explained, only the portion of the leakage flux between the windings produces the full leakage effect. As the number of turns linked vary as the distance between the inside of the primary and the outside of the secondary it can be shown that the linkage density graph over the two coils takes the form of two parabolic arcs of which the mean breadth is one-third of their maximum breadth.

Allowing an equal number of linkages in the two windows, the total number of linkages referred to the secondary is

$$\frac{2 \times \sqrt{2} \times 0.4\pi I_p T_p T_s}{l} \times w\left(h + \frac{\alpha_1 + \alpha_2}{3}\right)$$

and the e.m.f. produced by these linkages is

$$\frac{4.44f}{10^8} \times 2\sqrt{2} \times 0.4\pi I_p T_p T_s \times \frac{w}{l}\left(h + \frac{\alpha_1 + \alpha_2}{3}\right)$$

where f is the frequency in c/s

$$= 5.02\,\pi f I_s T_s^2 \cdot \frac{w}{l}\left(h + \frac{\alpha_1 + \alpha_2}{3}\right) \times 10^{-8}$$

so that the leakage reactance

$$X_L = 5.02\,\pi f T_s^2 \cdot \frac{w}{l}\left(h + \frac{\alpha_1 + \alpha_2}{3}\right) \times 10^{-8}$$

whence the secondary leakage inductance in henries is given by

$$L_{LS} = 0.8\pi T_s^2 \cdot \frac{w}{l}\left(h + \frac{\alpha_1 + \alpha_2}{3}\right) \times 10^{-8} \quad .. \quad (7)$$

Similarly, for a transformer having the dimensions and helical or " pancake " windings shown in Fig. 12(b)

$$L_{LS}' = 0.8\,\pi T_s^2 \cdot \frac{w}{b}\left(h + \frac{\beta_1 + \beta_2}{3}\right) \times 10^{-8} \quad .. \quad (8)$$

So far no allowance has been made for the leakage outside the core windows. MacCall[4] makes an approximation to allow for this extra leakage flux by treating the dimension w as being 1/5th longer so that equation (7) becomes :—

$$L_{LS} = 0.96\pi T_s^2 \cdot \frac{w}{l}\left(h + \frac{\alpha_1 + \alpha_2}{3}\right) \times 10^{-8} \quad .. \quad (9)$$

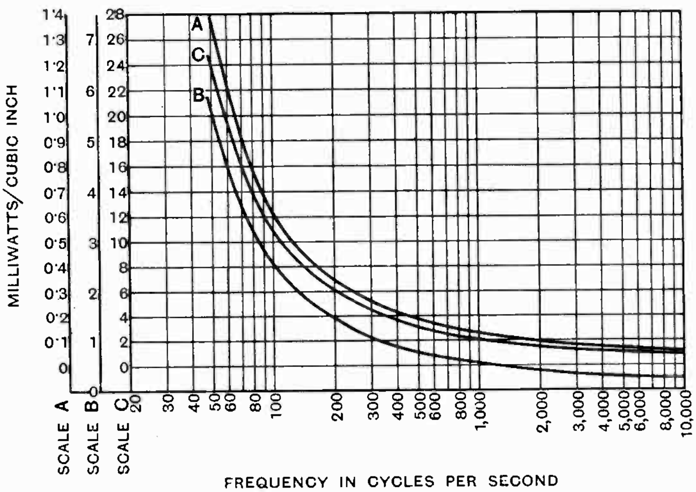


Fig. 11.—*Curve A : B_{max} 500 gauss at 50 c/s. Curve B : B_{max} 1,000 gauss at 50 c/s. Curve C : B_{max} 2,000 gauss at 50 c/s.*

and equation (8) is now

$$L_{LS}' = 0.96\,\pi T_s^2 \cdot \frac{w}{b}\left(h + \frac{\beta_1 + \beta_2}{3}\right) \times 10^{-8} \quad .. \quad (10)$$

In practice, however, if the leakage in-

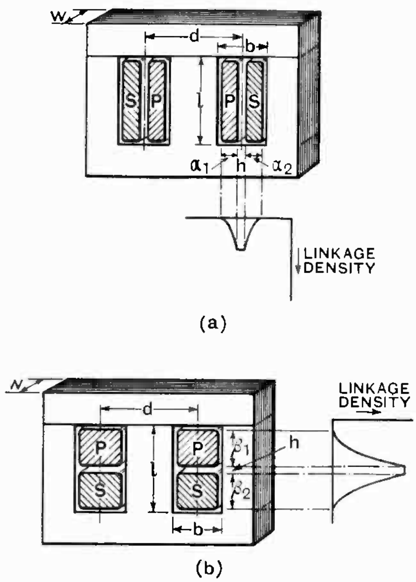


Fig. 12.

[4] " Alternating Current Electrical Engineering." W. T. MacCall. 2nd Imp.

ductance is calculated from either equations (9) or (10) it works out to be about 0.35 times the measured value. This means either that the leakage flux outside the core window is much greater than MacCall has allowed for, or that the length of the flux path inside the window is much shorter than l or b, or that both these conditions apply.

In view of the fact that in audio-frequency transformers the coils cannot generally be considered to be long solenoids it would not be surprising if some of the flux took a much shorter path through the coils themselves. In addition, the shape of the leakage field outside the core windows is probably considerably distorted by the presence of the core, with a result that it is possible that the reluctance of the leakage flux outside the windows is much less than might, at first sight, be expected.

In short, the distribution of the leakage flux is somewhat obscure, but after studying the results of a number of different core shapes and sizes two formulae have been found to give a solution of the leakage inductance within $\pm$ 10 per cent. of the actual measured value.

The formulae are based on equations (7) and (8), but assume that the leakage field is uniform around the coils instead of being concentrated inside the core windows. In addition, allowance is made for the insulation between layers of the coil windings, and for a shorter flux path in the case of helical windings.

So far, it has been assumed that the winding space consists of a homogeneous mass of copper. The presence of insulation will, however, modify the shape of the linkage density graph. In actual practice the linkage density will increase by a number of steps (the number of steps depending on the number of layers in the coils) of which the former parabolic arcs form the envelope.

Any formula for leakage inductance must therefore incorporate a factor depending on the depth of insulation surrounding the wire. To be strictly accurate, this factor should be varied according to the number of layers and the wire used, but a mean figure for enamelled single silk and double silk covered wires of the gauges and number of layers normally used in audio-frequency transformers is about 0.9.

The preferred formula for the leakage inductance of a concentrically wound transformer is therefore :—

$$L_{LS} = 0.4\pi^2 T_s^2 \frac{d}{l}\left\{h + 0.9\frac{(\alpha_1 + \alpha_2)}{3}\right\} \times 10^{-8}$$

or, since h is usually small compared with $\frac{(\alpha_1 + \alpha_2)}{3}$, to a first approximation

$$L_{LS} = 3.55\, T_s^2 \frac{d}{l}\left(h + \frac{\alpha_1 + \alpha_2}{3}\right) \times 10^{-8} \text{ henries} \quad \ldots \quad (11)$$

where d is the mean diameter of the space between windings.

The corresponding equation for a helical winding, assuming a fully wound bobbin, is :

$$L_{LS}' = 3.55\, T_s^2 \frac{d}{0.9b}\left(h + \frac{\beta_1 + \beta_2}{3}\right) \times 10^{-8} \text{ henries} \quad \ldots \quad (12)$$

If the primary and secondary windings are each divided into N sections, then the turns linked become $\frac{1}{N}$th of the previous value. Equations (11) and (12) may therefore be rewritten as follows :—

$$L_{LS} = 3.55\left(\frac{T_s}{N}\right)^2 \frac{d}{l}\left(Nh + \frac{\alpha_1 + \alpha_2 + \alpha_3 + \ldots \alpha_{2N}}{3}\right) \times 10^{-8} \quad \ldots \quad (13)$$

and

$$L_{LS}' = 3.55\left(\frac{T_s}{N}\right)^2 \frac{d}{0.9b}\left(Nh + \frac{\beta_1 + \beta_2 + \beta_3 + \ldots \beta_{2N}}{3}\right) \times 10^{-8} \quad \ldots \quad (14)$$

For small audio-frequency transformers having a large number of sections it is difficult to estimate accurately the dimensions of the insulation, and the accuracy of the estimation of the leakage inductance is correspondingly reduced.

6. Estimation of Effective Secondary Capacitance

It is not possible to calculate the effective secondary winding capacitance academically with any degree of accuracy and in practical design resort has again to be made to an empirical formula or existing data.

For electrostatically screened transformers having one primary and one secondary section the expression given below will yield fairly good results in normal designs and core sizes.

If D is the mean diameter, S is the length or breadth and δ is the depth of the secondary winding then the effective secondary winding capacitance in picofarads is given by :—

$$C_s = 20 + \frac{\pi DS}{11.3\delta} \quad \ldots \quad \ldots \quad (15)$$

This formula does not, however, apply to thin helical windings which are immediately adjacent to the electrostatic screen.

If the winding is interleaved between layers with paper or other insulating material the space factor must be taken into account to reduce the capacitance given by expression (15).

The winding capacitance of multi-section transformers and transformers having exceptional forms of winding is too complex to permit predetermination by a simple formula and the estimation is generally based on prior measurements.

The effective secondary capacitances of non-electrostatically screened transformers depends very much on the circuits connected to the primary and secondary (i.e. where earth potential is applied to the windings) and the voltage distribution between coils.

7. Selection of Type Winding

If equation (12) be divided by equation (11) we get

$$\frac{L_{LS}'}{L_{LS}} = \frac{\frac{1}{.9b}\left(h + \frac{\beta_1 + \beta_2}{3}\right)}{\frac{1}{l}\left(h + \frac{\alpha_1 + \alpha_2}{3}\right)}$$

and since $(\alpha_1 + \alpha_2) \approx b$, $(\beta_1 + \beta_2) \approx l$ and h is usually small compared with l or b

$$\frac{L_{LS}'}{L_{LS}} \approx 1.1\left(\frac{l}{b}\right)^2$$

It follows that if $\frac{l^2}{b^2}$ is greater than 0.9, as is usually the case, then the leakage inductance of a transformer having helical windings is greater than that of the concentrically wound prototype.

Furthermore, it is clear that where no electrostatic screen exists or where the secondary winding is spaced some way from such a screen the capacity of the helical winding is, for normal core window shapes, less.

Now, for transformers working into a very high impedance it is necessary to make the leakage reactance high at the cut-off frequency to match the secondary load. This nearly always entails a high leakage inductance and, in order that the cut-off frequency shall be beyond the normal frequency range over which the transformer is required to amplify uniformly, a low total secondary capacitance is necessary. The situation is similar to that of telephone cable design, where minimum capacitance and adequate loading are the requirements for high impedance.

For this type of transformer, then, the helical form of winding is generally essential. Remarkably high step-up ratios can be obtained with such a transformer in conjunction with a valve having a low input capacity, such as a tetrode or a pentode.

On the other hand, a concentric winding is more easily manufactured, and is therefore preferable when circumstances allow its use. Generally, concentric winding may be used when the impedances do not exceed 200,000 ohms.

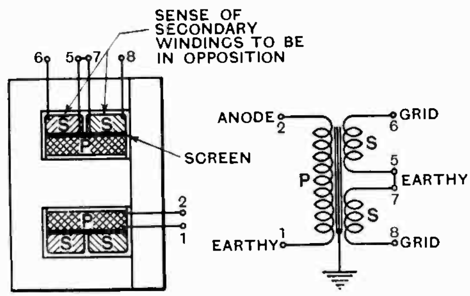


Fig. 13.

A type of winding particularly applicable to " straight to push-pull " intervalve transformers is shown in Fig. 13. This winding has the merits of having a low secondary capacity, since the capacities of each of the two half sections are in series, and of having a secondary which is balanced with respect to earth potential.

8. Core Window Shape

Since the leakage inductance and effective secondary capacity are both functions of the core dimensions, it is obvious that the shape of the core window will vitally affect the resultant product of these two transformer constants and therefore the value of the cut-off frequency.

Consider first of all an electrostatically screened and concentrically wound transformer for which the window and cross sectional areas of the core and the number of turns are fixed, but for which the dimensions b and l may be varied. Neglecting for the moment the modifications imposed by the presence of insulation, it will be seen that $L_{LS} \propto \frac{db}{l}$ or, since $d = (k_1 + b)$ and $b = k_2/l$, $L_{LS} \propto (k_1 . k_2/l^2 + k_1{}^2/l^3)$ when k_1 and k_2 are constants. The capacitance C_s varies very nearly as $(k_3 + k_4 l^2)$ for average core sizes, k_3 and k_4 being constants, so that, theoretically anyway, the larger the ratio l/b the smaller does $L_{LS} \times C_s$ become and the higher therefore is the cut-off frequency.

In practice, however, we are more concerned with constant open circuit inductance and, since the reluctance of the core increases as the core window departs from the form of a square, it follows that neither constant turns nor area appertain for these conditions. As a result of this and of the fact that the effect of the insulation becomes more marked as l is increased, experimental evidence shows that there is no advantage in making the ratio l/b much greater than 1.5 to 2.0 unless it is especially desirable to reduce the leakage inductance. In fact, the writer found that for a certain set of cores having different window shapes but designed to give the same open circuit inductance for a constant cross-sectional area of core and the same wire gauge there was a definite optimum value for l/b, for which $L_{LS} \times C_s$ was a minimum.

For the helical form of winding the effective secondary capacity rises more rapidly than the first power of b/l when electrostatic screening is employed and the optimum value of b/l is therefore more marked.

Again there appears to be nothing to gain by increasing b/l beyond 1.5 to 2.0 except in cases where the secondary winding may be spaced some distance from the screen.

9. Design Procedure

In the practical design of input and intervalve transformers it is usually advisable to start from the aspect of the performance over the upper frequency band, basing the calculations in the first instance on the assumption that the impedance of the secondary leakage inductance, total capacitance and load are all equal at the cut-off frequency.

The general outlines of procedure for an input transformer are as follows :—

(i) Determine the unavoidable secondary capacitance load. This capacitance will include (a) the input capacitance of the valve, (b) the effective secondary winding capacitance, and (c) stray wiring capacitances.

(ii) Determine the impedance of the above capacitance at the upper limit of the frequency band over which it is desired to amplify uniformly. This impedance fixes the nominal impedance of the secondary load and, since the source impedance is fixed, the step-up ratio.

(iii) Calculate the secondary leakage inductance which has an impedance equal numerically to the impedance of the capacity load at the cut-off frequency.

(iv) Calculate the number of secondary turns required to give the above leakage inductance from either equation (13) or (14) making a choice at the same time of the method of winding to be adopted.

(v) Divide the number of secondary turns thus obtained by the step-up ratio previously determined and thus obtain the number of primary turns.

(vi) Calculate the primary inductance from equation (6), making a suitable choice of core material.

(vii) Ascertain if the primary inductance is adequate to prevent undue loss at the low frequencies from equation (5).

It will generally be found that this loss is negligible. However, if in a particular design it is serious, the design must be recalculated based on a greater number of primary turns and therefore a different impedance ratio or, alternatively, a higher secondary leakage inductance.

(viii) Assuming that the bass loss is negligible, calculate the maximum flux density likely to be encountered in practice at a frequency of 50 c/s from the formula

$$B_{max} = \frac{v_2 \times 10^6}{2.22\, A\, T_p}$$

C

where A is the cross sectional area in square centimetres occupied by the core.

From the curves given in Figs. 9 or 10, or similar curves for other materials, estimate the amount of harmonic distortion likely to be met with at a frequency of 50 c/s. If the percentage total harmonic content is intolerable, it will be necessary to reconsider the design as in step (vii).

(ix) If, however, the design has so far proceeded satisfactorily, select the curve in Fig. 3 which is most suitable for the conditions of operation and determine the secondary and additional primary load from the values of K_1 and K_2 appertaining to the curve selected. The value of K_1 and K_2 for the basic curve, on which the design has hitherto been based, is, of course, unity.

Apart from manufacturing instructions, the choice of materials and the calculation of winding resistances, this would normally complete the design of an input transformer.

The procedure to be adopted in the design of intervalve transformers is very similar. The main difference lies in that the intervalve transformer seldom operates under matched impedance conditions. Steps (i) to (viii) remain the same, but in step (ix) a different set of curves must be selected, as those shown in Fig. 3 are only applicable to matched impedance conditions.

The conditions of operation will usually come within the scope of the curves shown in Fig. 2. If the rise in frequency characteristic is found to be more than can be tolerated, it will be necessary to reduce the impedance ratio of the transformer by increasing the number of primary turns and to reduce the value of R_2 such that the input impedance of the loaded transformer remains the same. One of the curves in Fig. 7 will generally be found to be applicable to the new conditions.

For example, suppose that it is required to couple a valve having an impedance of 9,000 ohms to the grid of a following valve. Suppose also that for a tentative design of a transformer for the purpose

$$\omega L_{LS} = \frac{1}{\omega C} = 100{,}000 \text{ ohms}$$

and as a trial the impedance ratio is 1 : 5. Assume that the minimum impedance into which the valve may work without undue distortion is 20,000 ohms, then, if R_2 is made 100,000 ohms, $K_2 = 1$, $R_1 = 45{,}000$ ohms and $K_1 = 0.45$. Referring to Fig. 2 it is seen that for these conditions the maximum rise in frequency characteristic is about 5 per cent.

Now, if this rise is considered to be too great, the impedance ratio can be reduced to, say, 1 : 4. In order to preserve the same input impedance R_2 must now be reduced to 80,000 ohms ($K_2 = 0.8$) and R_1 becomes 36,000 ohms ($K_1 = 0.36$). Referring to Fig. 7, the nearest curve is for $K_1 = 0.357$ and $K_2 = 0.833$ and for this curve the maximum rise is 1 per cent.

It should be borne in mind that the foregoing steps in procedure are given as a guide to the design of the majority of input and intervalve transformers. Cases do arise, however, where it is necessary to adopt a different order in the calculation. For instance, it is sometimes advantageous to consider the design from the point of view of the performance over the lower frequency band first and arrive at a suitable compromise in the performance at the upper frequencies.

In conclusion, the author expresses his thanks to Mr. C. G. Mayo for much valuable advice and assistance and to other members of the engineering staff of The British Broadcasting Corporation for assistance in making check measurements. The author also is indebted to The British Broadcasting Corporation for permission to publish this article.

The Industry

IMPROVED manufacturing facilities and increased production have made possible a substantial reduction in the price of various Marconi-Ekco test instruments. The firm also announces the introduction of an interference measuring set, acoustic measuring equipment and a noise meter.

The Osram indirectly heated triode Type DA100 has been reduced in price from £10 10s. 0d. to £8 8s. 0d.; this is a high-power valve capable of an anode dissipation of 100 watts.

The latest Cossor valve, Type 42OTDD, is a combined output tetrode and double diode.

Leland Instruments, of 46, Bedford Row, London, W.C.1, have issued a booklet describing the new Ferris Laboratory Signal Generator, Model 22A. A tentative specification has also been issued for a new Boonton Beat Frequency Generator designed for television engineers; the instrument has a frequency range of from 20 kilocycles to 5 megacycles in two steps and an output range of from 10 millivolts to 10 volts.

Electron Pump Effect at High Frequencies*

By Malcolm R. Gavin, M.A., B.Sc.

(Communication from the Research Staff of the M.O. Valve Company, Limited, at the G.E.C. Research Laboratories, Wembley, England)

SUMMARY.—A theory is derived to explain the phenomenon that electron current may flow to the anode of a triode when an H.F. alternating potential is applied to the grid and a negative potential to the anode. Calculated electron paths are shown diagrammatically and the theory is shown to be in good agreement with experimental observations.

Introduction

It is well known that at very high frequencies, when the transit time of electrons between the electrodes becomes an appreciable fraction of the period, effects appear in valves which are absent at lower frequencies. In particular, it is found that current may flow to electrodes which are at the same or lower potential than the cathode, so that electrons are delivered at a point negative to their starting point, as a pump delivers water to a higher level. For example, when an alternating potential of high frequency is applied to the grid of a triode and a steady negative potential to the anode, current is found to flow to the latter, if the frequency is sufficiently high, and the magnitude of the current increases with increasing frequency. This current may be measured on a D.C. ammeter and is due to electrons actually reaching the anode. It is quite distinct from the induced H.F. current due to the motion of the electrons constituting the space charge.

Further examples of this phenomenon are found in the currents to electrodes at zero or negative potential in multi-electrode valves.†

The following is devoted to an approximate theory of the triode case. The method is similar to that used by Sloane and James for diodes [1] and the results are shown in the pictorial form which aids considerably in the interpretation of the mathematics.

Theory

Consider a plane parallel triode, Fig. 1, with potentials applied to the grid and anode as follows

$$e_g = a + b \cos \omega t$$

and $$e_a = c.$$

If d is the distance between the grid and anode then, neglecting space charge, the field strength is

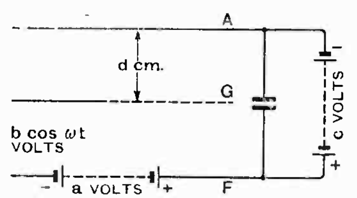


Fig. 1.—*Circuit diagram of plane parallel triode. The condenser between anode and filament is to ensure that the former is at zero H.F. potential.*

$$\frac{c - a - b \cos \omega t}{d}$$

The equation of motion of an electron is

$$km \frac{d^2x}{dt^2} = \frac{e}{d}(c - a - b \cos \omega t)$$

* MS. accepted by the Editor, July, 1937.

† In many cases, part of this current is due to the impedance of the leads, inside the valve, between the external terminals and the electrodes. On account of this impedance, whenever H.F. current flows to the electrode, there is an H.F. voltage between the active electrode and its external connection, even though the latter be at zero potential. During the positive part of the H.F. cycle electrons flow to the electrode. This is particularly noticeable in valves with long internal leads. In the experimental case considered at the end of this article, calculation shows that any current due to this effect is negligible compared with that due to electron inertia.

where x is the distance from the grid and $k = 10^{-7}$, the ratio of erg/joule and e and m have their customary meanings.

Hence $\frac{d^2x}{dt^2} = A + B \cos \omega t$

where $A = \frac{(c-a)e}{kmd}$ and $B = -\frac{eb}{kmd}$.

Integrating twice,

$$\frac{dx}{dt} = v_1 + A(t - t_1) + \frac{B}{\omega}(\sin \omega t - \sin \omega t_1) \quad .. \quad (1)$$

and

$$x = v_1(t - t_1) - \frac{A}{2}(t - t_1)^2 - \frac{B}{\omega}(t - t_1)\sin \omega t - \frac{B}{\omega^2}(\cos \omega t - \cos \omega t_1) \quad .. \quad (2)$$

where v_1 and t_1 are the velocity and time when $x = 0$.

From equations (1) and (2), the position and velocity of an electron in the grid-anode space can be calculated at any instant, provided v_1 and t_1 are known.

To determine v_1 and t_1, the conditions in the grid-filament space must be considered. In Fig. 2, the grid voltage is plotted against time. Now consider an electron leaving the filament at time t_0 and arriving at the grid at time t_1. During that time, the grid potential has changed from V_0 to V_1. However, the mean value of the potential over that range can be calculated from the equation

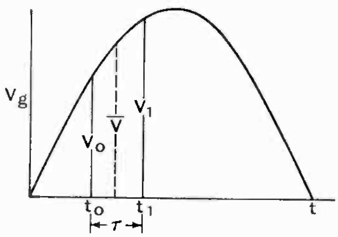


Fig. 2.—*Grid voltage—time curve.*

$$\bar{V} = \frac{1}{\tau}\int_{t_1-\tau}^{t_1} V_g dt \quad .. \quad .. \quad (3)$$

where $\tau = t_1 - t_0$.

Then the velocity and the time of arrival of the electron at the grid under the influence of the varying potential V_0 to V_1 will not differ much from those of an electron travelling under the influence of a steady potential $\bar{V}$ during the same time. Any errors involved in this assumption must be very small as far as the present article is concerned, since, under the special conditions here considered, the filament to grid transit times are small compared with the grid to anode transit times. In the calculations below the transit angles from the filament to grid are of the order of 5° and from grid to anode 40° to 150°.

The actual method is as follows. A certain value of $\bar{V}$ is assumed and the transit time, τ, for this potential is calculated from static considerations for a space charge limited diode from the formula given by McPetrie[2]. To be strictly correct, the effect of the anode potential ought to be brought in, but this is small, except for valves of low amplification factor, and as a first approximation it may be neglected.

Using these values of $\bar{V}$ and τ equation (3) is solved for t_1 and the time of arrival of the electron at the grid is thus known.

The velocity of arrival at the grid is found from

$$\tfrac{1}{2} m v_1^2 = e\bar{V} \quad .. \quad .. \quad .. \quad (4)$$

The values of v_1 and t_1 are now substituted in equation (2) and the position of the electron between grid and anode at any time t can be found. By giving a series of values to t, the path of the electron is determined. By repeating the whole procedure for a number of electrons a picture of the conditions in the grid-anode space can be obtained.

Pictorial Representation

Fig. 3 shows the calculated paths between grid and anode of 8 representative electrons at different points of the cycle for a valve working under Class C conditions. The following values were assumed :—$a = -250$ volts, $b = 500$ volts, $c = -200$ volts, $d = 0.35$ cm. and $\omega = 1.26 \times 10^9$, i.e., a wavelength of 1.5 metres. Under these conditions, electrons leave the filament during one third of the cycle, namely, from $\omega t = 30°$ to $\omega t = 150°$.

The first curve (a) corresponds to an electron arriving at the grid at $\omega t = 44°$. Its momentum carries it through, but the positive potential on the grid and the negative potential on the anode soon bring it to rest and then force it back to the grid. The same applies to (b) and (c). Here the velocities of arrival at the grid are greater and the electrons travel further before being turned back. In (d) the electron penetrates a distance of about 2 mm., then under the retarding field reverses. However, at

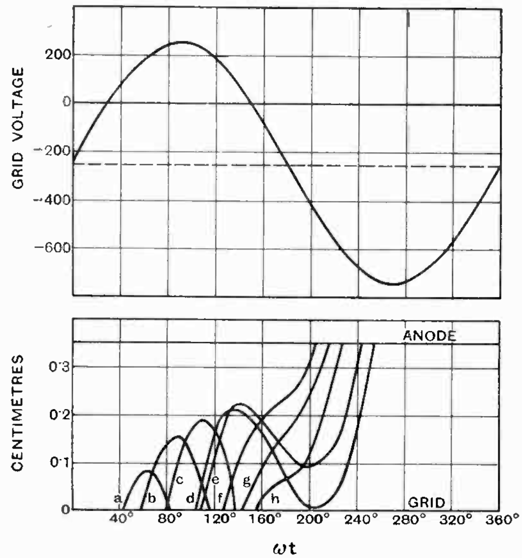


Fig. 3.—*Electron paths the grid-anode space. ωt is phased with the grid voltage which is shown above.*

$\omega t = 150°$, the grid goes negative and at $\omega t = 175°$, becomes more negative than the anode, so that the field reverses direction and the acceleration is towards the anode. The electron flight to the grid is slowed up and about $\omega t = 204°$ it turns again and finally reaches the anode at $\omega t = 254°$. (e), (f), (g) and (h) show the paths of 4 later electrons which all reach the anode. It can be seen that all these curves show a point of inflection at $\omega t = 175°$, the time when the grid becomes more negative than the anode, and the field reverses.

Experimental Verification

The negative anode voltage E_A necessary to ensure that all the electrons will be returned to the grid, can be found by calculation from equation (2), by trying varying values of c until the one is found which makes all the electrons return to the grid. The arithmetic is somewhat laborious. The results for three different frequencies are given in Table 1.

TABLE I.

Wavelength	E_A (calculated).	E_A (experimental).
1.5 m.	− 350 volts	− 350
2.0	− 285	− 270
3.0	− 220	− 225

Anode voltage necessary to prevent electrons reaching the anode with peak grid volts = 500, grid bias = − 250 volts, and anode at zero H.F. potential.

An attempt was made to check the theory by measuring E_A. The valve used, a D.E.T.12, has a cylindrical electrode system, but it is shown below that the planar theory agrees fairly well with experiment when applied to this valve. A condenser was connected between anode and earth to keep the anode at zero H.F. potential. The experimental results are of necessity only approximate, on account of the difficulty of measuring the peak volts on the grid at the frequencies under consideration. Even with an instrument capable of accurate measurement at 1.5 m. the voltage actually on the grid is considerably different from that on the grid seal due to the voltage drop in the inductance of the lead inside the valve. No great accuracy is therefore claimed for the value of 500 volts peak on the grid in the experimental tests. However, for each of the frequencies, the drive, as measured by grid current, was adjusted to the same value, so that the grid voltage was the same in each case. The bias was obtained automatically by means of a grid leak. The values of E_A are shown in Table 1, and the close agreement with the calculated values show that the theory gives at least an approximate account of the phenomenon which it attempts to explain.

In conclusion, the author desires to tender his acknowledgments to the General Electric Company and the Marconiphone Company on whose behalf the work was done which has led to this publication.

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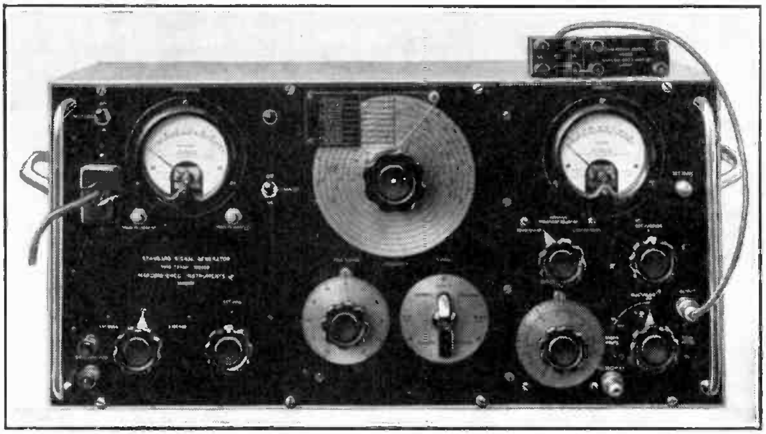
The Physical Society's Exhibition

Measuring Instruments for Research and Works Testing

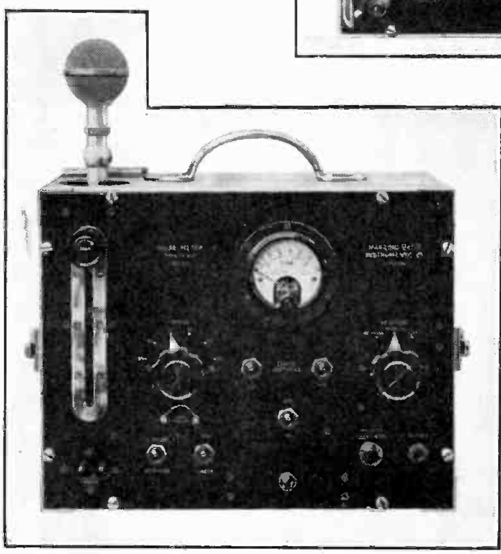
HELD once again at the Imperial College of Science and Technology, South Kensington, the twenty-eighth Exhibition of the Physical Society was notable for the wide variety of new radio measuring instruments for the use of the research worker and production engineer. In view of the unprecedented activity which was evident at last year's exhibition it would not have been a matter of great surprise if manufacturers of test instruments had contented themselves this year with a revision of existing types. To a certain extent this has been done, but not to the exclusion of much original work. At all events there is as yet little sign of any diminution in the rate of evolution of new designs.

Many specialised forms of test instrument, which hitherto have had to be devised and built by the user, are now available in commercial form. The Type OA109 acoustic measuring equipment shown by MARCONI-EKCO INSTRUMENTS, LTD., is a case in point. Designed to cover all types of electro-acoustic determinations, this instrument, which is rack-mounted on a trolley base, comprises a tone source consisting of a beat-frequency oscillator with a warble unit, a loud speaker control panel with speech-coil meter, etc., and a complete microphone amplifier equipment including an attenuator and slow-response rectifier-type indicating meter. A high-fidelity monitoring speaker is included and may be used in conjunction with a chronoscope, relay and decay level attenuator for the determination of reverberation times.

No fewer than twenty-four new instruments were shown by this firm. The medical and industrial equipment included a noise meter (Type TF 397)



(Right) Marconi-Ekco standard signal generator, Type TF430.



(Below) Marconi-Ekco noise meter, Type 397.

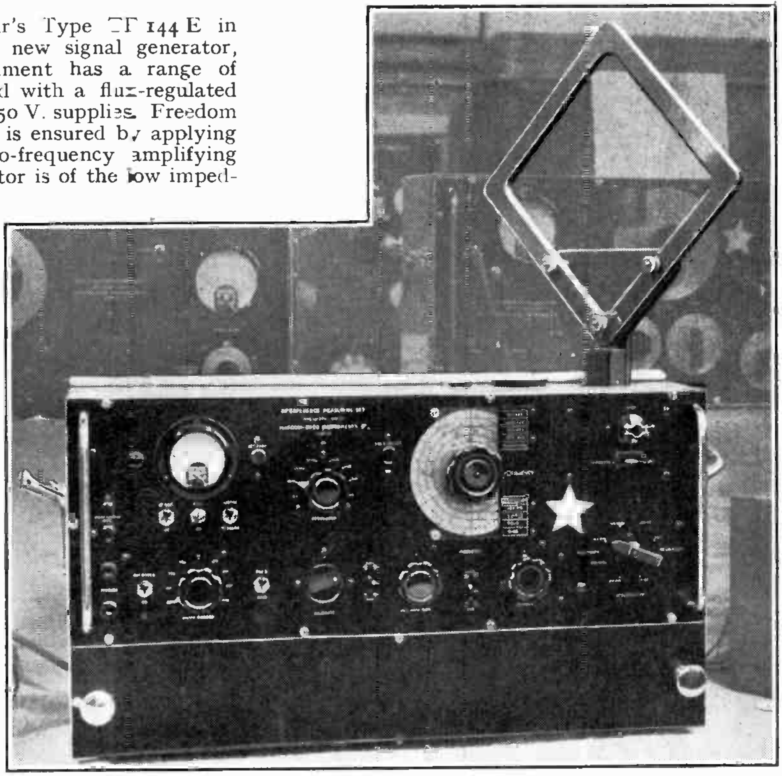
of the objective type calibrated directly in phons. It is equipped with a weighting network adjustable for the 40-phon or 70-phon equal loudness contours and is available in two forms, one with a range of 24–130 phons and the other which is suitably adjusted for the measurement of impulsive noises with a range of 40–130 phons.

Instruments for the testing of components included a circuit magnification meter and a precision valve bridge. The former (Type TF 329) is adaptable for the determination of the capacity and inductance of condensers and may be provided with a test jig for the measurement of dielectric loss. The frequency range of the oscillator is 50 kc/s–50 Mc/s and coil magnifications over a range of 25–500 may be read directly with an accuracy of 5 per cent. The precision valve bridge Type OA 116, consists of the power supply apparatus and all the necessary meters for the measurement of static characteristics, and a bridge circuit giving direct readings of anode resistance, mutual conductance and amplification factor under working conditions.

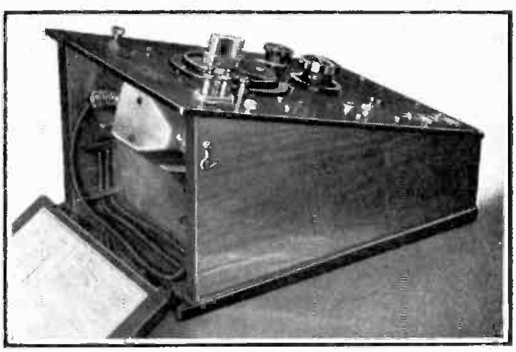
In addition to last year's Type TF 144 E in improved form there is a new signal generator, Type TF 430. This instrument has a range of 50 kc/s–50 Mc/s and is fitted with a flux-regulated mains transformer for 200/250 V. supplies. Freedom from frequency modulation is ensured by applying the modulation to a radio-frequency amplifying stage. The output attenuator is of the low impedance type and is monitored by a valve voltmeter.

For the measurement of interference a portable battery instrument based on the P.O. design has been introduced. A 4-ft. rod aerial is normally used, but rotating screened loops may be substituted. The sensitivity is 10μV for RF voltages and 1μV/metre for field strengths.

Among instruments of the laboratory standard type may be noted the decade resistance Type TF 378. Six ranges from 0.1–10,000 ohms are available and in the highest values a combination of high-resistance alloys is used to obtain a low temperature coefficient. The decades from 0.1–100 ohms are suitable for use up to 500 kc/s, the 1,000-ohm decade up to 200 kc/s and the 10,000-ohm decade up to 50 kc/s. Another interesting laboratory instrument is the Type TF 428 valve voltmeter. The measuring valve is mounted in a probe which may be retracted within the case and the voltage range covered is 0.1–150 V. The normal accuracy is $\pm$ 2 per cent. on full scale on each of the five ranges, and even at 100 Mc/s the error is stated to be only of the order of 3 per cent.



Marconi-Ekco interference measuring set, Type TF379.



G.R. valve voltmeter, Type 726A (Claude Lyons).

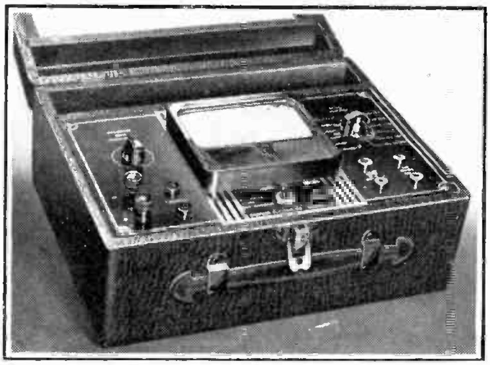
In the probe-type G.R. valve voltmeter, Type 726A shown by CLAUDE LYONS, LTD., an acorn triode is used and the probe element is neatly housed at the back of the case. The instrument is for A.C. mains operation and incorporates a voltage stabiliser. Frequency errors are less than 1 per cent. between 20 c/s and 50 Mc/s and at 100 Mc/s the error is positive and of the order of 2.7 per cent.

As on previous occasions the instruments exhibited on this stand served as an illustration of the trend of American test instrument design and included examples of the Dumont cathode ray equipment with the "electronic switch" for viewing alternately two waveforms taken from different parts of a circuit, the Simpson multi-range measurement instruments including a universal meter with voltage ranges at 20,000 ohms/volts, a complete broadcast transmitter monitoring assembly (G.R. Type 730A) and a useful sound-level meter (G.R. Type 759A) with a choice of three weighting characteristics and a range of 24–130 db. referred to 10^{-16} watts/cm^2.

Signal generators have always been a speciality of this firm and the G.R. Type 605B, which is based on last year's Type 605A has three important modifications—a range extended by the addition of a 30–50 Mc/s band, a second output jack with constant output of 1 volt and a slow-motion dial carrying an auxiliary scale giving frequency changes of 0.1 per cent. per division to facilitate the taking of selectivity curves.

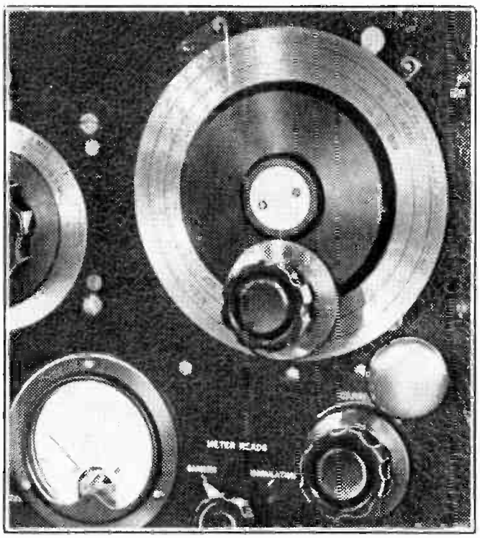
The Type 684A modulated oscillator is a useful radio-frequency source for laboratory and works testing and the design is based on the Type 605B signal generator. The open circuit voltage output is of the order of 20 V up to 2 Mc/s and decreased to 1 V at 30 Mc/s. The over-all range is 9.5 kc/s to 5 Mc/s.

Another interesting source is the Monarch Model 20 multivibrator. This consists of a 400 c/s two-valve multivibrator circuit generating harmonics up to 20 Mc/s. A compensating network reduces the harmonic amplitude in all cases to a constant value of 200 μV and a semi-logarithmic output attenuator is provided. The instrument is A.C. operated and should prove of value for the checking of receiver alignment.

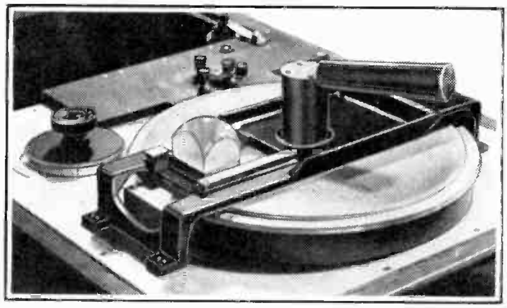


Simpson Model 250 universal meter (Claude Lyons).

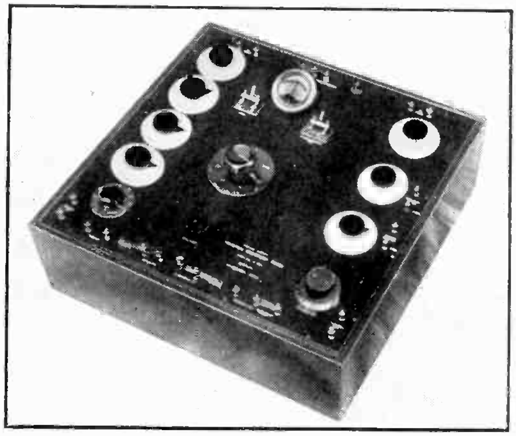
New G.R. wavemeters included a rectifier type for the range 20–300 Mc/s (Type 419A), and the G.R. heterodyne frequency meter and calibrator (Type 620A). The fundamental range of this instrument is 10–20 Mc/s and this is divided into ten parts selected by a switch. The scale is calibrated to read directly in fractions of 1 Mc/s, and a piezo-electric oscillator supplies harmonic checking points on each range. Making use of harmonics the useful range of the instrument is 300 kc/s to 300 Mc/s with an accuracy of at least 0.01 per cent.



G.R. standard signal generator, Type 605B (Claude Lyons).



Direct-reading dial in the Sullivan-Griffiths dynatron oscillating wavemeter.



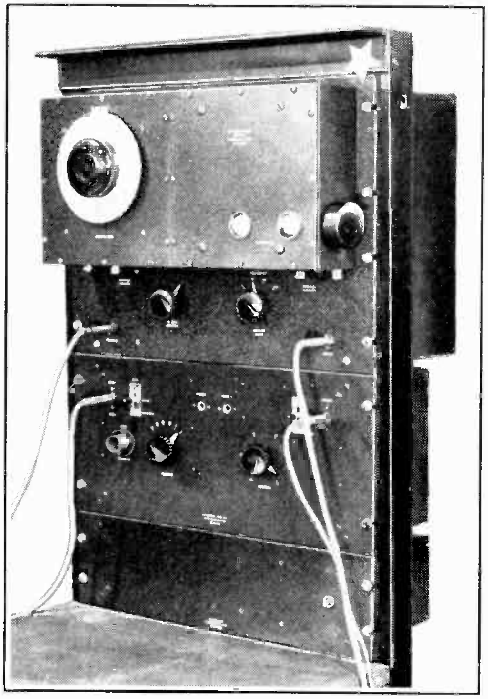
Sullivan-Griffiths direct-reading universal precision inductance bridge.

The direct-reading dynatron oscillating wavemeter of H. W. SULLIVAN, LTD., has this year been fitted with a new type of frequency scale with an improved method of mounting. The rotating metal disc is bridged by a rigid structure and the scale is viewed through an aperture provided with a suitable lens. A degree scale with vernier is fitted in addition to the direct-reading frequency scale.

Inductance standards incorporating the Sullivan-Griffiths thermal compensating principle include an adjustable direct-reading continuously variable standard from 0–100,000 μH and an inexpensive range of tapped inductances suitable for use as bridge standards. Terminal tags are provided for connection if desired to a decade switch. The products of this firm now include precision and second-grade screened non-reactive resistance boxes of sensibly uniform time constant, and these are also the foundation of a new series of Wheatstone bridges.

For the measurement of inductance a direct-reading precision universal inductance bridge with a range of 1μH to 100H has been developed. The over-all accuracy is 0.1 per cent. or 0.2μH whichever is the greater. The bridge is also adaptable for the measurement of capacity.

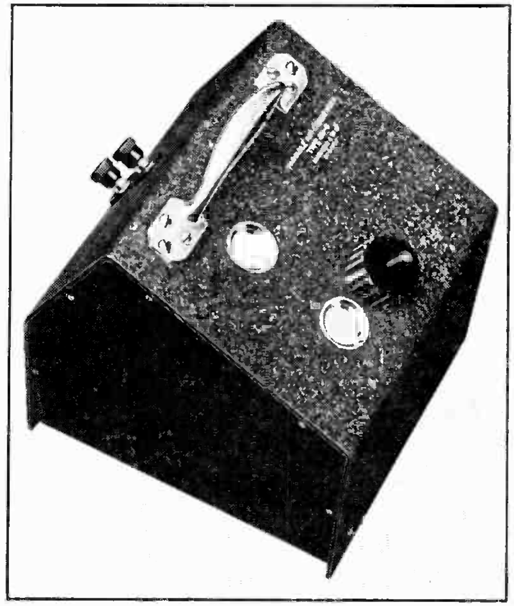
MUIRHEAD AND CO., LTD., were showing a new capacitance bridge based on the Schering principle and giving direct readings of both capacity and



Muirhead direct-reading capacitance and power factor bridge.

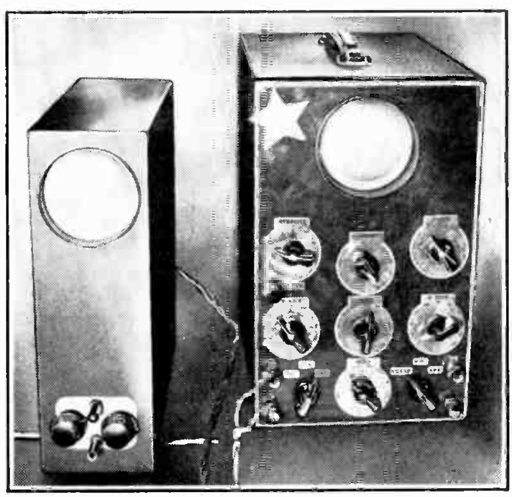
power factor. The standard condenser is quartz-insulated and has a scale which can be read with an accuracy of 0.1$\mu\mu$F. The new Type 29 variable air condenser employs a symmetrical arrangement of two sets of rotor and stator plates which gives good mechanical stability and low effective inductance. It is mounted in an aluminium box with sloping front for ease of operation and the base is drilled for the "Munit" type of mounting which has been adopted for many of Muirhead's products and is particularly suitable for educational and experimental purposes.

A large part of the exhibit of STANDARD TELEPHONES AND CABLES, LTD., was devoted to telephone equipment including a number of transmission measuring sets, an automatic level recorder



Muirhead variable air condenser, Type 29-G.

and an octave filter (Type 74101A) with a frequency range of 37.5–12,800 c/s in sixteen steps which should have applications in the analysis of acoustic noises and in the suppression of harmonics in oscillator and A.C. bridge outputs. Components shown by this firm included transmitting valves of the pentode type and a range of selenium rectifiers of small physical size in relation to their power-handling capacity.

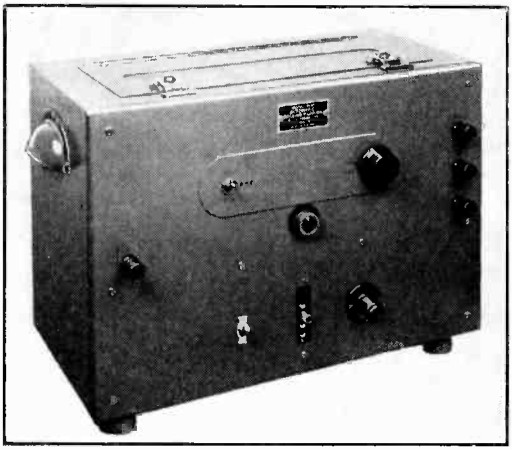


Standard Telephones 3-inch multiple tube unit, and (right) Type 74330A cathode-ray oscillograph.

Among the cathode-ray exhibits the Type 74330A oscillograph, a dual-wave unit with a motor driven commutator for the comparison of waveforms and a multiple tube unit incorporating a 3-inch hard vacuum tube and complete with its own power supply, were three items marked as being of special interest to radio research workers.

A double beam cathode-ray tube with independent vertical deflection electrodes was the most spectacular of the cathode ray exhibits shown by A. C. Cossor, Ltd. The mounting of the tube is similar to that of the 12½-inch cathode-ray oscillograph and with a common time base is ideal for demonstrating phase relationships in A.C. phenomena.

The automatic brilliancy control unit based on a suggestion of Prof. B. F. J. Schonland and developed by Cossor gives a spot intensity proportional to the "writing" velocity. Not only does this obviate the danger of burning the screen, but also enables photographs of transient phenomena to be obtained with better uniformity.



Cossor automatic brilliancy control unit, Model 3365.

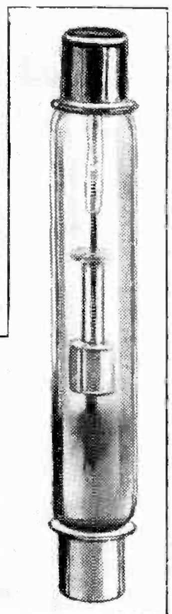
Of special interest to production engineers is the Cossor ganging oscillator which in conjunction with the oscilloscope provides a convenient works method of aligning tuned circuits. The oscillator frequency is controlled through the Miller effect in the valve by the saw-toothed voltage from the time base of the oscilloscope. A range of 30 kc/s is obtainable and the trace is repeated about 30 times per second.

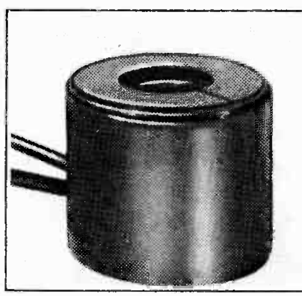
The Edison Swan Electric Co., Ltd., were showing a range of cathode-ray tubes from 5 to 12 inches in diameter, and a new experimental high-voltage projection tube for television. New valves included triodes and pentodes for RF oscillators among which was the Type ES20, which is suitable for small diathermy equipment. Another useful component shown on this stand was a vacuum switch for controlling high-tension circuits. Sliding contacts are enclosed in an exhausted tube and are controlled by a small external coil. The coil consumption is 0.8 amp. at 4 V and the switch is suitable for operating voltages up to 6,000 D.C.

Cossor Model 3343 *ganging oscillator.*

Philips' Lamps, Ltd., were showing their Type GM 3152 cathode-ray oscillograph and a measuring bridge Type GM 4140 for laboratory and general use. Resistance and capacity measurements are read directly from the scale and inductance measurements may be made by fitting an external standard. A pentode valve amplifier in conjunction with an electron beam indicator is used to adjust for balance.

A similar form of indicator is included in the coil-matching unit produced by British Physical Laboratories. The function of the indicator is to show that all contacts have been properly made, an important point in high-speed production testing. The instrument is a direct-reading limit bridge, and the meter will show a maximum discrimination of 0.1 per cent. or 0.1μH according to the inductance value. The standard inductance range is

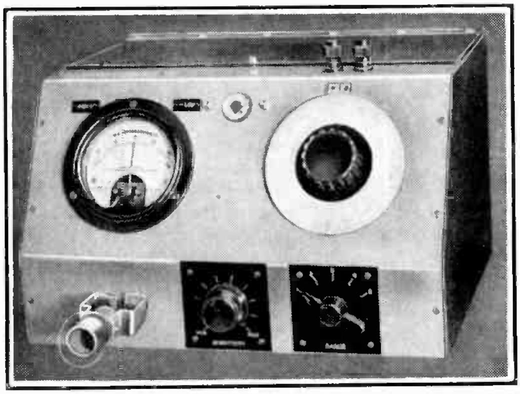




Ediswan vacuum switch for high-tension circuits.

50–3,500μH and the operating frequency may be varied between 100 and 1,000 kc/s. An interesting feature of this bridge is the inclusion of a form of "A.V.C." which automatically protects the meter from damage when the coil under test is removed and the bridge thrown out of balance.

In the power factor meter shown by the same firm a simultaneous check of capacity limits and effective resistance is obtained. The basic circuit operates on the substitution principle, and a rotary trimming condenser driven by a small motor relieves the operator from the necessity of making resonance



British Physical Laboratories coil matching unit.

adjustments. With this apparatus it is possible to test up to 2,000 condensers per hour.

Another interesting exhibit on this stand was the B.P.L. amplifying valve incorporating a compensating grid and due to Dr. Schneider. A cathode-ray oscillograph was used to demonstrate the straightness of the characteristic and it is claimed that the maximum total harmonic distortion does not exceed 0.25 per cent.

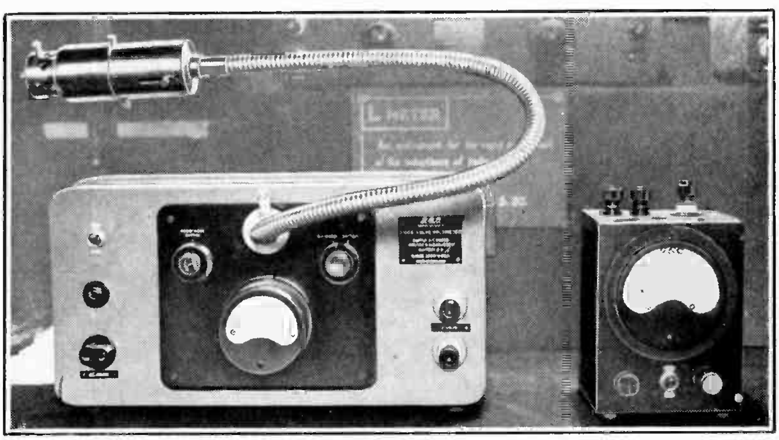
The inductance and capacity bridges shown by THE BALDWIN INSTRUMENT CO., LTD., include many types suitable for works and laboratory measurements, and EVERETT, EDGCUMBE & CO., LTD., were showing their range of "Radiolab" measuring instruments which includes a valve emission and mutual conductance gauge and a new workshop test set for the measurement at radio frequencies of capacity, resistance, voltage and insulating resistance.

The "Q" meter shown last year by SALFORD ELECTRICAL INSTRUMENT CO., LTD., has been extended in range and similar instruments have been produced to give rapid direct measurement of inductance and capacity. This firm also specialises in the production of valve voltmeters and the range this year included a compact diode valve voltmeter with a self-contained filament triode battery and a probe-type high voltage instrument for measurements at frequencies up to 100 Mc/s, or with suitable corrections up to 1,000 Mc/s. Rectifier instruments for radio frequencies were also shown with ranges up to 50 V and with a frequency characteristic flat from 30 c/s–1.1 Mc/s.

Permanent magnets of aluminium-nickel-cobalt alloy have been developed for use in moving coil meters and representative samples were shown by DARWINS, LTD. The Nalder-Lipman meters with 120° and 260° scales shown by NALDER BROS. AND THOMPSON, LTD., are now fitted with these magnets. ELLIOTT BROS. (LONDON), LTD., were showing a rectifier type instrument with centre-tapped coil having a resistance of 2,000 ohms per volt and suitable for audio-frequency measurements. Among the meters shown by the WESTON ELECTRICAL INSTRUMENT CO., LTD., there was a multi-range analyser, Model E772, incorporating all the basic requirements for servicing television apparatus. The "Avo" range of service instruments shown by the AUTOMATIC COIL WINDER AND ELECTRICAL EQUIPMENT CO., LTD., now includes an inexpensive modulated oscillator incorporating a shielded slide wire attenuator and having a fundamental range of 95 kc/s–35 Mc/s.

The MULTITONE ELECTRIC CO., LTD., who specialise in hearing aids, were showing a group hearing installation for schools and a remarkably compact 3-valve deaf-aid instrument energised by a 6-volt dry battery and a flexible 37½-volt high-tension battery. The microphone is of the crystal type and negative reaction is used for volume control. A demonstration was arranged to show differentially the advantages of automatic volume control in deaf-aid instruments.

The exhibit of DUBILIER CONDENSER CO., LTD., was divided between a display of the latest products of the firm and a series of simple experiments illustrating the properties of condensers. Among



Salford high-frequency diode valve voltmeter, and (right) miniature direct-reading diode valve voltmeter.

the new products shown were noted a range of metallised mica and ceramic condensers, tubular paper dielectric condensers designed to work satisfactorily in tropical atmospheres at temperatures up to 70° C. and the "Drilitic" type of electrolytic condensers of small physical size in relation to their capacity. Micro-projection apparatus was used to show the nature of the etched surface of the foil used in these condensers.

The ERIE RESISTOR, LTD., were demonstrating the mechanical advantages of their new method of "injection sealing" for the Type 3N and 4N insulating resistors and "Ceramicon" low-loss condensers. The latter employ dielectrics of the Steatite group for capacities of $5\mu\mu$F or less and titanium dioxide in the higher values. Some $\frac{1}{10}$th watt miniature resistances and a range of Shallcross "Akra-ohm" wire-wound resistance elements and robust rotary switches of low contact resistance should appeal to those interested in the construction of laboratory test gear. Another item of interest to the research worker was the adhesive copper and aluminium screening foil for experimental amplifiers, etc., shown by the TELEGRAPH CONSTRUCTION AND MAINTENANCE Co., LTD. The latest types of high-frequency cables employing "Trolitul" disc separators, and apparatus illustrating the company's high-permeability nickel-iron alloys, illustrated recent development work undertaken by this firm.

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

A Note on Negative Feedback

To the Editor, The Wireless Engineer.

SIR,—If an amplifier without feedback has a characteristic

$$E = a_0 + a_1 e + \frac{a_2}{\underline{|2}} e^2 + \frac{a_3}{\underline{|3}} e^3 + \ldots \qquad \ldots \quad (1)$$

$$= F(e)$$

where E is the output and e the input volts, then the relation between E and e if a fractional feedback k is added will be

$$E = F(e + kE) \qquad \ldots \quad \ldots \quad \ldots \quad (2)$$

It is required to put equation 2 into the form

$$E = b_0 + b_1 e + \frac{b_2}{\underline{|2}} e^2 + \frac{b_3}{\underline{|3}} e^3 \qquad \ldots \quad \ldots \quad (3)$$

where the b's are functions of the a's of equation 1 Applying Laplace's Theorem (Edwards Diff. Calculus, 2nd ed., chap. XVIII) to equation 2

$$E = F(e) + \frac{k}{2}\frac{d}{de}\{F(e)\}^2 + \frac{k^2}{\underline{|3}} \cdot \frac{d^2}{de^2}\{F(e)\}^3 +$$

$$+ \frac{k^n}{\underline{|n+1}} \frac{d^n}{de^n}\left\{F(e)\right\}^{n+1} + \qquad \ldots \quad (4)$$

From Joliffe's form of Arbogast's Rule (Edwards, chap. XVIII)

$$\left\{F(e)\right\}^{n+1} = a_0^{n+1} + e\Delta a_0^{n+1} + \frac{e^2}{\underline{|2}}\Delta^2 a_0^{n+1}$$

$$+ \frac{e^3}{\underline{|3}}\Delta^3 a_0^{n+1} + \qquad \ldots \quad \ldots \quad (5)$$

where Δ is the operator

$$\left(a_1 \frac{\partial}{\partial a_0} + a_2 \frac{\partial}{\partial a_1} + a_3 \frac{\partial}{\partial a_2} + \ldots\ldots\right)$$

It follows that—

$$\frac{d^n}{de^n}\left\{F(e)\right\}^{n+1} = \Delta^n a_0^{n+1} + e\Delta^{n+1} a_0^{n+1}$$

$$+ \frac{e^2}{\underline{|2}}\Delta^{n+2} a_0^{n+1} + \frac{e^3}{\underline{|3}}\Delta^{n+3} a_0^{n+1} + \qquad \ldots \quad (6)$$

Substituting from equation 6 into equation 4 gives the required expansion and picking out terms

$$\left.\begin{aligned} b_0 &= a_0 + \frac{k}{2}\Delta a_0^2 + \frac{k^2}{\underline{|3}}\Delta^2 a_0^3 + \frac{k^3}{\underline{|4}}\Delta^3 a_0^4 + \ldots \\ b_1 &= a_1 + \frac{k}{2}\Delta^2 a_0^2 + \frac{k^2}{\underline{|3}}\Delta^3 a_0^3 + \frac{k^3}{\underline{|4}}\Delta^4 a_0^4 + \ldots \\ b_2 &= a_2 + \frac{k}{2}\Delta^3 a_0^2 + \frac{k^2}{\underline{|3}}\Delta^4 a_0^3 + \frac{k^3}{\underline{|4}}\Delta^5 a_0^4 + \ldots \end{aligned}\right\} \quad (7)$$

and so on.

It will be seen that $b_n = \Delta^n b_0$.

The coefficients on the right-hand side of 5. may also be expressed explicitly in terms of the a's (Muir Theory of Determinants, Vol. IV, pp. 226 and 236).

$\Delta^r a_0^s$ is equal to the rth order determinant

$$a_0^{s-r} \times \begin{vmatrix} sa_1, & -\;a_0, & 0, & 0, & 0, \\ sa_2, & (s-1)a_1, & -\;2a_0, & 0, & 0, \\ \frac{sa_3}{\underline{|2}}, & \frac{(2s-1)a_2}{\underline{|2}}, & (s-2)a_1, & -\;3a_0, & 0, \\ \frac{sa_4}{\underline{|3}}, & \frac{(3s-1)a_3}{\underline{|3}}, & \frac{(2s-2)a_2}{\underline{|2}}, & (s-3)a_1, & -\;4a_0 \end{vmatrix} \quad (8)$$

Alternatively, it may be required to express E of equations 2 and 3 and its derivatives in terms of $F(e)$ and its derivatives.

From equation 4 it is seen that E and its derivatives with respect to e can be expressed as a series of terms of the type $\frac{d^r}{de^r}\{F(e)\}^s$

But $\frac{d^r}{de^r}\{F(e)\}^s$ is equal to the coefficient of h^r in

$$\lfloor r \times \left\{ F(e) + h\frac{d}{de}F(e) + \frac{h^2}{\lfloor 2}\frac{d^2}{de^2}F(e) + \ldots \right\}^s \quad \ldots (9)$$

which can be obtained from Joliffe's Rule or from the determinant 7. Thus E and its derivatives can be expressed in terms of $F(e)$ and its derivatives.

Farnborough. A. C. BARTLETT.

Distortion in Negative Feedback Amplifiers

To the Editor, The Wireless Engineer.

SIR,—In the January issue Mr. Marinesco points out some facts with regard to negative feedback which he believes to have been neglected, namely, that due to the reduction in gain produced by negative feedback the previous stage must supply a greater signal, and the resulting increase in distortion therein may exceed the decrease due to feedback.

The fact itself is surely well known, however, as in telephone amplifiers it is customary to feed back over 2 or 3 stages; and as regards the more popular applications I myself* have advocated feeding back to a point as early in the system as practicable in order to avoid this danger, which undoubtedly exists in most cases if the output stage only is treated.

It might be a matter of some difficulty to predict the magnitude of this effect from the analysis given by Mr. Marinesco. In practice most people deal with the matter by arranging that the signal demanded of the preceding stage is so far from overloading it as to give rise to negligible distortion, or better still, to avoid a preceding stage entirely. Whether this can be done without risking instability through feeding back over a number of stages is another matter!

M. G. SCROGGIE.

* "An Inexpensive Amplifier," *The Wireless World*, June 18th, 1937.

Book Reviews

Dictionary of Radio Terminology in the English, German, French and Russian Languages

By A. S. Litvinenko, edited by Prof. V. I. Bashenoff, Mem.I.R.E.; Moscow, U.S.S.R., 1937; in One Volume of 559 + XLII pp.; obtainable from Collet's Foreign Department, 31, Gerrard Street, London, W.1; price 17/-.

The compiler of this remarkable volume has taken something like 25,000 English, German, French and Russian terms of Wireless technique (including a number of fundamental terms of mathematics, acoustics, optics, the generation and transformation of electric current, and line theory) and has arranged the lot in alphabetical order irrespective of language. He has then taken the first word in this vast list, which happens to be the English (or American) term "A-battery" and has set it in heavy type at the top of the left-hand column of page 1, which like all its fellows is divided into four vertical columns, for English, German, French and Russian respectively. But against "A-battery" he writes "See Filament battery," so the German, French and Russian columns, on this particular line, are vacant. On the next line the only word in heavy type is in the German column: it is the term "A-Verstärker," followed by an *m* to show its gender. On this same line, in the other three columns, the exact equivalents in English, French and Russian are seen in smaller, lighter type: thus in the French column we find "amplificateur (*m*) classe A; amplificateur (*m*) de type A." On the next line lower down the heavy-type word happens to be in the French column: "abaisser." The same line gives, in the smaller, lighter type, "step down" in the English column, "abwärtstransformieren" in the German, and the equivalent in the Russian. Obviously, therefore, if one glances down any one column one encounters a queer mix-up without rhyme or reason; until, that is, one realises the trick of ignoring utterly everything that is not printed in heavy type. Then, of course, everything becomes clear, and the column is as orderly as that of an ordinary dictionary. Incidentally, this concentration on the heavy-type items is aided by the fact that each of these is slightly indented, the indention being filled up by a diamond mark which catches the eye as it skims down the column. Thus, pursuing our investigation of the very first word in the Dictionary, "A-battery," we obey the instruction "See Filament battery" by turning the pages, concentrating always on the left-hand (English) column, till we find p. 209, which has as its key-word (at the very top of the column) the word "figure"; running down this column with an eye only for the diamonds, we pass through "figure-of-eight pattern," "figure of merit" . . . to "filament battery; A-battery"; while on the same line, in the smaller and lighter type, we find in the other columns the renderings "Heizbatterie (*f*)," "batterie (*f*) de chauffage; batterie (*f*) de filament; batterie (*f*) A," and the Russian equivalent. If our given word had been in one of the other languages, the process would have been precisely similar and equally simple.

The result of this system (due, we are told in the Preface, to F. W. Lengnik, a former President of the Standards Committee of the U.S.S.R.) is that this one volume is equivalent to *twelve* ordinary two-language dictionaries (if—as is doubtful—these exist), with the added advantage that the word turned up is seen simultaneously translated into three languages instead of only one: a fact which is extremely useful when, as so often occurs, certain doubtful points can be made clear by such inter-comparison. The whole thing is remarkably well done, and there is no indication that any one language is less well and fully treated than the rest. Occasionally a blank is left in one or more of the columns, indicating that there is no equivalent in that particular language; where this occurs, so far as we have found, the decision has been reasonable—indeed, we were pleasurably surprised to find that although " monkey-chatter interference " is given no translation in German, it has a French equivalent in " bavardage (*m*) de singe." The Preface includes " Mitnahmebereich " among the terms which have no equivalents in English or French, but on page 347 one can find " Mitnahme " and its equivalents " pulling into tune; pull in " and " entraînement," which are perfectly good, although it is true that the original German word is often made use of in English. On the other hand, the well-known German " Durchgriff " is translated without any qualms as " penetration coefficient; shielding factor," whereas our own impression is that although these terms are met with occasionally, the German word is more often quoted, or a conversion made to the amplification factor. Again, the German " Raster; Bildraster " is translated, in English, only by " grating," without any suggestion that " raster " is often used. By the way, where there is definitely no equivalent word, it would, we think, be an advantage if some kind of paraphrase were given, instead of a mere blank which leaves the reader completely " in the air."

As is inevitable in a first edition, and in a volume of such scope compiled by one man and not an international group, there are some omissions. Thus the English term (none too good, it is true) " universal receiver," meaning an A.C./D.C. or " all-mains " receiver, is omitted; the German " Klirrfaktor " is rendered in English only as " klirr factor," without any suggestion of an equivalent such as " coefficient of harmonic (or non-linear) distortion "—here, however, the usefulness of the other columns becomes evident, for the French rendering gives the necessary clue. " Inverse feed-back " is omitted, though the more strictly English " negative reaction; negative regeneration " are given (incidentally, the more correct alternative to " reaction," the term " retroaction," is nowhere mentioned). The German words " Stirn " (with its compounds relating to surges and telegraphy signals) and " Pressstoffe " (usually rendered as " plastic materials "—this also is omitted), are examples of terms which might well be included in a second edition. There is no mention of " trigger action," either in the English columns or as (for instance) " Umschlagwirkung " in the German; nor is " tracking " dealt with. On the whole, however, such omissions seem to be remarkably few and far between.

It may occur to the ingenious reader that the four-column system, with its essential distinction between heavy and light type, is unnecessarily complicated, and that the alphabetically arranged heterogeneous list might have been printed in a single column. As a matter of fact, this plan has actually been applied to the multi-lingual dictionary problem: we have before us a copy of a *New Universal Dictionary of the English, French, Italian and German Languages*, published many years ago by Trowitzsch & Son, Berlin, in which the pages look like those of an ordinary dictionary, the four languages being distinguished only by a small numeral. At first sight this system appears to have the advantage of simplicity, but second thoughts reveal its disadvantages, particularly in the case where one of the languages (Russian) has an alphabet differing so markedly from the others.

H. D.

Moderne Mehrgitter-Elektronenröhren (Modern Multigrid Valves).

Dr. M. J. O. Strutt, Volume 1. Construction, Operation and Characteristics. Published by Julius Springer, Berlin. Price R.M. 12.60.

This excellent book is the first volume of a work describing the modern multigrid valve and is devoted to the construction, operation and characteristics of these valves. It covers the work carried out in the Philips Laboratories at Eindhoven in Holland, a lecture to the Physical Society of Zurich and a recent article in *The Wireless Engineer* on the measurement of the high frequency properties of valves between 1.5 and 300 megacycles per second.

A number of characteristics and descriptions, which are often omitted from books dealing with these valves, find a welcome place in this work. Amongst these may be mentioned cross-modulation, amplifier noise, valve admittances and amplification at very high frequencies (up to 300 Mc/s), secondary emission valves (including electron multipliers) and beam tubes.

The subject of mixer valves is dealt with in a satisfyingly complete manner, Schrott effect, conversion slope, distortion, whistles, etc., being discussed.

The potential gradients and electron paths in valves are also discussed. Finally an excellent bibliography is included.

It is perhaps unfortunate that the subject of critical distance anodes appears to have been omitted. There are two other aspects of the subject of which one, namely grid and anode detection, is, in the opinion of the reviewer, inadequately discussed and a second, cathode coupling, might, with advantage, have been included. It is necessary, however, to point out in the case of these matters that the author might, with some justification, assume that they should be discussed in a book dealing with valves in general and not in a discussion on special types of valves.

Apart from the excellence of this book, the names of the author and of the publisher form, in themselves, two excellent inducements to purchase it.

O. S. P.

Abstracts of Papers Published in the Year 1936.

A collection of abstracts of 140 official papers published from the National Physical Laboratory in the scientific and technical press. A number of the abstracts deal with radio subjects (especially propagation) and allied matters. Published by H.M. Stationery Office, price 1s., postage extra.

Abstracts and References

Compiled by the Radio Research Board and reproduced by arrangement with the Department of Scientific and Industrial Research

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 the abstract.

PROPAGATION OF WAVES

393. ELECTROMAGNETIC WAVES PROPAGATING THROUGH METALLIC TUBES OF SECTORIAL SECTION [Several Sections of a Circular Wave Guide, divided off by Thin Radial Conductive Plates, used as Separate Guides].—S. Sonoda. (*Electrot. Journ.*, Tokyo, Dec. 1937, Vol. 1, No. 7, pp. 214–215.)

394. THE PROPAGATION OF ULTRA-SHORT WAVES [Theoretical Investigation of Effects of Diffraction and Refraction: Experimental Confirmation on 2.05, 4.1, and 7.17 m Waves (including Aircraft Tests): Diffraction plays no Appreciable Part in Hyper-Optical Ranges, which (with Their Fluctuations) are accounted for by Refraction in Atmosphere and Troposphere].—H. Plendl & G. Eckart: Ochmann. (*Zeitschr. f. tech. Phys.*, No. 11, Vol. 18, 1937, pp. 441–450.)

"On the propagation of ultra-short waves there exists an extensive literature, which partly contradicts itself. In order to bring clarity to these confusing conditions, we must attack the propagation problem completely afresh. In so doing, two main influences must be studied, diffraction and refraction." Plendl found in 1929, from some calculations on the decrease of air density with height, that refraction in the atmosphere was enough, by itself, to account for the ranges attained: "these facts were not published at the time. In the last 3 years we have investigated the ranges of ultra-short waves and their causes. . . . Most of the test results given in this paper are taken from a Dissertation for the degree of doctor submitted by Herr Ochmann." The curve of average air density over Central Europe (Fig. 5) is taken from a book by Hann & Süring.

395. REGULARITIES AND IRREGULARITIES IN THE IONOSPHERE: I.—E. V. Appleton. (*Proc. Roy. Soc.*, Series A, 15th Oct. 1937, Vol. 162, No. 911, pp. 451–479: Bakerian Lecture.) The full paper, a long summary of which was dealt with in 3231 of 1937.

396. THERMAL RADIATION AND ABSORPTION IN THE UPPER ATMOPHERE [Theory].—G. H. Godfrey & W. L. Price. (*Proc. Roy. Soc.*, Series A, 19th Nov. 1937, Vol. 163, No. 913, pp. 228–249.)

From the author's summary:—The conditions for radiative equilibrium in the atmosphere above the 100 km level are examined, taking into consideration the absorbing properties of ozone, water vapour, and molecular oxygen. Graphs are provided giving the equilibrium temperatures for different concentrations of these substances extending over a wide range . . . for the latitude of Sydney. . . . Midwinter conditions are assumed, but . . . seasonal changes are found to have negligible effects. . . . The existence of high temperatures, of the order of 1000°C or more, in the F region of the ionosphere, is a necessary consequence of the presence of appreciable oxygen at these levels. Seasonal variations of these temperatures must be small, however. The approach to equilibrium conditions in the time available is considered, and curves are given from which may be obtained the rates of cooling at night and of heating by day. . . . A case is analysed assuming the distributions of temperature and pressure suggested by Martyn & Pulley [2073 of 1936] and an estimate is made of the effect of the convection which seems to be indicated by these authors' results.

397. IRREGULAR IONIC CLOUDS IN THE E LAYER OF THE IONOSPHERE [Presence shown by Scattered Momentary Echo Signals from High-Power Transmitter: Scatter Clouds lie within or slightly above E region: Possibility of Ionising Agency due to Bright Hydrogen Eruptions in Stars].—T. L. Eckersley. (*Nature*, 13th Nov. 1937, Vol. 140, pp. 846–847.)

398. COSMIC RADIATION AND ACTIVE SOLAR PHENOMENA.—Zirkler. (*See* 420.)

399. THE OCCURRENCE OF DISRUPTIVE DISCHARGES FROM THUNDERCLOUD TO IONOSPHERE.—Malan. (*See* 421.)

400. Unusual Ionospheric Conditions and Their Relations to Auroras and Terrestrial Magnetism.—G. Leithäuser & B. Beckmann. (*Zeitschr. f. tech. Phys.*, No. 10, Vol. 18, 1937, pp. 290–299.)

The phenomena here described were found in (P',t) records for which the frequency was changed at times which appeared best for the observations. The frequency range covered was 10—2.7 Mc/s. The normal behaviour of F-region ionisation is described (Fig. 1); examples of records showing disturbed conditions are given in Figs. 2—10. Fig. 11 shows records of simultaneous magnetic disturbances. The general course of the anomalous phenomena is summarised as follows:—" At the beginning of the disturbance a slowly sinking reflecting region appears at great apparent heights. The magnetic disturbance begins at the same time, frequently with an initially continuous decrease in H and an increase in Z. When the sinking region has reached a certain height, the F reflection begins to rise, which is caused . . . not only by ionisation decrease but chiefly by a displacement of the region or its gradient. When the two reflecting levels have become close to one another, marked diffusion of the region boundaries occurs. After a certain time, F region sinks again and shows marked ionisation decrease at low levels. The magnetic disturbances are strongest at the time when the reflection curves are nearly touching and diffusion occurs. The high region which sometimes becomes visible after F region has fallen is usually not accompanied by magnetic disturbances." A connection is found between solar and auroral activity and these ionisation disturbances (Fig. 12). This connection leads to the assumption that " auroras are due to recombination of space charges formed by the arrival of corpuscular radiation from the sun in polar regions. The disturbances in the ionised regions are caused by charges, set free during such outbreaks, penetrating to lower latitudes. Separation of the charges probably also occurs here. The regions which are chiefly positively charged on their upper surface cause a displacement of the F level and decrease of ionisation there, while negative particles wandering upwards after the F region has disappeared become visible as a very high region." It is found that F_2 region is the upper boundary of F region which is subject to disturbances of this kind. The magnetic disturbances are regarded as the consequences of the current system produced by the ionospheric disturbances and the earth's rotation. The solar outbreaks are found to precede the auroral activity.

401. Tropospheric Radio Wave Reflections [Correlation between Aurora of 1st/2nd Aug. 1937, Magnetic Storm, and Tropospheric (C Region) Reflections of 2.398 Mc/s Pulses at Heights from 0.7–2.56 Kilometres: Splitting of Main Reflection into Two Parts (C_1 and C_2 Reflections): Variations of Relative Strengths of C_1 and C_2 Reflections, sometimes so Rapid as to appear a Scintillating Phenomenon].—R. C. Colwell & A. W. Friend. (*Science*, 19th Nov. 1937, Vol. 86, pp. 473–474.)

402. Fundamental Mechanisms in the Ionosphere [General Review: Photoionisation, Recombination, Formation of Negative Ions, etc.].—N. E. Bradbury. (*Journ. of Applied Physics*, Nov. 1937, Vol. 8, No. 11, pp. 709–717.)

403. Terrestrial Magnetic Variations and the Ionosphere [General Account of Recent Work: Detailed Discussion of Case of Simultaneous Fade-Out and Bright Hydrogen Solar Eruption: Overhead Currents producing Observed Magnetic Effects: Magnetic Storms].—A. G. McNish. (*Journ. of Applied Physics*, Nov. 1937, Vol. 8, No. 11, pp. 718–731.)

404. Sudden Disturbances of the Ionosphere [Summarising Account of Recent Work on Short-Wave Fade-Outs and Terrestrial Magnetic Perturbations: Solar Eruptions causing Ionisation below E Region].—J. H. Dellinger. (*Journ. of Applied Physics*, Nov. 1937, Vol. 8, No. 11, pp. 732–751.)

405. The Nature of Bright Chromospheric Eruptions [Summary of Principal Features].—R. S. Richardson. (*Journ. of Applied Physics*, Nov. 1937, Vol. 8, No. 11, pp. 752–756.)

406. Ionosphere Studies during the Total Solar Eclipse of June 19th, 1936.—Minohara & Ito. (*Electrot. Journ.*, Tokyo, Oct. 1937, Vol. 1, No. 5, pp. 159–166.) An abridged version of the paper dealt with in 2456 of 1937.

407. Reflection of Broadcasting Waves in the Atmosphere [Results of Calculations of Reflection Coefficients of Medium and Long Waves with Given Variation of Collision Frequency with Height, and Ionisation Curves corresponding to Day and Night, explain Better Nocturnal Reflection].—I. & C. Mihul. (*Comptes Rendus*, 15th Nov. 1937, Vol. 205, No. 20, pp. 904–906.)

408. Further Investigations of the Dielectric Constants of Enclosures containing Electrons.—S. P. Prasad & M. N. Verma. (*Zeitschr. f. Physik*, No. 7/8, Vol. 107, 1937, pp. 441–448.)

Continuation of work dealt with in 2519 of 1936. Here the effect, on the dielectric constant, of the time of passage of the electrons across the condenser is investigated experimentally with the circuit shown in Fig. 1, which includes a battery for variation of screen-grid potential and therefore of the velocity of the electrons between screen-grid and anode. The results are shown graphically in Fig. 2. The variations of the dielectric constant with the high-frequency voltage (results in Fig. 3, showing a parabolic variation), and with the wavelength (Fig. 4), were also measured. The general conclusions reached were that the dielectric constant decreases and tends to a limiting value as the wavelength, the electron concentration, and the time of passage of the electrons increase. A formula previously found by the writers gave better agreement with observational results than the simple Larmor expression. The writers find that the dielectric constant of an enclosure containing electrons can never become negative.

409. Indirect Ray Measurements on the Droitwich Transmitter [Special Test Transmissions received at Newcastle: Fading Phenomena due chiefly to Changes of Phase Relations between Ground Ray and Singly-Reflected Ray: Doubly-Reflected Ray often Measurable but Not Strong enough to affect Reception: Phase Relations vary with Frequency and thus produce Distortion: Ratios of Ground and Reflected Rays: etc.].—C. H. Smith. (*Wireless Engineer*, Oct. 1937, Vol. 14, No. 169, pp. 537–540.) "Fig. 10 represents a condition which is not easily explained in terms of a single reflecting layer. Fig. 11 is of interest since it registers the only occasion on which the indirect ray was greater than the ground wave."

410. Excitation and Ionisation in Active Nitrogen [investigated with Sealed Discharge Tubes and Discharges of Long Duration: No Negative Bands or High Terms of First Positive Group in Afterglow: Kaplan's Bands may be due to Long-Lived Molecular Ions arising from Discharge: Duration of Their Life and Conditions for Band Occurrence].—G. Cario & U. Stille. (*Zeitschr. f. Physik*, No. 5/6, Vol. 107, 1937, pp. 396–408.)

411. Absorption Coefficients and Mean Temperature of Atmospheric Ozone [in Region 3326–3135 Å: Numerical Results].—G. Déjardin, A. Arnulf, & D. Cavassilas. (*Comptes Rendus*, 3rd Nov. 1937, Vol. 205, No. 18, pp. 809–811.)

412. The Ultra-Violet Absorption Spectra of Atmospheric Ozone [Data: No Appreciable Structural Difference between Atmospheric and Laboratory Ozone Spectra beyond Temperature Effect: Change of Contrast of Long-Wave Principal Bands].—G. Déjardin & A. Arnulf. (*Comptes Rendus*, 22nd Nov. 1937, Vol. 205, No. 21, pp. 1000–1002.)

413. The Absorption of Solar Radiation by the Atmosphere in Band A [of Oxygen: Terrestrial Origin of Absorption: Curve of Variations of Effective Thickness of Oxygen, 1935–1937].—P. Lejay. (*Comptes Rendus*, 11th Oct. 1937, Vol. 205, No. 15, pp. 585–588.)

414. Observations of a Searchlight Beam to an Altitude of 28 Kilometres.—E. O. Hulburt. (*Journ. Opt. Soc. Am.*, Nov. 1937, Vol. 27, No. 11, pp. 377–382.)

At 5 km. the observed intensity was greater than the theoretical intensity (calculated from Rayleigh theory of molecular scattering, using standard tables of stratospheric densities) by a factor of 7; the factor decreased to about unity above 10 km, indicating the presence of a small number of haze particles at 5 km, which decreased to an imperceptible amount above 10 km.

415. Two-Pulse Oscillator [producing Pairs of Pulses at Any Frequency up to 6000 per Second: for testing Resolving Power of Pulse-Recording Circuits].—I. A. Getting. (*Review Scient. Instr.*, Nov. 1937, Vol. 8, No. 11, pp. 412–413.)

416. Addendum to "Radio Propagation over Plane Earth—Field-Strength Curves" [Approximation used in deriving Equation 17, and Its Effects: Corrections to Footnotes].—C. R. Burrows: Norton. (*Bell S. Tech. Journ.*, Oct. 1937, Vol. 16, No. 4, pp. 574–577.) Prompted by a criticism by Norton (33 of January) of the equation in Burrow's paper (1692 of 1937).

417. The Physical Reality of Zenneck's Surface Wave.—G.W.O.H: Wise: Rice. (*Wireless Engineer*, Oct. 1937, Vol. 14, No. 169, pp. 525–526.) Editorial prompted by the paper dealt with in 1690 & 1691 of 1937. *See* also 32 of January.

418. On the Propagation of High-Frequency Currents along a Three-Phase Power Transmission Line when High-Frequency Transmitting Equipment is connected to One of the Three Lines.—Yu. R. Gints. (*Izvestiya Elektroprom. Slab. Toka*, No. 8, 1937, pp. 45–53.) A theoretical investigation in which methods are indicated for determining the effective attenuation of a three-phase transmission line when it is used as described above for signalling purposes.

ATMOSPHERICS AND ATMOSPHERIC ELECTRICITY

419. On the Nature of Atmospherics: V.—R. A. Watson Watt, J. F. Herd, & F. E. Lutkin. (*Proc. Roy. Soc.*, Series A, 15th Sept. 1937, Vol. 162, No. 909, pp. 267–291.)

Authors' summary:—The results of eye-and-hand delineations of atmospheric wave-forms observed in the Red Sea and Indian Ocean, the Anglo-Egyptian Sudan, and in "control" observations in S.E. England are presented in tabular form.

Photographic recording of wave-form and of apparent direction of arrival at the two ends of a 560 km base-line reveals the details of the dispersive process by which the higher frequency components, travelling with a higher group velocity and subject to heavier attenuation than the lower frequency components, form, at distances over some 500 km, a discrete oscillatory component preceding and completely detached from a slow form of the type delineated by the eye-and-hand method. The principal characteristics of the resulting dual wave-form are plotted against distance over ranges up to 4000 km.

The oscillatory component is shown to contain prominent frequencies of the order of 5–20 kc/s, and to have peak amplitudes falling from 500 mv/m at 100 km to 25 mv/m at 4000 km. The slow form, with peak amplitudes of 125 mv/m at 100 km and 10 mv/m at 4000 km, has a first "half-cycle" whose duration lies between 1.5 and 2.5 m-sec. in the first few hundred kilometres and rises to 6 msec. at 4000 km. Some of the complexities in the factors controlling relative amplitudes and structure at the two ends of the base-line are briefly indicated. The occurrence of a "precursor" of small amplitude, comprising still higher frequency components, and approximately a millisecond in advance of the main oscillatory component, is provisionally associated with the discontinuities in the leader stroke identified by Schonland, Malan, & Collens (451 of 1936).

420. Cosmic Radiation and Active Solar Phenomena [Increases of Cosmic Rays occurring simultaneously with Bright Hydrogen Eruptions and Sunspots].—J. Zirkler. (*Naturwiss.*, 29th Oct. 1937, Vol. 25, No. 44, p. 715.)

421. Thunderstorm Discharges into the Upper Atmosphere [Observations of Phenomena resembling Auroral Discharge above Thundercloud: Probability of Disruptive Discharge from Cloud to Ionosphere].—D. Malan. (*Comptes Rendus*, 3rd Nov. 1937, Vol. 205, No. 18, pp. 812–813.)

422. Thunderless Lightning.—K. B. McEachron. (*Gen. Elec. Review*, Dec. 1937, Vol. 40, No. 12, p. 603: paragraph only.)

423. Lightning Behaviour [Liability to bounce out of Poorly Conducting Soil and do Further Damage until It Meets Ground of Less Resistance].—K. B. McEachron. (*Journ. of Applied Physics*, Nov. 1937, Vol. 8, No. 11, p. 758: short note only.)

424. Progressive Lightning: III—The Fine Structure of Return Lightning Strokes.—D. J. Malan & H. Collens. (*Proc. Roy. Soc.*, Series A, 15th Sept. 1937, Vol. 162, No. 909, pp. 175–203.)

For I & II *see* 1934 Abstracts, p. 262, and 451 of 1936. The present paper gives a detailed study of the variations there described in luminosity and in velocity "after the stroke has passed points where the original leader channel has branched," and of "their relation to the branches of the channel." The luminosity/time curve at any point along the channel is found to have a fine structure which "indicates that at various times . . . the luminosity rises and falls as the result of the development of additional energy in the channel," so that the channel is pictured as "the seat of a number of 'component' return strokes . . . called into being by the branches on the channel." The conclusions are drawn from a study of a large number of flashes, many of which are described in detail, with photographs and diagrams.

425. Development of the Spark Discharge [Pre-Discharge is Leader-Stroke: Exact Analogy to Lightning Flash: Time Intervals between Leader and Main Stroke increase rapidly with Diminishing Pressure].—T. E. Allibone & J. M. Meek. (*Nature*, 6th Nov. 1937, Vol. 140, pp. 804–805.)

426. The Course of Ionisation Processes in Gases [Cloud-Chamber Investigations with bearing on Lightning-Stroke Development and Spark Discharge].—E. Flegler. (*E.T.Z.*, 25th Nov. 1937, Vol. 58, No. 47, pp. 1262–1264.)

427. Effect of Electric and Magnetic Fields on the Electric Spark in Air at Atmospheric Pressure [Electric Field produces Curved Spark: Varying Effect of Magnetic Field may be due to Different States of Dielectric Medium].—L. Bull & P. Girard. (*Comptes Rendus*, 8th Nov. 1937, Vol. 205, No. 19, pp. 846–847.)

428. Lightning Strokes in Field and Laboratory: II.—Bellaschi. (*Elec. Engineering*, Oct. 1937, Vol. 56, No. 10, pp. 1253–1260.) For I *see* 3781 of 1935.

429. Lightning Research: I—Results of Recent Investigations in South Africa with the Boys Camera and Cathode-Ray Oscillograph: II—Laboratory and Field Investigations. — Schonland: Bellaschi. (*Electrician*, 3rd & 10th Dec. 1937, Vol. 119, pp. 663–664 & 693–695.)

430. New American Investigations on the Effects of Thunderstorms on Power-Transmission Systems [and Comparison with German Work: with 25 Literature References].—H. Grünewald. (*E.T.Z.*, 11th & 18th Nov. 1937, Vol. 58, Nos. 45 & 46, pp. 1213–1215 & 1238–1240: Correction, *ibid.*, 2nd Dec., No. 48, p. 1308.)

431. On Lightning Conductors [including Discussion of Arguments for and against Pointed Ends].—Ch. Maurain. (*Ann. des Postes, T. et T.*, Sept. 1937, Vol. 26, No. 9, pp. 822–837.)

432. Radio Meteorographs [Survey of Recent Developments].—C. B. Pear, Jr. (*Electronics*, Sept. 1937, Vol. 10, No. 9, pp. 32 and 34, 36, 38.)

PROPERTIES OF CIRCUITS

433. Thermal Fluctuations in Complex Networks [Analytical Discussion (and the Failure of the Moullin-Ellis Representation to interpret Nyquist's Equation: Author's New Representation): Measurements with Metallic and Non-Metallic Resistors: Fluctuations in Resonant Circuits and Band-Pass Filters: Signal/Noise Ratio: Input Circuit of Radio Receivers (and the Optimum Coupling): Cables: etc.].—F. C. Williams. (*Journ. I.E.E.*, Dec. 1937, Vol. 81, No. 492, pp. 751–760.)

434. On the Calculation of the Fundamental Frequencies of Non-Uniform Lines with Distributed Constants [used in Ultra-Short-Wave Working].—Kopilovich. (*See* 510).

435. Natural and Harmonic Wavelengths of Transmission Line short-circuited at One End, and of Rectangular Circuits for Decimetre Waves.—Kopilovich. (*See* 458.)

436. The Reactance Transformer in Theory and Practice.—Wells. (*See* 511.)

437. SEPARATION OF WAVES BY SYSTEMS OF PERIODICALLY VARIED RESISTANCES.—Gabrilovitch. (*See* 476.)

438. GRAPHICS OF NON-LINEAR CIRCUITS: PART II [Application to Triode: Experimental Verification, including Dynatron Circuit and Usui's Results].—Preisman. (*RCA Review*, Oct. 1937, Vol. 2, No. 2, pp. 240–250.)

For Part I *see* 3616 of 1937. From author's summary:—" By breaking up a derivative ratio into two parts, and using one part as a finite operator curve, a graphical method of construction has been developed of wide scope and comparatively simple manipulation. In contrast to the usual method of isoclines, each linear element (starting with the initial point) helps to determine the next one, so that no visual judgment is required in choosing these to blend into a smooth curve." For Usui's work *see* 78 of 1936.

439. GENERALISED CHARACTERISTICS OF NON-LINEAR TRIODE AMPLIFIERS [Discussion of the Two Methods of Treatment, Graphical (Kellog Diagram) and Mathematical or Graphical (Kusunose Diagrams): Simplification of the Latter Procedure: Application to Detection and Amplification of Fundamental: Frequency Multiplication].—P. Baudoux. (*L'Onde Élec.*, Nov. 1937, Vol. 16, No. 191, pp. 611–630: to be contd.)

440. RELAXATION OSCILLATION OF DIRECT-CURRENT REGENERATIVE AMPLIFIER [Long Period in spite of Absence of Noticeable Inductance or Capacitance: Experimental Results and Discussion: Mechanism still Unknown: Possible Utilisation of Such Long Periods ?].—Awaya, Emi, & Hasegawa. (*Electrot. Journ.*, Tokyo, Dec. 1937, Vol. 1, No. 7, pp. 208–210.)

441. ACOUSTIC BACK-COUPLING AND RETROACTIVE EFFECTS.—Bürck. (*See* 575.)

442. AN ANALYSIS OF THE OPERATION OF A CIRCUIT CONTAINING A UNIDIRECTIONAL CONDUCTOR [Detector].—A. B. Sapozhnikov. (*Izvestiya Elektroprom. Slab. Toka*, No. 9, 1937, pp. 16–21.)

A mathematical analysis is given of the operation of a unidirectional conductor (detector). The conductor is replaced by an equivalent circuit (Fig. 1) consisting of the conductor resistance R in series with three parallel branches, D, ρ and C, where D is the ideal detector (carrier layer), ρ the leakage resistance, and C the shunting capacity. A system of equations (2) determining the operating conditions of the circuit is written down, and from this the voltage/current characterisic can be represented by a series (1); it is shown that sufficiently accurate results are obtained when the first three terms only of the series are taken into consideration. The discussion is illustrated by numerical examples.

443. THE PRINCIPLE OF A RECTIFIED-FEEDBACK AMPLIFIER AND ITS APPLICATION TO DETECTOR AND COMPANDOR.—H. Nukiyama, Y. Kikuchi, & K. Yamanouchi. (*Nippon Elec. Comm. Eng.*, Aug. 1937, No. 7, pp. 255–267.)

444. THE DUPLEX-FEEDBACK AMPLIFIERS DESIGNED FOR CABLE-LOSS COMPENSATION [Combination of Resonant & Antiresonant Circuits and Resistance, in Duplex-Feedback Amplifier, gives Gain increasing approx. in proportion to Frequency: Analysis and Experiment].—J. Oizumi & S. Nishikawa: Watanabe. (*Nippon Elec. Comm. Eng.*, Aug. 1937 No. 7, pp. 225–236.) For Watanabe's work on these amplifiers *see* 1306/8 of 1937.

445. THE DESIGN OF CORRECTING CIRCUITS [for Over-All Frequency-Response Characteristic of a Radio Transmitter].—Dempt. (*See* 467.)

446. METHODS OF DISTORTION REDUCTION IN LINE AMPLIFIERS FOR MULTIPLE COMMUNICATION SYSTEMS.—Werrmann. (*See* 603.)

447. THE MODE OF ACTION OF INVERSE-FEEDBACK AMPLIFIERS.—H. Bartels & F. Schierl. (*Telefunken*, Nov. 1937, Vol. 18, No. 77, pp. 9–23.) Introduction: advantages of inverse feedback. I—Parallel and series couplings. II—The effects of inverse feedback: reduction of fluctuations in amplification due to temporal changes in working voltages, in the valves, etc: decrease of non-linear distortion: diminution of background noise level: voluntary alteration of valve data (internal resistance, "durchgriff," etc.). III—Stability. IV—Experimental work on all these effects.

448. NOTE ON THE FUNCTIONING OF NEGATIVE FEEDBACK AMPLIFIERS TERMINATING ON ANY ARBITRARY IMPEDANCES [Analysis of "Parallel" and "Series" Retroaction, and of Black's Bridge-Type Retroaction].—M. Bélus. (*Ann. des Postes, T. et T.*, Sept. 1937, Vol. 26, No. 9, pp. 804–812.)

449. VARIABLE-FREQUENCY ELECTRIC CIRCUIT THEORY.—Carson & Fry. (*See* 464.)

450. DISCUSSION ON "ON A METHOD OF DESIGNING NEW TYPE FILTERS."—Matsumae & Yoneyama: Chiba. (*Nippon Elec. Comm. Eng.*, Aug. 1937, No. 7, p. 303: reference only.) *See* 3625 of 1937.

451. TRIPOLE FILTER NETWORKS AND WAVE SEPARATORS ["Undulating Type" and "Constant Impedance Type"].—A. Matsumoto. (*Nippon Elec. Comm. Eng.*, Aug. 1937, No. 7, pp. 201–210.)

452. VALIDITY OF THE DEVELOPMENT INTO THE FOURIER INTEGRAL: APPLICATION TO TRANSIENT RÉGIMES IN FILTERS.—P. Poincelot. (*Ann. des Postes, T. et T.*, Aug. 1937, Vol. 26, No. 8, pp. 721–728.)

"If the transient régime in a filter is studied by Küpfmüller's method, the contradictory result is found of an effect anterior to the cause. Leroy [3818 of 1935] has shown that the absurdity consists in choosing arbitrarily the propagation constant of a quadripole, which is equivalent to modifying, in an arbitrary manner, the amplitude and phase of the components of the Fourier integral." The present paper takes into account the real form of the propagation constant, in the case of a low-pass filter assumed to be free from resistance. Incidentally, it explains a difficulty propounded by Bouasse relative to the use of the Fourier integral in dealing with the action of a colour filter on intermittent light (p. 728).

453. RESISTANCE-COMPENSATED BAND-PASS CRYSTAL FILTERS FOR USE IN UNBALANCED CIRCUITS [All Types reducible to Three Lattice Networks: Formulae for These: Disagreement with Landon's Comparison with Electrical Filters].—W. P. Mason: Landon. (*Bell S. Tech. Journ.*, Oct. 1937, Vol. 16, No. 4, pp. 423–436.) For Landon's paper *see* 1310 of 1937.

454. WIDE-BAND ADJUSTABLE QUARTZ FILTERS.—Kautter. (*See* 478.)

455. THEOREM OF THE IMPEDANCE UNBALANCE IN THE CASE OF A QUADRIPOLE DEFINED BY ITS CONJUGATE ELEMENTS.—M. Bélus. (*Ann. des Postes, T. et T.*, Oct. 1937, Vol. 26, No. 10, pp. 889–893.)

456. NEW METHOD OF DESIGNING RETARDATION NETWORKS [replacing Usual Filter Principle by Use of Phase-Shifter Circuit: the "Constant Voltage Feeding Type" Retardation Network].—Y. Watanabe & K. Kikuti. (*Nippon Elec. Comm. Eng.*, Aug. 1937, No. 7, pp. 268–277.) Using "duplex feedback" (1043 of 1936).

457. NOVEL METHOD OF COUPLING.—Beard. (*See* 477.)

TRANSMISSION

458. ON THE DESIGN OF MAGNETRON OSCILLATING CIRCUITS FOR DECIMETRE WAVES.—E. A. Kopilovich. (*Journ. of Tech. Phys.* [in Russian], No. 15, Vol. 7, 1937, pp. 1546–1551.)

The natural and harmonic wavelengths of a transmission line short-circuited at one end are determined, and the results so obtained are applied to an oscillating circuit consisting of a conductor bent into the shape of a rectangle and connected to the two halves of the magnetron anode. Two equations, of which one is exact (8) and the other approximate (11), are derived determining the natural and harmonic wavelengths of the circuit, and graphical methods are indicated for solving these equations. A comparison between the theoretical and experimental results shows that the accuracy of the method proposed is of the order of 2%. The case of a circuit made up of a ribbon-type conductor is also discussed.

459. GENERATION OF THREE-PHASE OSCILLATION BY A THREE-SPLIT-ANODE MAGNETRON [Cathode and Anodes connected to form a Parallel Resonance Circuit: Analysis on Analogy with 4-Electrode Valve, with Experimental Confirmation on Equivalent 3-Triode Circuit].—S. Katsurai. (*Electrot. Journ.*, Tokyo, Oct. 1937, Vol. 1, No. 5, pp. 152–158.) For another paper on the split-anode magnetron, and for Müller's work on the 3-segment type, *see* 73 & 72 of January, respectively.

460. THE MAGNETIC-FIELD VALVE EMITTER, WITH SPECIAL CONSIDERATION OF THE PRODUCTION OF DECIMETRE WAVES [Summarising Report from the Research Institute of the German State Post Office].—O. Groos. (*E.N.T.*, Oct. 1937, Vol. 14, No. 10, pp. 325–340.)

Definitions and characteristic quantities (Fig. 1, the classical magnetron; Fig. 2, its characteristics; Fig. 3, split-anode emitter; Fig. 4, single-phase oscillating circuits; Fig. 5, three-phase circuits). § A. *Theoretical principles.* 1. Habann (dynatron) oscillations. 2. Transit-time oscillations. Oscillations of the first and higher orders. § B. *The technique of magnetron emitters.* 1. Emitters for the shortest wavelength. 2. High-power emitters (with numerical data). 3. Construction, circuit, and modulation of normal magnetron emitters (with numerical data and photographs of the tubes and apparatus used by the German Post Office).

461. CONSIDERATIONS OF A SYSTEM OF ULTRA-SHORT-WAVE SIMULTANEOUS [Duplex] TELEPHONY.—Ohtaka & Hasegawa. (*See* 689.)

462. AN EXPERIMENT ON MULTIPLEX-CARRIER TELEPHONY ON AN ULTRA-SHORT WAVE AT TSUGARU STRAIT.—Matsumae & Yonezawa. (*See* 690.)

463. A NOVEL SYSTEM OF DIPLEX TRANSMISSION.—Gracie. (*See* 693.)

464. VARIABLE-FREQUENCY ELECTRIC CIRCUIT THEORY, WITH APPLICATION TO THE THEORY OF FREQUENCY MODULATION [Fundamental Formulae derived and applied to Transmission, Reception, and Detection: Comparison with Amplitude Modulation].—J. R. Carson & T. C. Fry. (*Bell S. Tech. Journ.*, Oct. 1937, Vol. 16, No. 4, pp. 513–540.)

465. MODULATION BY INTERRUPTION AND BY INVERSION: CALCULATION OF THE MODULATION PRODUCTS.—M. Parmentier. (*Ann. des Postes, T. et T.*, Sept. 1937, Vol. 26, No. 9, pp. 773–803.)

466. PRACTICAL OVER-MODULATION PREVENTER [Western Electric: giving Automatic Compression or Limiting when Modulation Depth exceeds Predetermined Value].—W. N. Weeden. (*Wireless World*, 2nd Dec. 1937, Vol. 41, pp. 563–564.)

467. THE DESIGN OF CORRECTING CIRCUITS [for Amplitude Distortion]. — B. K. Dempt. (*Izvestiya Elektroprom. Slab. Toka*, No. 8, 1937, pp. 35–39.)

A theoretical investigation is presented of a circuit suitable for correcting the over-all frequency-response characteristic of a communication channel from the input of the microphone to the output of the radio transmitter. It is suggested that such a circuit should be connected in front of the last amplification stage of the radio transmitter.

The circuit considered (Fig. 1) operates into a load r_2 and consists essentially of a series element (resistance r_1) and a shunt element (resistance r_3 and capacity C_3 in series). Coefficients K_Ω and K_ω, indicating the voltage attenuation introduced by the circuit at the lower and the upper ends respectively of the broadcast frequency band, are determined, and a formula (5) is derived representing the ratio of K_Ω and K_ω. From this formula the constants of the circuit can be calculated for a particular case.

The discussion is illustrated by two numerical examples in which more complicated circuits than the one indicated above are calculated, and in order to simplify the necessary calculations a number of curves are given.

468. CATHODE-COUPLED DRIVER FOR CLASS B MODULATORS.—R. B. Shimer. (*QST*, Dec. 1937, Vol. 21, No. 12, pp. 35 and 100.)

469. GRAPHICS OF NON-LINEAR CIRCUITS [including Dynatron Oscillator: Usui's "Fundamental Concept for Oscillators": etc.].—Preisman. (*See* 438.)

RECEPTION

470. THE NOISE-SUPPRESSING ACTION OF A SECONDARY CIRCUIT IN SUPER-REGENERATIVE RECEIVERS OF ULTRA-SHORT WAVES.—S. Uda. (*Nippon Elec. Comm. Eng.*, Aug. 1937, No. 7, pp. 237–245.) A summary was dealt with in 948 of 1937.

471. THE "UDA" EFFECT IN THE SUPER-REGENERATIVE RECEPTION OF ULTRA-SHORT WAVES [Appearance of Condition of Clear Communication].—Ohtaka & Hasegawa: Uda. (In the paper dealt with in 689, below.)

472. ON SEVERAL PROBLEMS OF SUPER-REGENERATION.—T. Hayasi. (*Nippon Elec. Comm. Eng.*, Aug. 1937, No. 7, pp. 246–254.) A summary was dealt with in 2952 of 1937.

473. FREQUENCY STEP-UP METHOD IN RADIO RECEPTION [Signal stepped-up in Frequency before Detection: Wide Wavelength Range obtained: Super-Regenerative Reception applicable, with Its High Sensitivity for Short and Ultra-Short Waves].—S. Uda. (*Nippon Elec. Comm. Eng.*, Aug. 1937, No. 7, pp. 305–306: summary only.)

474. FORMULAE APPLIED TO THE RECEPTION AND DETECTION OF FREQUENCY-MODULATED WAVES.—Carson & Fry. (*See* 464.)

475. THERMAL FLUCTUATIONS IN COMPLEX NETWORKS [and the Input Circuit of Radio Receivers].—Williams. (*See* 433.)

476. SEPARATION OF WAVES BY SYSTEMS OF PERIODICALLY VARIED RESISTANCES.—L. Gabrilovitch. (*Comptes Rendus*, 22nd Nov. 1937, Vol. 205, No. 21, pp. 969–971.)

"Up to the present only one means has been used to separate electric waves, namely resonance (or its homologue, electrical filtration)." The theory is here given on which periodic variation of the internal resistance of a thermionic valve permits the suppression of a wave whose carrier has the same frequency as that of the resistance variation, while a wave of another frequency is not suppressed. The writer denotes such processes by the term "quasi-linear" and gives the general form of the equations governing them; the phenomena do not obey the principle of superposition of small movements. Among the results already obtained by this arrangement are the following: attenuation of 57.2 db per stage of a modulated wave: elimination of a continuous interfering signal right in the middle of the frequency spectrum of a modulated wave (this elimination was produced regularly, even when the interference coincided with one or other of the sidebands): and the separation of two modulated waves whose sidebands were almost entirely superposed, the carrier-frequency difference being only 100 c/s.

477. NOVEL METHOD OF COUPLING [Upper and Lower Limits of Band-Pass of Coupled Circuits adjusted by Combination of Series and Parallel Coupling Impedances].—E. G. Beard. (*Wireless Engineer*, Nov. 1937, Vol. 14, No. 170, p. 608.) For Editorial see *ibid.*, pp. 586–587. *Cf.* also 3294 of 1937.

478. WIDE-BAND ADJUSTABLE QUARTZ FILTERS [and the Mathematical Treatment when Filter Band-Width is No Longer Narrow compared with That of Associated Oscillatory Circuit].—W. Kautter. (*Telefunken*, Nov. 1937, Vol. 18, No. 77, pp. 42–50.)

Leading from the work on variable quartz filters dealt with in 3284 of 1937. The mathematical treatment of such filters is greatly simplified by the assumption that the impedance of the associated oscillatory circuit is independent of frequency in comparison with the filter itself; but in the case mentioned in the title-extension, which is particularly liable to occur when a low intermediate frequency is used, this simplification cannot be made, and a different treatment, here given, becomes necessary. It is shown that the bandwidth increases at first linearly with the damping of the quartz, but later with the square root of this. The tuning of the oscillatory circuit must be carried out very carefully, otherwise the filter curves will become asymmetrical; thus with wide-band filters the plan of band-width variation by a detuning of the oscillatory circuit, possible with narrow-band filters, is out of the question. The calculation of characteristic curve data, such as the distance between humps, their heights ("excess amplification"), and the dip in the plateau, is given.

479. SCREENED AERIALS [General Principles: Conditions for Satisfactory Working: Revised Theory of Operation].—F. R. W. Strafford. (*Wireless World*, 25th Nov. 1937, Vol. 41, pp. 516–518.)

480. HIGH-FREQUENCY [up to and over 100 kc/s] TRANSIENTS IN THE SWITCHING OF THREE-PHASE SYSTEMS.—H. Baatz. (*E.T.Z.*, 18th Nov. 1937, Vol. 58, No. 46, p. 1240: summary only.)

481. THE VITH NATIONAL CONGRESS OF RADIO-ELECTRIC PROTECTION [against Interference: Paris, 2nd Oct. 1937].—M. Adam. (*Génie Civil*, 20th Nov. 1937, Vol. 111, No. 21, pp. 430–432.)

482. A REVIEW OF RADIO INTERFERENCE INVESTIGATION [including External Cross Modulation].—F. E. Sanford & W. Weise. (*Elec. Engineering*, Oct. 1937, Vol. 56, No. 10, pp. 1248–1252.)

483. THERMAL DRIFT IN SUPERHETERODYNE RECEIVERS [Too Great and Prolonged to be explained by Ordinary Effects on Coils, Condensers, or Valves: Test Results lay blame on High Positive Temperature Coefficients of Dielectric Constants of Synthetic Resins used in Formers, Insulators, Sockets, etc: Great Reduction by use of Ceramic Materials].—J. M. Miller. (*Electronics*, Nov. 1937, Vol. 10, No. 11, pp. 24–25.) Another alleged criminal was a "tickler" winding wound over the main oscillator coil, with several layers of varnished silk between.

484. MATHEMATICAL TREATMENT OF THE GRID BIAS RESISTOR [showing Equivalence of Z_c in Cathode Circuit to $(\mu+1) . Z_c$ in Anode Circuit].—W. Richter. (*Electronics*, Nov. 1937, Vol. 10, No. 11, pp. 62 and 64.)

485. REMARKS ON A DOUBLE SUPERHETERODYNE IN COMMERCIAL FORM.—E. G. Beard. (*Wireless Engineer*, Nov. 1937, Vol. 14, No. 170, p. 608.) In the letter dealt with in 477, above. *See* also 3294 of 1937. The present remarks are prompted by the "pessimistic conclusions" of Kinross (3295 of 1937). For the latter's reply see *ibid.*, December, p. 657.

486. 2-RF STRAIGHT SET, *and* SMALL QUALITY AMPLIFIER.—(*Wireless World*, 18th & 4th Nov. 1937, Vol. 41, pp. 494–496: pp. 438–441.)

487. AN IMPROVED DUAL-DIVERSITY RECEIVER FOR HIGH-QUALITY 'PHONE RECEPTION.—J. L. A. McLaughlin & K. W. Miles. (*QST*, Dec. 1937, Vol. 21, No. 12, pp. 17–21 and 76, 78, 80.) For the original receiver *see* 2581 of 1936. Among the improvements is the introduction of the "infinite-rejection i.f. system"—*see* 488, below.

488. A NEW I.F. AMPLIFIER SYSTEM WITH INFINITE OFF-FREQUENCY REJECTION [by Use of Combined Mutual-Inductive and Capacitive Couplings, with Power-Factor Correction].—K. W. Miles & J. L. A. McLaughlin. (*QST*, Nov. 1937, Vol. 21, No. 11, pp. 19–23.) Giving, for instance, an over-all selectivity curve "less than 10 kc wide at ten thousand times down" and still retaining "a band-width near the nose of approximately three kilocycles," while acting as "a variable rejector of infinite attenuation for removing heterodyne carriers within this frequency band."

489. AVOIDING GANGING ERRORS [Influence of Primary of RF Transformer or Aerial Tuned Circuit on Accuracy of Ganging].—W. T. Cocking. (*Wireless World*, 4th Nov. 1937, Vol. 41, pp. 463–464.)

490. THE DESIGN CALCULATION OF TONE CONTROLS [Resistance- and- Variable-Condenser Type, a Control to restore Low Notes in Gramophone Reproduction, and a "Resonance" Tone Control for reinforcing High Notes].—H. Pitsch. (*Funktech. Monatshefte*, Nov. 1937, No. 11, pp. 329–332.)

491. BASS COMPENSATION DESIGN CHART [for Tapped-Volume-Control Bass Compensators].—D'Orio & De Cola. (*Electronics*, Oct. 1937, Vol. 10, No. 10, pp. 37 and 38.)

492. ON THE DISTORTION DUE TO FADING ON SHORT-WAVE RADIOTELEPHONY [and the Use of A.V.C.]. — M. P. Dolukhanov. (*Izvestiya Elektroprom. Slab. Toka*, No. 8, 1937, pp. 16–35.)

The effects of various types of fading of a sinusoidally modulated wave are examined theoretically for the cases when the receiver uses (a) a linear detector and (b) a square-law detector. For each of these cases the amplitude and phase distortions of both the carrier wave and the sidebands are considered separately. Reception with an automatic volume control is next discussed, and also reception on two aerials.

The results of calculations are shown in a number of tables and curves, and the following two main conclusions are reached: 1. Reception with a.v.c. reduces the amplitude distortion of the sidebands and the phase distortion of both the carrier wave and the sidebands. 2. In order to reduce the amplitude distortion of the carrier wave a linear detector should be used in the receiver and a square-law detector in the a.v.c. circuit.

493. AVC SHORTCOMINGS [Distortions liable to be produced by Delayed AVC: Precautions against Them].—K. R. Sturley. (*Wireless World*, 23rd Dec. 1937, Vol. 41, pp. 632–634.)

494. AUTOMATIC INPUT CONTROL [Avoidance of R.F. Distortion, etc., by Valve-Controlled Potentiometer].—A. Landmann. (*Wireless World*, 25th Nov. 1937, Vol. 41, pp. 521–522.)

495. LINEAR CONTRAST EXPANSION [Survey of Methods, and a Multielectrode Valve System], *and* CONTRAST EXPANSION UNIT [Constructional Details of Above].—K. A. Macfadyen. (*Wireless World*, 2nd Dec. 1937, Vol. 41, pp. 559–560: 9th Dec. 1937, pp. 590–593.)

496. COILS WITH COMPRESSED-POWDER CORES [and the Various Components of Their Effective Resistances—Losses in Winding Space (Eddy Current, Dielectric, and Self-Capacity), in Core, and in Surroundings, particularly Screening Can: Separation and Measurement of the Components].—M. Kersten. (*E.T.Z.*, 16th & 23rd Dec. 1937, Vol. 58, Nos. 50 & 51, pp. 1335–1338 & 1364–1367.)

For a previous paper *see* 2377 of 1937. The optimum core permeability, giving the smallest loss angle, moves towards smaller values as the working frequency increases. For coils of usual size and of reasonably economical construction, the smallest loss angle obtainable is around 1‰, such a value being given only in the neighbourhood of the "optimum" frequency.

497. THE DESIGN OF INDUCTANCES FOR FREQUENCIES BETWEEN 4 AND 25 MEGACYCLES.—Pollack. (*RCA Review*, Oct. 1937, Vol. 2, No. 2, pp. 184–201.) *See* 104 of January.

498. THE S.P.I.R. STANDARDISATION [for Coils and Variable Condensers of Radio Receivers: Examination of Its Results].—U. Zelbstein. (*Toute la Radio*, Dec. 1937, No. 47, Supp. No. 30, pp. 289–292.)

499. INDUCTANCES IN RECTIFIER CIRCUITS [Survey of Action of Smoothing Chokes in Various Circuits: Field in Iron Circuits coupling Such Chokes magnetically: Circuit giving practically Constant Field with Single-Phase Feed without Transformer].—K. Strobl. (*Arch. f. Elektrot.*, 15th Sept. 1937, Vol. 31, No. 9, pp. 594–608.)

500. AN ADJUSTABLE HIGH RESISTANCE WITHOUT SLIDING CONTACT [Semiconductor with High Negative Temperature Coefficient, combined with an Electrically Separate Heater: suitable for Many Purposes including Remote Control of H.F. Amplifiers].—Neldel. (*Zeitschr. f. tech. Phys.*, No. 11, Vol. 18, 1937, pp. 464–466.)

Using, as the semiconductor, magnesium-titanium spinel (originally an insulator) made semiconducting, with electronic conductivity, by a reduction treatment, and forming a small hollow cylinder inside which is a hairpin heating filament.

501. COMPONENTS FOR 1938 RADIO SETS.—(*Electronics*, Sept. 1937, Vol. 10, No. 9, Supp. pp. 1–8.)

502. METALS IN RADIO [particularly in Die Castings for New Mechanisms, etc., in Broadcast Receivers].—H. Chase. (*Electronics*, Oct. 1937, Vol. 10, No. 10, pp. 12–17 and 76.)

503. NEW PLASTIC MATERIALS FOR CABINETS.—H. Chase. (*Electronics*, Nov. 1937, Vol. 10, No. 11, pp. 26–30.)

504. POWER CONSUMPTION OF RADIO RECEIVERS.—(*Electrician*, 29th Oct. 1937, Vol. 119, p. 490.) *See* also *BEAMA Journal*, Oct. 1937, p. 97.

505. TECHNICAL EDUCATIONAL REQUIREMENTS OF THE MODERN RADIO INDUSTRY: PART II—THE FIELD OF RADIO SERVICING.—F. L. Horman. (*RCA Review*, Oct. 1937, Vol. 2, No. 2, pp. 213–219.)

506. THE FACTS ON RST [System of Signal-Strength Reporting].—A. M. Braaten. (*QST*, Dec. 1937, Vol. 21, No. 12, pp. 59–60.) *See* also 1427 of 1935.

507. HIGHLY SENSITIVE MORSE SOUNDER [Use of Super-Permalloy and Proper Design reduces Working Current from 60 to 8 Milliamperes].—S. Shimada & T. Nishina. (*Nippon Elec. Comm. Eng.*, Aug. 1937, No. 7, p. 304: summary only.)

AERIALS AND AERIAL SYSTEMS

508. THE SERIES PHASE ARRAY [Principles of "End-Fire" ("In-Line") Arrays in general: the Franklin Series Phase Array, with Considerable Effective Height: Suitability for Transmission and Reception: etc.].—A. W. Ladner. (*Marconi Review*, Sept./Dec. 1937, No. 67, pp. 1–13.) *See* also Wells, 120 of January.

509. THE CALCULATION OF INPUT, OR SENDING-END, IMPEDANCE OF FEEDERS AND CABLES TERMINATED BY COMPLEX LOADS.—H. Cafferata. (*Marconi Review*, Sept./Dec. 1937, No. 67, pp. 21–39.)

Continuation of the work dealt with in 2678 of 1937. Three further examples of the use of the chart are given, showing its wide applications. Fundamental principles are discussed, and a supplementary chart is given.

510. ON THE CALCULATION OF THE FUNDAMENTAL FREQUENCIES OF NON-UNIFORM LINES WITH DISTRIBUTED CONSTANTS.—E. A. Kopilovich. (*Journ. of Tech. Phys.* [in Russian], No. 12, Vol. 7, 1937, pp. 1253–1255.)

In ultra-short-wave work, transmission lines having sections with different characteristic impedances are often used. In the present paper the following three cases are considered separately: (a) when a Lecher system is connected to a pair of short-circuited conductors (Fig. 1), (b) when it is connected to a pair of open-circuited conductors (Fig. 4), and (c) when the transmission line consists of three sections, of which the first and the last are identical (reference is made to "Fig. 6," but the figure itself is not shown in the paper). For each of the above cases equations are derived determining the fundamental frequencies and harmonics of the lines, and graphical methods are indicated for solving these equations.

511. THE REACTANCE TRANSFORMER IN THEORY AND PRACTICE [for Matching a T Joint in Feeders, etc.].—N. Wells: Green. (*Marconi Review*, Sept./Dec. 1937, No. 67, pp. 40–48.)

Amplifying and extending the theoretical treatment given by Green (3368 of 1935). A graphical treatment is given, its validity being proved. The advantages of the transformer are discussed, such as the wide range of load ratio covered within comparatively small limits of physical component values, and the ease of adjustment.

512. AN INVESTIGATION OF THE INTERACTION BETWEEN TWO RHOMBIC AERIALS.—B. V. Braude. (*Izvestiya Elektroprom. Slab. Toka*, No. 8, 1937, pp. 1–16.)

Two rhombic aerials, one "active" and the other "passive," placed side by side are considered and methods are indicated for calculating the current induced in one side of the passive aerial by the current in the nearest side of the active aerial, when (a) these two sides are parallel, and (b) when the longitudinal axes of the two aerials are parallel. The losses due to the induced currents in the passive aerial are also determined.

The theoretical discussion is followed by a report on an experimental investigation to check the theoretical results and to determine the effect of the passive aerial on the directive properties of the active aerial. The experiments, fully described, were carried out with models of aerials on a wavelength of 65 cm. The paper is concluded by a number of practical suggestions.

513. WIDE-ANGLE INTERFERENCE OF MULTIPOLE RADIATION [Optical Theory: Formula representing Interference Pattern for Various Geometrical Arrangements and Arbitrarily Composed Sources: Coherence Properties of Beams: etc.].—O. Halpern & F. W. Doermann. (*Phys. Review*, 1st Nov. 1937, Series 2, Vol. 52, No. 9, pp. 937–943.)

514. "THE DESIGN AND CALCULATION OF AERIALS" [in Russian].—(Published by Svyaz'tekhizdat 2, proezd Chistoprudnogo bul'vara, Moscow).

A volume including the following papers: The Present State of Aerial Technique (Dombrovski): Anti-Fading Aerials for Broadcasting Waves (Dembovski): Directive Broadcasting Aerials (Markov): On Aerials radiating along Their Planes (Naidenenko): The Rhombic Aerial (Aizenberg): The Method of Induced E.M.F.'s and Its Use in the Design of Aerials (Dombrovski).

515. A ROTARY SPIDER-WEB LOOP ANTENNA WITH REFLECTOR: AN INEXPENSIVE HORIZONTAL ARRAY OF GOOD DIRECTIVITY.—C. W. Lugar. (*QST*, Dec. 1937, Vol. 21, No. 12, pp. 25–26 and 90, 92, 94.)

516. COMPARATIVE INVESTIGATIONS ON ROD ["Stab"] AERIALS [Various Types on Market for Broadcast Reception, in conjunction with Screened Downleads: Effectiveness depends Not on Amount of Metallic Surface but on Amount of Space Enclosed: etc.].—H. Röhl. (*E.T.Z.*, 16th Dec. 1937, Vol. 58, No. 50, pp. 1345–1346.)

517. SCREENED AERIALS [General Principles: Conditions for Satisfactory Working: Revised Theory of Operation].—F. R. W. Strafford. (*Wireless World*, 25th Nov. 1937, Vol. 41, pp. 516–518.)

518. RADIO RECEIVING ANTENNAS OF THE NOISE-REDUCING TYPE [including One for both Broadcast and Short-Wave Bands].—R. B. Dome. (*Gen. Elec. Review*, Dec. 1937, Vol. 40, No. 12, pp. 580–583.)

519. "DIE BESTEN ANTENNEN" [for Broadcast Reception: Book Review].—Kappelmayer & Engel. (*E.T.Z.*, 16th Dec. 1937, Vol. 58, No. 50, p. 1360.)

VALVES AND THERMIONICS

520. ON "SENTRON"—A NEW TUBE FOR ULTRA-SHORT WAVES [2, 3, and 4-Split Magnetrons with Extra Wings to increase Heat-Radiation, and Indirectly or Directly Heated Spiral Filament in Central Aperture in One of Two End-Discs, or in Both: Useful Dynatron-Type Output 10-20 Watts at 70-100 cm: also Stable Electronic Type 15-20 cm].—Uda, Uchida, & Sekimoto. (*Electrot. Journ.*, Tokyo, Oct. 1937, Vol. 1, No. 5, pp. 167–168.)

521. SPLIT-ANODE MAGNETRON OF SPECIAL TYPE [giving Improved Efficiency and Other Advantages: B-Type Oscillations: Coaxial Spiral Filament, End Discs, and (in One Model) Central Disc].—K. Okabe. (*Electrot. Journ.*, Tokyo, Dec. 1937, Vol. 1, No. 7, pp. 213–214.)

522. THE REQUIREMENTS AND PERFORMANCE OF A NEW ULTRA-HIGH-FREQUENCY POWER TUBE [RCA 888, 750 Watts Class C Output: also RCA 887, with Smaller Amplification Factor].—W. G. Wagener. (*RCA Review*, Oct. 1937, Vol. 2, No. 2, pp. 258–264.) On the valves referred to in 3322 of 1937.

523. TRANSIT-TIME EFFECTS IN ELECTRONIC VALVES [Theoretical Investigations of Conditions producing Additional Damping or Reduced Damping: the Dependence of Conductivity on Frequency].—I. Runge. (*Zeitschr. f. tech. Phys.*, No. 11, Vol. 18, 1937, pp. 438–441.)

Further development of the work dealt with in 4041 of 1937. Author's summary:—At high frequencies the convection current of an electronic discharge is no longer constant along its path, owing to changing acceleration. The current in the external circuit is in this case, apart from the current of the pure electrode capacity, equal to the spatial mean of the convection current. Since the convection current can be separated from the other current by a negative grid, the grid current is equal to the excess of the spatial mean over the local convection current. In cases where the real component of the convection current decreases along its path, the grid has therefore a positive energy consumption: this occurs in space-charge-limited discharges. In discharges in the saturation zone, on the other hand, the real component of the convection current increases along its path: here the grid energy is negative—that is, the grid receives energy at the cost of the anode circuit.

524. THE CAUSES OF THE INCREASE IN THE ADMITTANCES OF MODERN H.F. AMPLIFIER VALVES IN THE SHORT-WAVE RANGE.—M. J. O. Strutt & A. van der Ziel. (*E.N.T.*, Sept. 1937, Vol. 14, No. 9, pp. 281–293.)

Recent measurements of input and output losses and retroaction capacity of modern h.f. amplifier valves show that these quantities increase in the short-wave range. This has been ascribed to an increase in electron inertia and therefore in the electron transit time between cathode and control grid. This paper puts forward an experimental and theoretical proof that this view is not correct but that the cause is to be sought in capacitative and inductive effects inside and outside the valves. In §II the general theory, based on circuit equations, is given of the tetrode as an h.f. amplifier (Fig. 1); in §III this is extended to pentodes and hexodes. The formulae obtained are discussed in §IV, taking into account the magnitude of the inductances and capacities between the straight leads, electrodes, etc; it is found that the anode admittance, the retroaction, etc., are much influenced by the connections inside the valve. Resonance phenomena inside the valve are also discussed.

In §V measurements for separating the various parts of the input admittances are described;

it is found that it is useless to make the distance between the control grid and cathode too small in valves of otherwise normal dimensions. §VI gives measurements of the part of the input admittance due to the electrons, and §VII measurements of the anode admittance and the retroaction. It is found that about 1/2 to 2/3 of the input losses are due to inductive effects, for which the experiments give good confirmation of the formulae; this is not the case for the formulae including electron transit time.

525. FURTHER INVESTIGATIONS OF THE DIELECTRIC CONSTANTS OF ENCLOSURES CONTAINING ELECTRONS.—Prasad & Verma. (*See* 408.)

526. TRACING ELECTRON PATHS IN ELECTRIC FIELDS [Simple but Rigorous Method where No Magnetic Forces are present].—H. Salinger. (*Electronics*, Oct. 1937, Vol. 10, No. 10, pp. 50 and 52, 53.)

527. "ON THE ACCURACY OF FOCUSING ELECTRON STREAMS IN A KUBETSKI [Electron-Multiplier] TUBE": CRITICISM.—Astaf'ev: Voroshilov. (*See* 624.)

528. A MODIFIED FORM OF THE MAGNETIC ELECTRON MULTIPLIER OF A.C. TYPE.—Mito. (*See* 625.)

529. SHOT EFFECT OF SECONDARY ELECTRONS FROM NICKEL AND BERYLLIUM [measured over Range of Primary Energies up to 1600 V: Secondary Emission Ratio].—B. Kurrelmeyer & L. J. Hayner. (*Phys. Rev.*, 1st Nov. 1937, Series 2, Vol. 52, No. 9, pp. 952–958.) Details of work dealt with in 3312 of 1937.

530. THE EFFECT OF THE EXTERNAL FIELD ON THE ELECTRON-EMISSION CONSTANTS OF BARIUM-COATED PLATINUM SURFACES.—R. Suhrmann & J. L. von Eichborn. (*Zeitschr. f. Physik*, No. 7/8, Vol. 107, 1937, pp. 523–548.)

The photocell shown in Fig. 1 is used to measure the variation of the total photoelectric emission of a barium-coated platinum wire with the temperature of the light source over a large range of anode potential, for various surface conditions. The method of the photoelectric straight line (Figs. 4, 5) is then used to determine the variation with the external field of the "separation potential" ψ and the "mass-constant" M. Both ψ and M are found to decrease first rapidly and then more slowly as the external field increases (Figs. 6a–e). The ψ-curves can be represented over a large range by superposing the "image field" and a composite "spot field," though this does not hold for small external fields. The results of other writers are discussed in relation to the present experiments.

531. ON A NEW METHOD OF DETERMINING THE SATURATION CURRENT OF A THERMIONIC TUBE [from Measured Values of Initial Current, without Injury to Valve or Complications caused by Large Plate Currents].—Y. Watanabe & T. Takahasi. (*Nippon Elec. Comm. Eng.*, Aug. 1937, No. 7, pp. 299–300: summary only.)

"The most interesting point in the above explained new method is that by measuring a current of the order of 10^{-8} A we obtain the actual saturation current of nearly a million-fold measured value. In such an indirect method the accuracy theoretically depends on the assumption of Maxwell's velocity-distribution law," and tests confirm this accuracy so long as the saturation current is very small compared with the filament current.

532. THERMIONIC EMISSION [Experiments leading to Simpler Emission Law than Schottky's: Explanatory "Contact Potential" Theory].—E. W. B. Gill. (*Phil. Mag.*, Dec. 1937, Series 7, Vol. 24, No. 165, pp. 1093–1103.)

Measurements are described of the thermionic emission from a hot valve filament, particularly of the region where the current flowing is "saturated." It is found that the emission is better described by the formula $i = i_0 + a\sqrt{V}$ than by Schottky's expression $i = i_0 e^{b\sqrt{V}}$; the new expression applies equally to bright emitters and to coated filaments. To explain the results, "it is suggested that there is a constant contact potential difference between a hot filament at a fixed temperature and an external vacuum, the electrons producing this potential being available for removal from the vicinity of the filament under an external field. If they are removed, an equal number come from the filament to maintain the contact potential at its constant value. The majority of the electrons from the filament take part in this process, but a smaller number pass from the filament with a higher velocity, and leave its vicinity completely unless forced back by a sufficiently large opposing external field. It is the presence of these higher velocity electrons which alone distinguishes the phenomenon from the contact potential between two dissimilar metals, or between a metal and a liquid."

533. THERMIONIC EMISSION OF POSITIVE IONS FROM MOLYBDENUM [Theory of Ion Emission: Equation for Temperature Variation of Current Density of Thermionic Positive Ions: Experiments on Mo and W: Effect of Ions of Alkali Impurities: Corrected Ion Work Function for Mo].—H. Grover. (*Phys. Review*, 1st Nov. 1937, Series 2, Vol. 52, No. 9, pp. 982–986.)

534. *Wireless World* VALVE DATA SUPPLEMENT.—(*Wireless World*, 25th Nov. 1937, Vol. 41, pp. 527–550.)

535. METAL VALVE USED TO MEASURE DIFFUSION OF HYDROGEN [through Steel, from Surrounding Water: Stainless Steel has Better Resistance: No Appreciable Amount admitted from Air: etc.].—F. J. Norton. (*Electronics*, Oct. 1937, Vol. 10, No. 10, p. 46.) *See* also *Journ. of Applied Physics*, July 1937, Vol. 8, No. 7, p. 486.

536. THE TELEFUNKEN TRANSMITTING VALVES, POWER AMPLIFIERS, AND RECTIFIERS: III—RECTIFIERS.—Kühle & Kluge. (*See* 673.)

537. "CHARACTERISTIC CONSTANTS OF H.F. PENTODES": CORRECTIONS.—Strutt. (*Wireless Engineer*, Oct. 1937, Vol. 14, No. 169, p. 551.) *See* 4094 of 1937.

538. Class B Radio-Frequency Amplifier Chart [Calculation of Power Output, Plate Efficiency, and R.F. and D.C. Plate Currents, from Valve Characteristics and Operating Voltages, making Use of "Perveance" of Amplifier Valve].—(*Electronics*, Nov. 1937, Vol. 10, No. 11, p. 41.)

539. Generalised Characteristics of Non-Linear Triode Amplifiers.—Baudoux. (*See* 439.)

540. A Method of Determining the Operation of Class C Amplifiers [by Möller's "Schwinglinie" Technique].—K. Hosaka. (*Nippon Elec. Comm. Eng.*, Aug. 1937, No. 7, p. 293: summary only.)

DIRECTIONAL WIRELESS

541. Electrical Compensation of Deviation in Radio Direction-Finders.—P. V. Karmalin. (*Izvestiya Elektroprom. Slab. Toka*, No. 9, 1937, pp. 1–9.)

Methods are indicated for correcting errors in Bellini-Tosi direction-finders due to re-radiation from near-by metallic objects. The methods proposed are based on modifying the fields of the fixed coils in the goniometer unit. This is achieved by connecting capacities and inductances in parallel with one of the coils.

A formula (15) is derived determining the value of the correcting inductance for a d.f. system consisting of inductances only, and other formulae (27 and 29) are given in which inductances and capacities are taken into account. The variation of the error with the operating frequency and methods for compensating this are also discussed. It is stated that by using the methods proposed the error can be kept within approximately 1° over the whole frequency range. The paper is concluded by a numerical example in which the sequence of various operations is clearly set out.

542. Cathode-Ray Compass [giving "Average" Reading in presence of Rapidly Changing Wave-Front Phases].—Telefunken. (*Electronics*, Sept. 1937, Vol. 10, No. 9, p. 38: photograph and caption only.)

543. Telecommunication Services for Civil Aviation.—R. M. Badenach. (*Journ. Inst. Eng. Australia*, Oct. 1937, Vol. 9, No. 10, pp. 413–421.)

ACOUSTICS AND AUDIO-FREQUENCIES

544. A Method for Investigating Oscillating Processes taking place in a Loudspeaker.—I. Ya. Breydo & L. L. Myasnikov. (*Izvestiya Elektroprom. Slab. Toka*, No. 9, 1937, pp. 30–33.)

A report on an experimental investigation in which the various phenomena taking place in an electrodynamic loudspeaker were observed by means of a circuit consisting essentially of the following: a condenser, one plate of which served also as the diaphragm of the loudspeaker, was connected to the tuned circuit of a h.f. oscillator. The output of the oscillator, modulated by the movement of the diaphragm, was applied after detection and amplification to a cathode-ray oscillograph and a valve voltmeter. In this way the oscillations of the diaphragm at various frequencies, and at inputs of the order of 7 watts, were studied, as well as the transient phenomena taking place in the loudspeaker when it was switched on or off. The frequency-response curve of the loudspeaker was also taken, and the sound pressure on the diaphragm observed by applying the output of a microphone, actuated by the loudspeaker, to the oscillograph. A number of experimental curves are shown.

545. Oscillographic Investigations of Building-Up Processes in Loudspeakers [and the Relations between the Loudspeaker Frequency Characteristics and the Form of the Building-Up Processes].—J. G. Helmbold. (*Akustische Zeitschr.*, Sept. 1937, Vol. 2, No. 5, pp. 256–261.)

546. Horn Loudspeakers: Part II—Efficiency and Distortion.—H. F. Olson. (*RCA Review*, Oct. 1937, Vol. 2, No. 2, pp. 265–277.) For Part I *see* 2607 of 1937.

547. The Frequencies and Nodal Systems of Circular Plates [calculated by Simplified Kirchhoff Method].—R. C. Colwell & H. C. Hardy. (*Phil. Mag.*, Dec. 1937, Series 7, Vol. 24, No. 165, pp. 1041–1055.)

548. The Spectrum of the Vibration Equation of a Plate with Fixed Boundaries [Theory giving Lower Limits of Frequency].—A. Weinstein. (*Comptes Rendus*, 26th Oct. 1937, Vol. 205, No. 17, pp. 707–708.) Continuation of work referred to in 3439 of 1936.

549. Theoretical and Experimental Investigation of the Flexural Oscillations of Freely-Vibrating Elliptical Plates [Ritz's Method for the Seven Geometrically Simplest Vibrations: Agreement with Experiment].—B. Pavlík. (*Zeitschr. f. Physik*, No. 7/8, Vol. 107, 1937, pp. 458–462.)

550. Middle C [Errors in Musical-Instrument Ranges of a Frequency-Spectrum Chart].—R. W. Young. (*Electronics*, Nov. 1937, Vol. 10, No. 11, p. 75.)

551. Electronic Piano produced Commercially.—Miessner. (*Electronics*, Nov. 1937, Vol. 10, No. 11, p. 48.) For Miessner's work *see* 1922 of 1935, 3061 of 1936, and 571 of 1937.

552. Two Electronic Musical Instruments from Germany ["Hellertion" and "Trautonium" Circuits].—(*Electronics*, Nov. 1937, Vol. 10, No. 11, pp. 56 and 58.) *See* also 1934 Abstracts, p. 327 (Leonhardt), and 797 of 1935.

553. Sound Transitions in the Organ [and Their Connection with the Building-Up Processes peculiar to Each Type of Pipe].—F. Trendelenburg. (*Zeitschr. f. tech. Phys.*, No. 11, Vol. 18, 1937, pp. 477–480.)

554. Phonograph Pickup Tracking Error and Its Effect on Distortion and Record Wear.—B. Olney. (*Electronics*, Nov. 1937, Vol. 10, No. 11, pp. 19–23 and 81.)

555. QUALITY IN DISC REPRODUCTION ["Many Broadcasting Stations are obtaining 1926 Results from 1937 Equipment": Hints on Improvement].—C. J. LeBel. (*Electronics*, Oct. 1937, Vol. 10, No. 10, pp. 25–27 and 77.)

556. A REVIEW OF THE QUEST FOR CONSTANT SPEED [in Sound Recording and Reproduction].—E. W. Kellogg. (*RCA Review*, Oct. 1937, Vol. 2, No. 2, pp. 220–239: to be contd.)

557. "GROUND NOISE" CUT OUT FROM TALKING PICTURES [Diffusion of Light on to Silent Portions prevented by Two Additional Photocell Circuits operating a Covering-Up Shutter].—E. W. Kellogg. (*Sci. News Letter*, 6th Nov. 1937, Vol. 32, p. 296.)

558. STUDIES ON NOISE AND RECORDING MATERIALS FOR THE MAGNETIC RECORDING [Experiments with Discs of Carbon Steels and Special Alloys: Superiority of "Sen-Alloy" (Iron-Nickel-Copper): Improved Erasing Method using 6–8 Magnetic Coils of Alternate Polarities and Decreasing Ampere-Turns: etc.].—Nagai, Nishina, Sasaki, & Endo. (*Nippon Elec. Comm. Eng.*, Aug. 1937, No. 7, pp. 218–224.)

559. STUDY ON CARBON STEEL FOR MAGNETIC RECORDING.—Nagai, Nishina, Sasaki, & Endo. (*Nippon Elec. Comm. Eng.*, Aug. 1937, No. 7, p. 304: reference only.)

560. THE CORBINO METHOD FOR THE CALIBRATION OF CONDENSER MICROPHONES [Investigation of the Method dealt with in 1383 of 1937, and Its Applications: Effects of Third Harmonic of Generator and of D.C. Polarisation of Microphone: Possible Application to Investigation of Vibrations of Plates of Air Condensers under Action of Applied Alternating Voltage].—G. Sacerdote: Corbino. (*La Ricerca Scient.*, 15th/31st Aug. 1937, Series 2, 8th Year, Vol. 2, No. 3/4, pp. 174–185.)

561. REVIEW OF MICROPHONES [Pressure-Gradient Pressure-Operated, and Inductor Types].—M. Rettinger. (*RCA Review*, Oct. 1937, Vol. 2, No. 2, pp. 251–257.)

562. TESTS ON THE QUESTION OF THE "ROHMANN SKIN" IN CONTACT MICROPHONES [Carbon is Effective not because of Its Adsorbing Properties but because of Its High Melting Point: etc.].—D. Brodhun. (*Akustische Zeitschr.*, Sept. 1937, Vol. 2, No. 5, pp. pp. 254–255.)

563. TELEPHONY IN NOISE AND WIND [Noise Measurement: Influence of Noise on Speech Formation, and the Sound Field of Speech in the Neighbourhood of the Mouth: Influence of Noise on Hearing: Effect of Distortions: Requirements of Microphones and Mouthpieces: of Telephones and Ear Fitments].—W. Janovsky. (*E.T.Z.*, 2nd Dec. 1937, Vol. 58, No. 48, pp. 1289–1294.)

564. DESIGNING THE FIRST STAGE OF THE SPEECH AMPLIFIER: A PENTODE CIRCUIT FOR LOW HUM AND R.F. PICKUP.—T. A. Gross. (*QST*, Dec. 1937, Vol. 21, No. 12, pp. 33–34 and 98, 100.)

565. ON THE POWER DISSIPATED IN THE WORKING OF CLASS B AUDIO-FREQUENCY AMPLIFIERS.—P. Pontecorvo. (*Alta Frequenza*, Dec. 1937, Vol. 6, No. 12, pp. 825–833.)

Author's summary:—It is known that the power dissipated by the anodes of an a.f. class B push-pull amplifier, when the load resistance is fixed, is a function of the transmission level. This function, contrary to what might be expected, reaches a maximum for a lower transmission level than the permissible maximum. On the basis of recent experimental work on the statistical distribution of level, the power dissipated for the transmission of music, during which the level is continuously varying, is calculated. For usual values of volume variations the results show that the power dissipation is about 50% of the permissible maximum.

566. THE PRINCIPLE OF A RECTIFIED-FEEDBACK AMPLIFIER AND ITS APPLICATION TO DETECTOR AND COMPANDOR.—H. Nukiyama, Y. Kikuchi, & K. Yamanouchi. (*Nippon Elec. Comm. Eng.*, Aug. 1937, No. 7, pp. 255–267.)

567. A METHOD FOR IMPROVING ARTICULATION IN A COMMUNICATION CHANNEL SUBJECTED TO INTERFERENCE.—B. F. Vysotski & S. I. Tetelbaum. (*Izvestiya Elektroprom. Slab. Toka*, No. 9, 1937, pp. 9–14.)

An experimental investigation of the effect of a "compressor," raising the level of unaccentuated syllables to that of the loudest sounds, on the quality of articulation in a telephone circuit subjected to interference.

568. NEW INVESTIGATIONS ON THE "FLUTTER" EFFECT [in Telephony: Change of Loss Impedance of Iron-Cored Coils with Slow Movements of Working Point along Magnetisation Curve].—R. Adler. (*Hochf:tech. u. Elek:akus.*, Nov. 1937, Vol. 50, No. 5, pp. 166–168.)

For an investigation of this effect *see* Deutschmann, 1930 Abstracts, p. 291. Here the effect is studied by using a continuously varying d.c. field instead of a low-frequency alternating field (circuit Fig. 1). Fig. 2 shows how the test coil is coupled to the oscillator, Fig. 3 curves of the momentary effect and after-effect. "The effect is found to depend on the amount of the field change and its orientation to the audio-frequency field but not on its sign. The limiting value is reached at about 20 gauss per sec.; an increase of permeability is also observed. The effect increases as the audio-frequency amplitude decreases but appears to tend to a limit for very small amplitudes."

569. IRREGULARITIES IN BROAD-BAND WIRE TRANSMISSION CIRCUITS.—Mertz & Pfleger. (*See* 596.)

570. TRANSMITTED FREQUENCY RANGE FOR CIRCUITS IN BROAD-BAND SYSTEMS [Open Wire, Toll Cable, and Coaxial].—H. A. Affel. (*Bell S. Tech. Journ.*, Oct. 1937, Vol. 16, No. 4, pp. 487–492.)

571. THE CALCULATION OF CROSSTALK BETWEEN COAXIAL TRANSMISSION CIRCUITS, AND THE COMPARISON OF ITS CALCULATED AND MEASURED VALUES.—Y. Tuzi. (*Nippon Elec. Comm. Eng.*, Aug. 1937, No. 7, pp. 291–292 : summary only.)

572. COAXIAL CABLES.—Colpitts & others. (*Nippon Elec. Comm. Eng.*, Aug. 1937, No. 7, pp. 183–192.) In a lecture "Recent Trends in Toll Transmission in the United States" and the subsequent Discussion.

573. NARROW BAND-PASS TRANSFORMER WITH IRON CORE [Loosely-Coupled Tuned Transformer (for Narrow Band-Pass Filter) is usually Air-Cored and hence is limited to High Frequencies : Iron Core with Magnetic Leakage makes it Applicable to Audio-Frequencies].—H. Nukiyama & Y. Kikuti. (*Nippon Elec. Comm. Eng.*, Aug. 1937, No. 7, p. 298 : summary only.)

574. TRIODE INPUT CAPACITANCE [Correction to Formula in "Audio-Frequency Transformers"].—L. B. Turner : Wrathall. (*Wireless Engineer*, Nov. 1937, Vol. 14, No. 170, p. 608.) Misprint on p. 298 of Wrathall's paper (3009 & 3737 of 1937).

575. ACOUSTIC BACK-COUPLING AND RETROACTIVE EFFECTS [Analysis of Physical Processes leading, at the Limit, to Retroactive Howl : Distortion Effects on Steady Notes and Transients prior to Limit, for Linear, Non-Linear, and Contrast-Compressed Transmission Systems : Complete Similarity between Retroactive Effects and Reverberation Effect of a Room : Practical Rules for Design Calculation : Oscillograms].—W. Bürck. (*Telefunken*, Nov. 1937, Vol. 18, No. 77, pp. 23–42.)

576. THE ELECTRO-ACOUSTIC INSTALLATION IN THE GERMAN PAVILION OF THE WORLD EXPOSITION, PARIS 1937.—Brühe. (*Telefunken*, Nov. 1937, Vol. 18, No. 77, pp. 96–97.)

577. NEW JERSEY RAILROAD INSTALLS PUBLIC ADDRESS SYSTEM ON SIGHTSEEING TRAIN [for Running Commentary, etc.].—(*Electronics*, Nov. 1937, Vol. 10, No. 11, pp. 54 and 56.)

578. THE INSULATION AGAINST ACOUSTIC VIBRATION [" Körperschalldammung "] IN WALLS CONSTRUCTED ON THE " NOVADOM " [Mortarless] SYSTEM.—Hofbauer & Bruckmayer. (*Akustische Zeitschr.*, Sept. 1937, Vol. 2, No. 5, pp. 249–253.)

579. THE DYNAMIC TESTING OF SOFT MATERIALS [*e.g.* Rubber].—Anastasevich & Pamfilov. (*Journ. of Tech. Phys.* [in Russian], No. 12, Vol. 7, 1937, pp. 1304–1310.) The tests are based on observing the frequency of a mechanical oscillating system containing a sample of the material.

580. ACOUSTIC ATTENUATION OF SPRINGS AND ATTENUATING MATERIALS.—E. Meyer & L. Keidel. (*Zeitschr. f. tech. Phys.*, No. 10, Vol. 18, 1937, pp. 299–304.)

The theory of transmission of forces through insulating systems of elastic springs is first discussed mathematically, using the schematic representation of Fig. 1 with its analogous electric circuit. Figs. 2, 3 give theoretical curves of the transmission level (the logarithmic representation of the degree of transmission) for attenuation proportional to the velocity and for after-effect attenuation. The apparatus used in the experiments is shown in Figs. 4, 5. The attenuating materials are excited with alternating forces of variable frequency ; the forces transmitted through them to the base are changed by a quartz crystal into alternating voltages and recorded automatically on a logarithmic scale. Fig. 7 shows recorded transmission curves for a system of springs on logarithmic and linear scales. Figs. 8–11 give curves for various thicknesses of rubber, Figs. 12, 13 for compressed cork, Figs. 14, 15 for felt and similar materials, Fig. 16 for a mechanical choke, Figs. 17, 18 for weak and strong spiral springs. It is found that resonance points decrease the attenuating effect to a very high degree. The relative practical merits of systems of springs and of attenuating materials are discussed.

581. AUDITORIUM ACOUSTICS : PARTS II–V.—D. B. Foster. (*Wireless World*, 29th Oct., 11th & 18th Nov. and 23rd Dec. 1937, Vol. 41, pp. 424–425, 480–482, 508–509, & 628–630.) For Part I *see* 4138 of 1937.

582. THE THEORETICAL DERIVATIONS OF THE REVERBERATION LAWS : PART I.—H. & L. Cremer. (*Akustische Zeitschr.*, Sept. 1937, Vol. 2, No. 5, pp. 225–241.)

583. REVERBERATION TIME AND SENSITIVITY [of Ear : Difference between Real Reverberation Time and Measured Value (60 db Damping) and Value obtained by Trebling the 20 db Damping Time].—M. Kinase & K. Hosi. (*Nippon Elec. Comm. Eng.*, Aug. 1937, No. 7, pp. 297–298 : summary only.)

584. THE THEORY OF OPERATION OF A THERMO-COUPLE IN REVERBERATION MEASUREMENTS.—S. Skrebkov. (*Journ. of Tech. Phys.* [in Russian], No. 12, Vol. 7, 1937, pp. 1268–1272.)

A brief description is given of the well-known method of measuring reverberation by using a thermo-couple as an integrator. It is stated that with this method errors amounting to several hundred per cent. may occur under certain conditions. In the present paper one of the possible sources of error is indicated from an examination of the physical processes taking place in a thermo-couple.

Equation (8) is derived determining the thermal balance of a thermo-couple, and it is shown that the accuracy of the measurements is reduced by 40–50% if the reverberation is not attenuated exactly according to the exponential law. Methods are also indicated for eliminating this effect.

585. Frequency Analysis Apparatus using the "Search-Tone" [Exploring Note] Method with Two Intermediate Frequencies and Logarithmic Indication [of the Amplitude of the Partial Tones].—W. Holle. (*Zeitschr. f. tech. Phys.*, No. 10, Vol. 18, 1937, pp. 312–318.)

A general discussion is given (§ 1) of the low- and high-audio-frequency methods of frequency analysis, using a search-tone. The frequency scheme of the method here adopted is shown in Fig. 1. The intermediate frequency is chosen considerably higher than the highest frequency to be analysed; the advantages of this are that a smaller search-tone variable condenser is needed and the harmonics of the search-tone give no false readings. The relative advantages and disadvantages of logarithmic and linear scales are discussed. A second lower intermediate frequency stage is used to obtain the required sharpness of frequency separation; the circuit scheme of the whole apparatus is shown in Fig. 2. The frequencies chosen for the various component circuits are given. The separate parts of the analyser, which are described in detail, are (a) microphone amplifier (microphone frequency curve Fig. 3, circuit Fig. 4, intermediate amplifier circuit Fig. 5); (b) analysis apparatus and search-tone condenser drive (circuit Fig. 6, characteristics of mixing hexode Fig. 7, compensation circuit Fig. 8, filter curve for second intermediate frequency Fig. 9); (c) amplifier for indicator (circuit Fig. 10) and recording apparatus (ink recorder). Figs. 11–15 show some analyses made with the apparatus; an analysis over a range 0–12 000 c/s can be made in 4 min. The accuracy of the apparatus is discussed.

586. A New Acoustic Rectifier [for Measurement of Sound Pressure at Low Frequencies].—K. O. Lehmann. (*Zeitschr. f. tech. Phys.*, No. 10, Vol. 18, 1937, pp. 309–312.)

This rectifier is based on the principle of Kundt's valve manometer; it was designed for measurement of acoustic pressure at low frequencies and also as a current rectifier for acoustic alternating air currents with large velocities. Its construction is shown in Fig. 1; it consists of a microscope stage pierced by a hole with a glass cover which can move up and down. Pressure in the air space *a* gives rise to excess of pressure in space *b* which can be read off on the manometer *M*. Constructional details are given and the calibration described (§ 2). Measurement of velocity in the middle of the tube was made with the Rayleigh disc shown in Fig. 2. Fig. 3 shows the valve characteristic, Fig. 4 the relation between the maximum value of the acoustic pressure and the manometer pressure of the rectifier, Fig. 5 the resonance curve of a closed piece of the tube, measured with (a) Rayleigh disc and (b) valve manometer.

587. The Essential Characteristics of Apparatus for the Objective Measurement of Noises [and the Difficulties of Standardisation: Further Researches needed].—A. Labrousse. (*Ann. des Postes, T. et T.*, Aug. 1937, Vol. 26, No. 8, pp. 677–698.)

588. The Mechanical Frequency Analysis of Non-Recurrent Oscillatory Phenomena and the Determination of the Frequency Variation of Transmission Systems and Impedances by the Use of Transients.—G. von Békésy. (*Akustische Zeitschr.*, Sept. 1937, Vol. 2, No. 5, pp. 217–224.)

Author's summary:—It is shown that the transmission equivalent for pure alternating currents is, for many transmission systems, advantageously obtained not by direct measurement, but by integration from the building-up processes of the system. For this purpose a suitable mechanical integration method is described and its usefulness illustrated by an example. The integration method employed is also suitable for the mechanical determination of the amplitude spectrum of a non-recurrent decaying oscillatory process.

589. Apparatus for the Synthesis of Non-Linear Distortions.—A. Barone. (*La Ricerca Scient.*, 15th/30th Sept. 1937, Series 2, 8th Year, Vol. 2, No. 5/6, pp. 329–345.)

A complex valve circuit with characteristic $v_{\text{output}} = av + bv^2 + cv^3$, where v is the input voltage, and a, b, and c can be adjusted at will within certain limits.

590. A Method for the Inertialess Recording of "Melody Curves" [of the Fundamental Frequencies in Speech & Song: by Use of Thyratron Relaxation-Oscillation Circuit whose Amplitudes are made Visible by Cathode-Ray Oscillograph].—Grützmacher & Lottermoser. (*Akustische Zeitschr.*, Sept. 1937, Vol. 2, No. 5, pp. 242–248.)

Objections to previous recording methods are first given. The new method is illustrated by specimen oscillograms.

591. The Periodicity of Image Formation with Supersonic Waves [Observation of Images of Supersonic Lattice in Many Planes behind the Supersonic Field: Connection with Optical Grating Phenomena and Abbé's Theory of Microscope Images].—E. Hiedemann & E. Schreuer. (*Zeitschr. f. Physik*, No. 7/8, Vol. 107, 1937, pp. 463–473.)

For the theory of these phenomena *see*, for example, 198 of 1937.

PHOTOTELEGRAPHY AND TELEVISION

592. A New Television System.—G. V. Braude. (*Journ. of Tech. Phys.* [in Russian], No. 15, Vol. 7, 1937, pp. 1510–1540: *Tech. Phys. of USSR*, No. 9, Vol. 4, 1937, pp. 671–706 [in German].

A new method is proposed for scanning the image to be transmitted, utilising the following principle. If a thin metallic ribbon is located with its length parallel to the lines of force between a pair of condenser plates across which a d.c. potential is applied, the potential gradient at the surface of the ribbon will of course be zero at that point *A* along its length at which the condenser field has the same potential as the ribbon. If the ribbon is coated with photo-sensitive material, electrons will be emitted only from that part which is negative with respect to the condenser field, *i.e.* which lies on one side of point A, and not from the remaining part. By varying the potential of the ribbon as a whole, point A can be made to move along the length of the ribbon and hence the proportion of the length which emits electrons can be varied.

In this system one complete line of the image is projected on to the sensitised ribbon and point A is made to traverse from one end to the other in the manner indicated above. The resulting electron current is at any instant proportional to the integral of the light falling on one side of A, but contains a component, easily separated out, which varies according to the change of illumination on point A itself, as this moves along the ribbon. Hence, simply by varying the potential of the ribbon in a linear manner with time, which can be done in the conventional way, one complete line of the image is scanned. In the present paper the theory of the system is discussed, and the practical possibilities indicated. An experimental transmitter using this system has been built for use with films, and images of 240 to 360 lines are stated to have been transmitted with quite satisfactory results.

593. THE WAVE-SLOT, AN OPTICAL TELEVISION SYSTEM [New Scophony Development replacing High-Speed Mechanical Scanners by Supersonic-Wave Cells].—F. Okolicsanyi. (*Wireless Engineer*, Oct. 1937, Vol. 14, No. 169, pp. 527–536.) "Practical work to date resulted in pictures about the size of those obtained with directly-viewed cathode-ray tubes. The stage at present reached is that of transition from the type of Fig. 2 to the flashing light method. The author hopes in this way to have sufficient light for bright pictures of a much larger size."

594. CATHODE-RAY PORTRAIT SCANNER FOR NORMALLY LIGHTED ROOMS [as used at 1937 Berlin Exhibition for projecting Magnified Image of Speaker].—M. Knoll & H. Eistermann. (*Telefunken*, Nov. 1937, Vol. 18, No. 77, pp. 65–69.)

595. SUPER-EMITRON CAMERA [first used by B.B.C. during Nov. 1937].—(*Wireless World*, 18th Nov. 1937, Vol. 41, pp. 497–498.)

596. IRREGULARITIES IN BROAD-BAND WIRE TRANSMISSION CIRCUITS [Effects of Inhomogeneities along Length of Wire (Cable Pair, Coaxial Conductor, etc.) on Impedance, Attenuation and Its "Sinuosity," and Delay Distortion].—P. Mertz & K. W. Pfleger. (*Bell S. Tech. Journ.*, Oct. 1937, Vol. 16, No. 4, pp. 541–559.)

597. THE CALCULATION OF INPUT, OR SENDING-END, IMPEDANCE OF FEEDERS AND CABLES TERMINATED BY COMPLEX LOADS.—Caffetata. (*See* 509.)

598. DISTORTION OF SAW-TOOTH WAVE FORMS.—M. von Ardenne. (*Electronics*, Nov. 1937, Vol. 10, No. 11, pp. 36–38 and 84.) English version of the paper dealt with in 1710 of 1937.

599. SCANNING IN TELEVISION RECEIVERS [and Precautions in Design to avoid Distortion and Loss of Detail: Harmonic Content of Sawtooth Wave: etc.].—F. J. Somers. (*Electronics*, Oct. 1937, Vol. 10, No. 10, pp. 18–21.)

600. ON DISTORTION PRODUCED BY THE SCANNING SYSTEM OF A CATHODE-RAY TELEVISION RECEIVER.—A. A. Raspletin. (*Izvestiya Elektroprom. Slab. Toka*, No. 9, 1937, pp. 21–30.)

The effect of non-linear movement of the scanning ray on the quality of the received image is discussed, and on the basis of an experimental investigation the maximum permissible non-linearity of the movement of the ray (along both the horizontal and vertical axes) is stated to be 15–20%. It is shown that the amount of deviation from linearity in the movement of the ray is mainly determined by (a) the shape of the voltage curves at the output of the scanning oscillators, (b) the dynamic characteristics of the amplifier valve, and (c) the time constants of the deflecting coils. The effect of each of these factors on the linearity of the movement of the ray is examined in detail and a number of practical suggestions are made.

601. ANALYSIS AND DESIGN OF VIDEO AMPLIFIERS [for 441-Line Interlaced Scanning: 60 c/s to 2.5 Mc/s at least: including Measurement of Gain and Phase Delay].—S. W. Seeley & C. N. Kimball. (*RCA Review*, Oct. 1937, Vol. 2, No. 2, pp. 171–183.)

602. NOTE ON VIDEO AMPLIFIER DESIGN [Corrections to Equations on Limit of Phase Distortion].—Freeman & Schantz. (*Electronics*, Nov. 1937, Vol. 10, No. 11, pp. 52 and 54.) *See* 4192 of 1937.

603. METHODS OF DISTORTION REDUCTION IN LINE AMPLIFIERS FOR MULTIPLE COMMUNICATION SYSTEMS [applicable also to Multiple Television Channels: General Considerations and Survey of Methods, with 82 Literature References].—H. Werrmann. (*Telefunken*, Nov. 1937, Vol. 18, No. 77, pp. 50–65.)

Author's summary:—For certain line amplifiers used in carrier-current communication systems the "klirr" [non-linear] attenuations [Table I] must, for a zero line noise level, amount to 9-10 nepers for harmonics of the second order and 11–12 nepers for those of the third order. Since the "klirr" attenuation of standard amplifier valves lies generally below these values, the amplifiers must be provided with auxiliary linearising circuit arrangements. The various linearising methods applicable to line amplifiers are described, specially detailed attention being given to "negative feedback" which has recently come into the foreground of interest.

604. TELEVISION IN GREAT BRITAIN: IS BRITISH TELEVISION FURTHER ADVANCED TECHNICALLY THAN AMERICAN?—H. M. Lewis & A. V. Loughren. (*Electronics*, Oct. 1937, Vol. 10, No. 10, pp. 32–35 and 60, 62.)

Report by two Hazeltine engineers who set up a laboratory in London to study the situation. "Unless changes are made in the type of signal which is now being used for experimental transmitters, American receivers will be more expensive, more difficult to service, and will give performance inferior to British receivers" [in steadiness and contrast]. Virtues of positive modulation: synchronisation extremely steady: transmission of d.c. component: German television: etc.

605. TELEVISION: STATEMENT BY PRESIDENT OF RCA ON RETURN FROM EUROPE, SEPT. 1937. —D. Sarnoff. (*RCA Review*, Oct. 1937, Vol. 2, No. 2, pp. 139–140.)

606. PRESENT SITUATION AND NEW ORIENTATIONS OF TELEVISION IN THE U.S.A. [Lecture].—V. K. Zworykin. (*Alta Frequenza*, Dec. 1937, Vol. 6, No. 12, pp. 785–808.)

607. RÉSUMÉ AND COMPARISON OF THE CHARACTERISTICS OF VARIOUS SYSTEMS OF TELEVISION.—M. Chauvierre. (*Génie Civil*, 4th Dec. 1937, Vol. 111, No. 23, p. 487: summary only.)

608. TELEVISION AND THE COAXIAL CABLE [Demonstration over New York/Philadelphia Cable].—R. L. Ives. (*Science*, 19th Nov. 1937, Vol. 86, Supp. pp. 11–12.)

609. TELEVISION SIGNALS "LAID ON" [Baird System of Distribution by R.F. Lines from Central Receiver to Various Rooms].—C. E. Maitland. (*Wireless World*, 16th Dec. 1937, Vol. 41, pp. 605–606.)

610. OLYMPIA, 1937: A TECHNICAL SURVEY.—(*Wireless Engineer*, Oct. 1937, Vol. 14, No. 169, pp. 541–551.)

611. TELEVISION AT THE 14TH GREAT GERMAN RADIO EXHIBITION 1937.—Schröter. (*Telefunken*, Nov. 1937, Vol. 18, No. 77, pp. 94–96.)

612. THE NEW TELEVISION STANDARD OF THE GERMAN STATE POST OFFICE [Data for the New 441-Line System: Exact Form of Synchronising Signal to be Decided shortly].—F. Banneitz. (*Telefunken*, Nov. 1937, Vol. 18, No. 77, pp. 452–454.)

613. RADIO AMATEURS IN THE TELEVISION PICTURE: ANNOUNCING A PLANNED PROGRAMME OF TECHNICAL CO-OPERATION.—J. J. Lamb. (*QST*, Dec. 1937, Vol. 21, No. 12, pp. 8–10 and 66, 68.)

614. EXPERIMENTS WITH LIGHT-SENSITIVE SEMICONDUCTING FILMS IN ELECTRON-BEAM TUBES [for Television Reception].—M. von Ardenne. (*Hochf:tech. u. Elek:akus.*, Nov. 1937, Vol. 50, No. 5, pp. 145–149.)

These experiments on the use of the resistance variations of thin semiconducting films for television reception were first made in 1933/34 (German Patent L 84 500 of 20.9.1933). A tube with a large Cu_2O-plate covered by (but insulated from) a fine wire netting is shown in Fig. 1. The difference between the semiconducting plates used for cathode-ray scanning and technical semiconductor photocells is that, in the former, there is no conducting film on the front side of the semiconductor (§ 1). Other necessary properties of the plates are mentioned. Suitable circuits for the tube are described in § II (Fig. 2); for circuit *see* Fig. 2A: *also* Knoll & Schröter, 3034 of 1937). A circuit equivalent to that in Fig. 2B is shown in Fig. 3; the current flowing through the coupling resistance R is varied by controlling the division, between film and anode, of the current at the point where the electron beam meets the semiconducting film. The choice of the relative magnitudes of the equivalent resistances in Fig. 3 is discussed; production of a potential minimum in front of the film by an auxiliary electrode with weak negative bias gives a great increase in sensitivity. Practical results are described in § III; Fig. 5 shows how the degree of modulation depends on the intensity of illumination. Current and voltage variations during illumination must be one or two orders of magnitude greater than variations due to such causes as irregularities in the film.

615. A NEW METHOD FOR PRODUCING LIGHT SOURCES OF CONSTANT ENERGY THROUGHOUT THE VISIBLE SPECTRUM.—M. von Ardenne. (*Zeitschr. f. Physik*, No. 5/6, Vol. 107, 1937, pp. 414–419.)

It is already known that the degree of activity of silver-activated zinc-cadmium-sulphide phosphors, which differ only in the cadmium-sulphide content, is independent of this content and of the colour it gives to the phosphor. The fluorescent light source here described is based on this fact, being composed of several components with spectra of equal energy, with cadmium-sulphide contents graded so that the "centres of gravity" of their radiation curves are distributed uniformly along the visible spectrum (Fig. 1a). The number of components is chosen so that the half-values of succeeding curves occur at the same wavelength. Fig. 1b shows the resultant frequency curve of the fluorescence. Spectrograms are given (Figs. 2, 3) showing the intensity distribution for excitation by electrons and by long-wave ultra-violet radiation. The tube incorporating the composite phosphor is shown in Fig. 4.

616. A NEW APPARATUS FOR THE INVESTIGATION OF FLUORESCENT MATERIALS FOR CATHODE-RAY TUBES.—M. von Ardenne. (*Angewandte Chemie*, 4th Dec. 1937, Vol. 50, No. 49, pp. 905–906.) Improved version of the equipment dealt with in 1934 Abstracts, pp. 623–624. A Pulfrich photometer is used, as in the arrangement referred to in 1947 of 1935.

617. ELECTRICAL AND LUMINESCENT PROPERTIES OF WILLEMITE UNDER ELECTRON BOMBARDMENT.—W. B. Nottingham. (*Journ. of Applied Physics*, Nov. 1937, Vol. 8, No. 11, pp. 762–778.)

The tube and circuit used for these investigations are shown in Figs. 1 and 2 respectively. The potential and resistance of the phosphor while under bombardment by electrons were measured; Fig. 5 shows hypothetical curves devised to explain the experimental results on stabilisation of screen potentials (Fig. 4). The construction of a phototube for luminosity measurements is described; the light output was measured as a function of current density and of the energy of the bombarding electrons. Measurements of screen potential and luminosity were also made with an experimental nine-inch cathode-ray tube. A marked saturation effect was found at high current densities. Numerical results are given.

618. SCREENS FOR TELEVISION TUBES [Survey, including Influence of Various Factors on Contrast].—I. G. Maloff & D. W. Epstein. (*Electronics*, Nov. 1937, Vol. 10, No. 11, pp. 31–34 and 85, 86.) Abstracts from Chapter XI of "Electron Optics in Television," to appear this winter.

619. THE INTEGRATING POWER OF THE EYE FOR SHORT FLASHES OF LIGHT [Duration 10^{-2} to 8×10^{-9} Second : Response depends only on Total Amount of Light received by Eye per Second and is independent of Length of Flash].—T. E. Gilmer. (*Journ. Opt. Soc. Am.*, Nov. 1937, Vol. 27, No. 11, pp. 386–388.)

620. THE EVAPORATION OF QUARTZ ON SILVER [Protective Film on Freshly Evaporated Silver Mirror : Technique].—H. W. Edwards. (*Review Scient. Instr.*, Nov. 1937, Vol. 8, No. 11, pp. 451–452.)

621. NOTE ON THE COMPUTATION OF OPTICAL CONSTANTS [Fry's Equation really Identical with Drude's].—J. B. Nathanson. (*Journ. Opt. Soc. Am.*, Nov. 1937, Vol. 27, No. 11, pp. 393–394.) Fry's equation is used by Ives & Briggs (*see* 622, below).

622. OPTICAL CONSTANTS OF RUBIDIUM AND CAESIUM.—Ives & Briggs. (*Journ. Opt. Soc. Am.*, Nov. 1937, Vol. 27, No. 11, pp. 395–400.) For previous work *see* 3082 of 1937.

623. REMARKS ON THE OPTICAL CONSTANTS OF RHODIUM [Superiority in Reflection and Transparency : etc.]. — M. Auwärter. (*Zeitschr. f. tech. Phys.*, No. 11, Vol. 18, 1937, pp. 457–459.)

624. REMARKS ON THE PAPER OF L. VOROSHILOV "ON THE ACCURACY OF FOCUSING OF ELECTRON STREAMS IN A KUBETSKI TUBE" —S. A. Astaf'ev : Voroshilov. (*Journ. of Tech. Phys.* [in Russian], No. 15, Vol. 7, 1937, pp. 1590–1591.)

For Voroshilov's paper in question *see* 3059 of 1937. It is pointed out that Voroshilov has not considered certain undesirable processes taking place in a Kubetski tube and that the method for measuring the efficiency of the tube is therefore not accurate. Voroshilov replies on p. 1591.

625. A MODIFIED FORM OF THE MAGNETIC ELECTRON MULTIPLIER OF A.C. TYPE [Electron progresses along Space between Two Parallel Plates (Lower One prepared to give Secondary Emission) in Series of Hops, ending at Collector Plate : Number of Multiplications is thus Limited, should give Reduction of Dark Current : also a Concentric Cylinder Type].—S. Mito. (*Electrot. Journ.*, Tokyo, Oct. 1937, Vol. 1, No. 5, p. 168.) Under the combined action of an alternating voltage and a magnetic field.

626. THE SELECTIVE PHOTOEFFECT AT OXIDE CATHODES CONTAINING METALLIC ATOMS.—R. Fleischer & H. Pietzsch. (*Zeitschr. f. Physik*, No. 5/6, Vol. 107, 1937, pp. 322–331.)

Experimental curves (Figs. 2, 3, 4a) are given for composite photocathodes with metallic atoms in the semiconductor which show, both for vacua and for low gas pressures, the movement of the selective maximum from short to long wavelengths, for accelerating voltages up to 2 v, already described by Fleischer & Görlich (2741 of 1935 and back reference). Cells with composite cathodes of very large sensitivity in the red show a backward movement of the maximum for higher accelerating voltages (Figs. 4, 5). This is attributed to space charges produced by electrons collecting in and under the cathode surface. The short-wave minimum is not affected by the accelerating voltage.

627. MEASUREMENTS ON TRANSPARENT COMPOSITE PHOTOCATHODES.—P. Görlich. (*Zeitschr. f. tech. Phys.*, No. 11, Vol. 18, 1937, pp. 460–462.)

Author's summary :—By sensitisation with O_2, displacements of the long-wave maxima of transparent cathodes of the type Sb- or Bi-M (where M denotes an alkali metal) can be obtained. It is not, however, possible to show this effect of O_2 in all cases. Certain sensitised cathodes display two long-wave maxima. Non-transparent thick cathodes of the type Sb- or Bi-M give, for an approximately similar spectral distribution, photocurrents which are in all cases about a tenth of those from good transparent cathodes [" this unexpected result inspired further investigation " and led to a hypothesis which was confirmed by the fact that a transparent cathode with a thick non-transparent silver base gave as large photocurrents as a truly transparent cathode : section 2, p. 462. Finally, a "double-layer" cell, combining a transparent cathode and a Cs-Cs_2O cathode, was constructed, giving practically uniform sensitivity over the whole visible spectrum : such a cell should be of particular use in astrophysical work].

628. METALLIC REFLECTION AND THE SURFACE PHOTOELECTRIC EFFECT [Theory based on Sommerfeld Model of a Metal and Classical Calculation of Field of Incident Light Wave : Calculated Photoelectric Emission for Potassium compared with Recent Experimental Results : Effect of Small-Scale Roughness].—R. E. B. Makinson. (*Proc. Roy. Soc.*, Series A, 1st Oct. 1937, Vol. 162, No. 910, pp. 367–390.)

629. AN INVESTIGATION OF INERTIA IN GAS-FILLED PHOTOCELLS.—G. P. Bel'govski. (*Journ. of Tech. Phys.* [in Russian], No. 14, Vol. 7, 1937, pp. 1462–1467.)

Report on an experimental investigation to check various theories on the inertia of gas-filled photocells at low frequencies. Experiments with argon-filled photocells are described and a number of oscillograms shown. The main conclusion reached is that the inertia is due to secondary phenomena caused by positive ions falling on the photocathode. This was proved by preventing the ions from reaching the photocathode, when a considerable diminution of inertia was observed.

630. THE EFFECT OF THE EXTERNAL FIELD ON THE ELECTRON-EMISSION CONSTANTS OF BARIUM-COATED PLATINUM SURFACES [Photoelectric Emission measured].—Suhrmann & von Eichborn. (*See* 530.)

631. THE SELENIUM PHOTOELEMENT: I—THE EFFECT OF MEDIUM-VELOCITY CATHODE RAYS.—A. Becker & E. Kruppke. (*Zeitschr. f. Physik*, No. 7/8, Vol. 107, 1937, pp. 474–484.)

Five selenium anterior-wall ("vorderwand") cells with different thicknesses of the front gold electrode were used for the investigation. Fig. 1 shows their "dark" characteristic curves. The effect of cathode rays was studied with the apparatus of Fig. 2; the connection between the cell current and the electron current for electron velocities 5 and 20 kv is shown in Fig. 3. The ratio of these two currents is termed the "practical yield"; its variations with the exciting electron current and with the electron velocity are shown in Figs. 4 & 5 respectively. The "pure yield" is defined as the ratio of the cell current to the number of electrons penetrating the front metallic electrode. Some probable values of this quantity are denoted in Fig. 5 by arrows. In the discussion it is found that the differential secondary radiation, *i.e.* the number of secondary electrons produced by the primary beam in a limited "effective" layer of the cell, is responsible for the cell current. The thickness of this effective layer is found to be relatively small.

632. A NEW METHOD FOR MANUFACTURING SELENIUM BARRIER-LAYER PHOTOCELLS.—I. S. Freivert & N. B. Berdnikov. (*Journ. of Tech. Phys.* [in Russian], No. 13, Vol. 7, 1937, pp. 1333–1336.)

A new and simplified method for manufacturing selenium photocells has been developed in which, instead of sublimating the selenium in a hard vacuum, the layer is deposited on the surface of the electrodes in the following manner:—A drop of molten selenium is placed on the electrode and covered by a glass plate. This causes selenium to spread over the surface of the electrode, and the thickness of the layer is regulated by the pressure on the plate. Without removing the glass plate, the electrode is then subjected for several hours to heat treatment at a temperature of 200–210°C. The upper semi-transparent layer of gold is deposited afterwards on the electrode by the usual method of cathode sputtering. The cells so prepared have shown an increased sensitivity (400–500 mA/lumen) and a considerable reduction in the resistance of the barrier layer: in one case this was reduced from 3350 ohms to 54 ohms.

633. INFLUENCE OF THE CONTACT RESISTANCE ON THE RECTIFYING AND PHOTOELECTRIC PROPERTIES PRESENTED BY BARRIER-LAYER ELEMENTS.—J. Roulleau. (*Ann. de Physique*, Sept. 1937, Series 11, Vol. 8, pp. 153–236.)

Method of measuring the contact resistance: the four chief variables controlling the c.r. of a metal/cuprous-oxide element (*see* also 1214 of 1936): relation between photoelectric and rectifying effects: anomalies of temperature coefficients of these effects only apparent: superposition, in Becquerel effect, of barrier-layer and electrochemical effects: critical examination of theories of photoelectric and rectifying effects—"not generally in agreement with observed results."

634. THE ANGULAR EFFECT IN BARRIER-LAYER PHOTOCELLS.—V. P. Bobrikov. (*Journ. of Tech. Phys.* [in Russian], No. 13, Vol. 7, 1937, pp. 1329–1332.)

It has been observed that when selenium or copper-oxide barrier-layer photocells are actuated by X-rays the photocurrent depends on the angle at which the rays fall on the cell. In this paper a tentative explanation of this phenomenon is offered and formulae are derived determining the photocurrent I_ϕ in terms of ϕ and I_0 (the current at $\phi = 90°$), both for a very narrow beam (equation 3) and for a wide beam covering the photoelement at all angles (equation 4). Curves are drawn (Figs. 4 and 5) which show a very close agreement between the theoretical and experimental results.

635. ERRORS OCCURRING IN THE TRANSMISSION AND REPRODUCTION [in Photographs and Newsprint] OF RADIO PICTURES, AND THEIR ELIMINATION.—E. Hudec. (*E.N.T.*, Oct. 1937, Vol. 14, No. 10, pp. 311–325.)

The errors occurring in the transmission of radio pictures are described (§ 1), including the broadening of signals by short-wave propagation (§ 1b, Fig. 2); the advantages of positive transmission (§ 1c, Figs. 3, 4), which gives a positive image at the receiver and a larger spread of blackening than negative transmission, are discussed. § 2 deals with faithful picture reproduction; in § 2a the required relation between the length of the signals and the brightness of the image is worked out. The ideal, approximately linear, relation between the length of the white signal and the reflected light current is shown in Fig. 5. The methods of obtaining the required signal length are discussed in § 2b. Fig. 6 gives practical curves of the demodulated image voltage and the length of the white signals as functions of the reflected current. These have the opposite curvature to that required by Fig. 5. The demodulated current controls the time modulation apparatus (Fig. 7; *see* 4189 of 1937) in which the telegraphic signals for short-wave transmission are produced. Fig. 8 shows the current and voltages on the "trip" circuit K_1. Experimental results (§ 2c) include a curve of decrease of signal duration and of the breadth of the white signals as a function of the demodulated image voltage (Fig. 9), transmitted signals of various lengths giving shades of white, grey, and black (Fig. 10), curves as in Fig. 6 with improved adjustment (Fig. 11), degrees of shading from white to black with complete (Fig. 12a) and incomplete (Fig. 12b) compensation of the demodulation and transmission errors. The transmission of pictures with weak contrast is discussed in § 2d. The errors in the recording of radio pictures are the transient errors (§ 3a) and those due to the "light tap" used for brightness control (§ 3b, Fig. 15a); these may be decreased by using the device shown in Fig. 15b. The illumination intensity acting on the film is worked out in § 3d (Fig. 16). The errors arising in photographic reproduction are described in § 3e.

Too long signals must not be transmitted; it is best to employ negative reception of positively transmitted images, by adjustment of the device shown in Fig. 15b. § 4 deals with the printing of the radio image, the alteration of the signals due to the printing procedure (§ 4a), and the increase of the range of blackening (§ 4b, Fig. 21) by proper choice of the dimensions of the "raster" employed.

636. PHOTOTELEGRAPHY OVER WIRES BY DOT-AND-DASH SYSTEM.—Herrmann: Siemens & Halske. (*Science*, 22nd Oct. 1937, Vol. 86, Supp. p. 11.)

637. NEWS PICTURES BY WIRE [Survey of Systems of Picture Telegraphy by Telephone Line]. —(*Electronics*, Nov. 1937, Vol. 10, No. 11, pp. 12–17 and 82, 83.)

638. THE POSITION OF PICTURE TELEGRAPHY IN THE U.S.A. [General Account of Recent Developments of A.T. & T. System].—Goetsch. (*E.N.T.*, Sept. 1937, Vol. 14, No. 9, pp. 299–304.)

639. METHOD OF INCREASING THE CONDUCTIVITY OF THE SILVER IMAGE ON PRINT OR NEGATIVE.—(*Electronics*, Nov. 1937, Vol. 10, No. 11, p. 76.)

MEASUREMENTS AND STANDARDS

640. OPTICAL CURRENT AND VOLTAGE MEASUREMENTS FOR ULTRA-SHORT WAVES BY THE "SCHLIEREN" METHOD.—J. Malsch. (*Ann. der Physik*, Series 5, No. 6, Vol. 30, 1937, pp. 534–540.)

The normal optical arrangement (Fig. 1) for the use of the "schlieren" method is made applicable to ultra-short-wave measurements by replacing the camera by a photocell and using the arrangement shown in Fig. 2 to increase the intensity of the light. "The current-measuring instrument proper, S, which produces the 'schlieren' (temperature gradient), is joined to the lens L_2," on which the light is focused through a line grating R_1, an image being formed on a second grating R_2. Details of S are shown in Fig. 3; the h.f. current heats the wire H, which is stretched over a circular frame M. The construction and adjustment of the apparatus are described, with the conditions for maximum sensitivity. Numerical data of a particular apparatus are given, with a curve (Fig. 4) showing the variation of the sensitivity with the position of the image of R_1 relative to R_2; Fig. 5 shows the sensitivity attainable.

641. A NEW HIGH-FREQUENCY AMMETER [Polariscopic Principle, Thin Metal Film on Glass: for Ultra-High and Micro-Wave Frequencies]. —Straubel. (*Zeitschr. f. tech. Phys.*, No. 11, Vol. 18, 1937, pp. 434–437.) A summary was dealt with in 4224 of 1937. Observation error is found to be about 5%. No alteration of current distribution in the metal film is observable between 60 and 600 Mc/s.

642. AN ELECTROSTATIC VOLTMETER FOR USE AT EXTREMELY HIGH FREQUENCIES [for Dielectric-Loss Measurements at High Voltages: Self-Heating Errors reduced to Minimum by Use of Ultra-Calan Base, etc.]. —F. E. J. Ockenden. (*Journ. Scient. Instr.*, Dec. 1937, Vol. 14, No. 12, pp. 406–408.) Recesses are made in the surface before firing. These are later sprayed with copper, which is then fired on to the surface: the deposit can if necessary be thickened by electro-plating. Pillars and other components are soldered to these foundations.

643. MARCONI ULTRA-SHORT-WAVE FIELD STRENGTH MEASURING EQUIPMENT [20 to 100 Mc/s: 2–3 μV/m to 1 V/m: Portable: Entirely Self-Checking: Substitution-Signal Method: Almost Direct-Reading].—F. M. Wright. (*Marconi Review*, Sept./Dec. 1937, No. 67, pp. 14–20.)

644. A NEW FIELD-STRENGTH MEASURING APPARATUS FOR BROADCAST WAVES.—M. von Ardenne. (*E.N.T.*, Sept. 1937, Vol. 14, No. 9, pp. 293–299.)

The circuit of the apparatus, which includes a built-in, calibrated auxiliary emitter, is shown in Fig. 1. It is based on "the known method of comparison of the resonance voltage of a frame circuit with a locally-produced voltage of known magnitude." The use of the apparatus is described with the help of the "transformation ratio" between the measured resonance voltage on the input circuit and the value of the field-strength to be measured. A very selective heterodyne receiver is used in combination with the frame circuit and input stage. Figs. 2–5 give photographs of various views of the apparatus; the calibration and method of measurement are described, with frequency curves (Figs. 6, 7). The field-strength range covered is 0.1 mv/m to 5 v/m, with accuracy within 10%. The selectivity is such that measurements are not affected when a broadcast emitter of 9 kc/s frequency-separation has a field-strength at least 10 times as great as that to be measured. The apparatus is said to be easily transportable and can be run off the mains if required.

645. A NEW HIGH-FREQUENCY HETERODYNE SIGNAL GENERATOR [using the Beat-Note Principle (usual for Audio-Frequencies) to give a Single Continuous High-Frequency Range of 50 kc/s to 5 Mc/s, by a Fixed and Stabilised Push-Pull 30 Mc/s Oscillator and a Second Oscillator similar except that Its Condenser is Variable].—L. Rohde. (*Zeitschr. f. tech. Phys.*, No. 11, Vol. 18, 1937, pp. 450–452.) Mains driven. Since the two circuits are so similar, the frequency variation due to temperature changes is less than 1×10^{-6}. The accuracy of frequency is to $\pm 2\%$.

646. DIRECT PHASE MEASUREMENT WITH THE CATHODE-RAY TUBE.—W. Lutz. (*E.N.T.*, Oct. 1937, Vol. 14, No. 10, pp. 307–310.)

The phase-meter circuit is shown in Fig. 1; the currents or voltages whose phase difference is to be measured are connected to the primaries of the equal transformers T_I, T_{II}. Their secondaries are connected to the opposite corners of a bridge circuit whose four arms contain the same amount of ohmic resistance and capacity in series. The plates of the cathode-ray tube are connected between the points F and D on the arm BD of the bridge and between D and a point on a potentiometer in the arm AD which is adjusted according to the frequency. The theory of the circuit is given (Fig. 2, vector diagram of currents and voltages); when the amplitudes of the primary transformer currents are equal, there is a bright line on the tube screen whose angle of displacement is half the phase difference to be measured. If the amplitudes are unequal, an ellipse appears, whose major axis takes the place of the line in the measurement. T_I and T_{II} are earthed by Wagner circuits. The adjustments of the circuit for a frequency of 10^4 c/s are given. When the amplitudes are equal, an automatic record can be obtained by registering the horizontal projection of the line indicator on a loop oscillograph (circuit Fig. 4).

647. PRECISION MEASUREMENTS WITH A RADIAL-DEFLECTION CATHODE-RAY OSCILLOGRAPH [as a H.F. Phase Meter (including Test on U.R.S.I. Standard Frequency—"Rapid Hunting of Carrier during Fadings"): as Time Microscope and Comparator (Tests on Pendulums, etc.)].—J. J. Dowling & T. G. Bullen. (*Proc. Roy. Irish Acad.*, Sept. 1937, Vol. 44, Sec. A, No. 1, pp. 1–10 and Plate.)

648. "FREQUENZMESSUNG DURCH . . ." [Frequency Measurement by the Summation of the Current Pulses occurring in the Charging of a Condenser through Electronic Valves: Thesis].—H. A. Wahl. (At Patent Office Library, London: Cat. No. 78 026: 58 pp.)

649. A PIEZO-QUARTZ OSCILLATOR WITHOUT AN OSCILLATORY CIRCUIT.—G. A. K'yandski. (*Izvestiya Elektroprom. Slab. Toka*, No. 9, 1937, pp. 15–16.) The circuit (Fig. 2: *see* 2366 of 1935) used by the National Bureau of Standards as a primary standard of frequency is discussed and conditions for its excitation are established.

650. LUMINOUS QUARTZ RESONATORS [as Frequency Substandards: Cutting and Mounting Technique: Methods of Supporting, and Corresponding Luminous Forms: High-Precision Calculation of Resonant Frequencies, even for High-Order Harmonics].—F. Galotti. (*Alta Frequenza*, Dec. 1937, Vol. 6, No. 12, pp. 809–824.)

651. THEORY OF THE OSCILLATIONS OF CRYSTAL PLATES (REMARKS ON PAPERS BY PETRŽILKA) [Theoretical Explanations of Discrepancies between Petržilka's Theoretical and Experimental Results].—E. Lonn: Petržilka. (*Ann. der Physik*, Series 5, No. 5, Vol. 30, 1937, pp. 420–432.) *See* 282 of 1936.

652. THE CAPACITY OF A SINGLE-LAYER COIL, TAKING INTO ACCOUNT THE WIRE THICKNESS AND THE DISTANCE BETWEEN WINDINGS [Theory].—E. Hallén. (*Arch. f. Elektrot.*, 9th Oct. 1937, Vol. 31, No. 10, pp. 690–700.)

653. THE COEFFICIENT OF SELF-INDUCTANCE OF A SOLENOID [Success of Author's Approximate Formula is due to Particular Graphical Nature of Accurate Curve, which may be represented by Rectangular Hyperbola over Large Interval].—R. Esnault-Pelterie. (*Comptes Rendus*, 15th Nov. 1937, Vol. 205, No. 20, pp. 885–888.) For the formula in question see *ibid.*, 3rd Nov. 1937, No. 18, pp. 762–765. Numerical errors in this paper are here corrected.

654. THE MEASUREMENT OF HIGH RESISTANCES WITH THE HELP OF A THYRATRON [Simple Method: More Exact and Convenient Method using Relaxation Oscillations: Instrument for Resistances in Range 10 000 Ohms to 1000 Megohms].—J. L. Eck. (*L'Onde Élec.*, Nov. 1937, Vol. 16, No. 191, pp. 631–637.) For a previous paper *see* 946 of 1937. The method is specially useful for measuring insulation resistances and their variations, even when these are very slight.

655. THE BALLISTIC USE OF [Ordinary] INSTRUMENTS [for Unusual Measurements].—T. A. Rich. (*Gen. Elec. Review*, Dec. 1937, Vol. 40, No. 12, pp. 583–589.)

656. THE THEORY OF OPERATION OF A THERMOCOUPLE IN REVERBERATION MEASUREMENTS.—Skrebkov. (*See* 584.)

657. THE 6E5 [Cathode-Ray Indicator Tube] ALTERNATING CURRENT BRIDGE DETECTOR.—J. F. Koehler. (*Review Scient. Instr.*, Nov. 1937, Vol. 8, No. 11, p. 450.) More sensitive than the circuits of Brezeale and Waller (3129 of 1936 and 1368 of 1937) and with reduced background hum. The 6E5 both rectifies and indicates.

658. A COMPLEX COUPLING METER FOR USE ON COMMUNICATION CABLES [for measuring Very Small Electromagnetic or Electrostatic Couplings].—Sadakiyo & others. (*Nippon Elec. Comm. Eng.*, Aug. 1937, No. 7, p. 301–302: summary only.)

659. A SIMPLE [Low-Capacity and Rugged] QUARTZ-FIBRE ELECTROMETER.—C. C. & T. Lauritsen. (*Review Scient. Instr.*, Nov. 1937, Vol. 8, No. 11, pp. 438–439.)

660. RESISTANCE-COUPLED AMPLIFIER VOLTMETER WITH A CONSTANT RELATIVE SENSITIVITY [giving Readings proportional to Logarithm of Applied P.D.].—G. A. Beauvais. (*L'Onde Élec.*, Nov. 1937, Vol. 16, No. 191, pp. 638–642.)

Using variable-mu valves. For low voltages the earlier stages amplify and the last detects; as the voltage mounts, the later stages become saturated one after the other, and finally the first valve detects. *Cf.* Hunt, 1934 Abstracts, p. 162, r-h column; but the present writer, by using resistance coupling instead of choke coupling, gets readings practically independent of frequency between, say, 100 and 10 000 c/s.

661. METERS AND INSTRUMENTS: SOME IMPROVED AND NEW DESIGNS DEVELOPED DURING THE LAST TWELVE MONTHS.—(*Electrician*, 29th Oct. 1937, Vol. 119, pp. 507–516.)

SUBSIDIARY APPARATUS AND MATERIALS

662. ERRORS OF ELECTRON IMAGES [General Unifying Theory].—Rogowski. (*Arch. f. Elektrot.*, 15th Sept. 1937, Vol. 31, No. 9, pp. 555–593.)

Author's summary :—The so-called third-order errors of an electron image are derived by means of the simple Hamilton characteristic function (the "point-eikonal"). For a real electron beam, this function need only be expanded in a Taylor series up to fourth-order terms and compared with the corresponding expansion for an ideal ray. If the difference of the two is differentiated with regard to the stop coordinates, the result gives the desired errors immediately. This derivation assumes that the characteristic function and its relation to optics and mechanics are known. For this reason, a special paragraph is devoted to a résumé of the principles of Fermat and Maupertuis and the properties of the characteristic function. A simple proof is given of the extension required in the case of the magnetic field. The errors themselves are then discussed in detail, the treatment being both analytical and geometrical.

663. THE ORTHOGONAL SYSTEMS OF ELECTRONIC OPTICS AND THEIR APPLICATION TO SPECTROSCOPY.—Cotte. (*Comptes Rendus*, 22nd Nov. 1937, Vol. 205, No. 21, pp. 974–976.) Extension of theory referred to in 3849 of 1937.

664. THE IMAGE ERRORS OF THE WEAK MAGNETIC ELECTRON LENS [Calculation to First Approximation].—Gratsiatos. (*Zeitschr. f. Physik*, No. 5/6, Vol. 107, 1937, pp. 382–386.) For previous work *see* 326 of 1937.

665. "BEITRÄGE ZUR ELEKTRONENOPTIK" [Book Review].—Busch & Brüche (Edited by). (*Zeitschr. f. tech. Phys.*, No. 11, Vol. 18, 1937, p. 492.) Collected papers from the 1936 "Physikertag."

666. DISCUSSION ON "A NEW HIGH-SPEED CATHODE-RAY OSCILLOGRAPH."—Kuehni & Ramo. (*Elec. Engineering*, Nov. 1937, Vol. 56, No. 11, pp. 1401–1404.) *See* 3117 of 1937.

667. DUST FIGURE AND SURFACE CHARGE DENSITY [in connection with Cathode-Ray Dust Oscillograms].—Suzuki & Hoshino. (*Electrot. Journ.*, Tokyo, Oct. 1937, Vol. 1, No. 5, pp. 166–167.) For previous work *see* 668 of 1937.

668. POTENTIOMETERS FOR HIGH IMPULSIVE VOLTAGES [for Use with Cathode-Ray Oscillographs]: PART I—THE RESISTANCE POTENTIOMETER [Errors: Suitability of Various Resistance Materials: Methods of eliminating Variation of Electrolytic Conductivity of Liquid Resistances with Voltage Magnitude and Steepness].—Raske. (*Arch. f. Elektrot.*, 9th Oct. 1937, Vol. 31, No. 10, pp. 653–666.)

669. A HIGH-VACUUM MULTI-PLATE CAMERA [for Electron Microscopy, Cathode-Ray Oscillography, etc.].—Richards & Bound. (*Journ. Scient. Instr.*, Dec. 1937, Vol. 14, No. 12, pp. 402–406.)

670. MODIFICATIONS IN THE PHOSPHORESCENCE OF A SEMICONDUCTING ZINC SULPHIDE UNDER THE INFLUENCE OF AN ELECTRIC CURRENT.—Déchêne. (*Comptes Rendus*, 8th Nov. 1937, Vol. 205, No. 19, pp. 850–852.) Continuation of work referred to in 3211 of 1935.

671. ELECTRICAL AND LUMINESCENT PROPERTIES OF WILLEMITE UNDER ELECTRON BOMBARDMENT.—Nottingham. (*See* 617.)

672. A NEW METHOD FOR PRODUCING LIGHT SOURCES OF CONSTANT ENERGY THROUGHOUT THE VISIBLE SPECTRUM, *and* A NEW APPARATUS FOR THE INVESTIGATION OF FLUORESCENT MATERIALS FOR CATHODE-RAY TUBES.—von Ardenne. (*See* 615 & 616.)

673. THE TELEFUNKEN TRANSMITTING VALVES, POWER AMPLIFIERS, AND RECTIFIERS: III—RECTIFIERS [Hot-Cathode Type, Vacuum and Mercury-Vapour Filled, with and without Grids].—Kühle & Kluge. (*Telefunken*, Nov. 1937, Vol. 18, No. 77, pp. 69–84.) For Part II *see* 1934 Abstracts, p. 325.

674. INFLUENCE OF THE CONTACT RESISTANCE ON THE RECTIFYING AND PHOTOELECTRIC PROPERTIES PRESENTED BY BARRIER-LAYER ELEMENTS.—Roulleau. (*See* 633.)

675. INDUCTANCES IN RECTIFIER CIRCUITS.—Strobl. (*See* 499.)

676. AN ADJUSTABLE HIGH RESISTANCE WITHOUT SLIDING CONTACT.—Neldel. (*See* 500.)

677. SOME EXAMPLES OF BRIDGE CONNECTIONS WITH SEMICONDUCTING RESISTANCES [for Voltage Stabilisation: as High-Sensitivity Pirani Manometer: as Resistance Thermometer].—Weise. (*Zeitschr. f. tech. Phys.*, No. 11, Vol. 18, 1937, pp. 467–470.) Arising out of Neldel's results (676, above).

678. TWO-PULSE OSCILLATOR.—Getting. (*See* 415.)

679. A VACUUM-TUBE CIRCUIT FOR SCALING-DOWN COUNTING RATES [for High-Speed Geiger-Counter Discharges, etc.].—Stevenson & Getting. (*Review Scient. Instr.*, Nov. 1937, Vol. 8, No. 11, pp. 414–416.)

680. THE COURSE OF IONISATION PROCESSES IN GASES [Cloud-Chamber Investigations with bearing on Lightning-Stroke Development and Spark Discharge].—Flegler. (*E.T.Z.*, 25th Nov. 1937, Vol. 58, No. 47, pp. 1262–1264.)

681. REACTANCE AMPLIFIERS [Multi-Stage Magnetic-Saturation Amplifiers for Various Control Purposes: Stage Gain about 12 db: Advantages over D.C. Valve Amplifiers].—FitzGerald. (*Electronics*, Oct. 1937, Vol. 10, pp. 28–30.) On the development work at Haverford College.

682. COILS WITH COMPRESSED-POWDER CORES.—Kersten. (*See* 496.)

683. THE DESIGN OF INDUCTANCES FOR FREQUENCIES BETWEEN 4 AND 25 MEGACYCLES.—Pollack. (*See* 497.)

684. A New Insulating Material ["Rubbon B," from Catalytic Oxidation of Rubber].—(*Elec. Review*, Vol. 121, 1937, pp. 147–148.)

685. Dielectric Losses in Inorganic Glasses at Radio Frequencies [Industrial Glasses classified according to Chemical Composition and R.F. Dielectric Losses: Effect of Oxides: Mechanism of Dielectric Losses].—Bogoroditski & Friedberg. (*Tech. Phys. of USSR*, No. 9, Vol. 4, 1937, pp. 707–716: in English.) For previous work *see* 1953 (*also* 1955) of 1936.

686. Third Plenary Meeting of the Bureau of Electrical Insulation [including Description of "Sovol" (Viscous Insulating Liquid with D.C. twice that of Ordinary Transformer Oil): Replacement of Imported by Home-Produced Materials: etc.].—(*Tech. Phys. of USSR*, No. 9, Vol. 4, 1937, pp. 752–754: in English.)

687. Thermal Drift in Receivers and the Part played by Synthetic Resins: Effect of Replacement By Ceramic Materials.—Miller. (*See* 483.)

688. A Review of the Quest for Constant Speed.—Kellogg. (*See* 556.)

STATIONS, DESIGN AND OPERATION

689. Considerations of a System of Ultra-Short-Wave Simultaneous [Duplex] Telephony ["Single-Valve" and "Two-Valve" Systems with Long-Wave Control].—Ohtaka & Hasegawa. (*Nippon Elec. Comm. Eng.*, Aug. 1937, No. 7, pp. 211–217.) Further development of the work dealt with in 933 & 1325 of 1937.

690. An Experiment on Multiplex-Carrier Telephony on an Ultra-Short Wave at Tsugaru Strait [over 61 km: Preliminary Tests on 7.15, 4.05, and 3.85 Metre Waves: 6 Channels on Frequencies between 34 and 64 kc/s].—Matsumae & Yonezawa. (*Nippon Elec. Comm. Eng.*, Aug. 1937, No. 7, pp. 278–290.) As a stand-by for the non-loaded submarine cable linking a toll line.

691. Utilisation of the Ultra-Short Waves (2.5–10 m): Mobile Stations of Max. Weight 20 Kilograms, for Unskilled Personnel.—Dieutegard. (*Génie Civil*, 4th Dec. 1937, Vol. 111, No. 23, p. 487: summary only.)

692. A Novel Relay-Broadcast Mobile-Unit Design [Speedy "Private Car" Unit permanently fitted with Ultra-Short and Medium Wave Stations].—Rife. (*RCA Review*, Oct. 1937, Vol. 2, No. 2, pp. 141–148.)

693. A Novel System of Diplex Transmission [Two Crystal-Controlled Oscillators Each with Output alternately amplified and suppressed in Succeeding Half-Cycles of Superposed 200 c/s Grid Voltage: used at Portishead Shore Station].—A. J. A. Gracie. (*P.O. Elec. Eng. Journ.*, April 1937, Vol. 30, Part 1, pp. 15–17.)

694. The Most Favourable Band Width for Radiotelegraphic Communication with Audible Reception [Minimum of Errors obtained with Considerably Smaller Band Widths than Those usually employed: Properties of Ear allow Greater Station Density: Necessity for Development of Transmitters and Receivers to utilise This Fact to the Full].—Kotowski. (*Zeitschr. f. tech. Phys.*, No. 11, Vol. 18, 1937, pp. 454–456.)

695. An Automatic Line-Level Indicator [used at KTRH for calling Operator's Attention to Stopped Programme or Insufficient Modulation, etc.].—Odell. (*Electronics*, Oct. 1937, Vol. 10, No. 10, p. 36.)

696. A Synchroniser for Small Broadcasting Stations [Common-Wave System].—Kayano. (*Nippon Elec. Comm. Eng.*, Aug. 1937, No. 7, pp. 306–307: summary only.) *See* 3176 of 1937.

697. The Sofia Broadcasting Station, *and* The Hörby [Sweden] Broadcasting Station.—Meyer. (*Telefunken*, Nov. 1937, Vol. 18, No. 77, pp. 90–91: pp. 91–92.)

698. Broadcast Rediffusion and State Monopoly [and the Case of a Paris Company].—Mestre. (*Génie Civil*, 4th Dec. 1937, Vol. 111, No. 23, p. 484.)

699. Applying Police Radio [Necessary Analysis of Terrain, Noise Level, and Type of Service Required: Some Useful Data and Curves].—Harmon. (*Electronics*, Oct. 1937, Vol. 10, No. 10, pp. 22–24.)

700. Telecommunication Services for Civil Aviation.—Badenach. (*Journ. Inst. Eng. Australia*, Oct. 1937, Vol. 9, No. 10, pp. 413–421.)

GENERAL PHYSICAL ARTICLES

701. Diamagnetism of the Electron Gas [Calculations showing that Magnetic Behaviour of Electron Gas remains Normal even with Weak Fields].—Papapetrou. (*Zeitschr. f. Physik*, No. 5/6, Vol. 107, 1937, pp. 387–392.) For previous work *see* 3551 of 1937: the diamagnetism there prophesied is here proved not to occur.

702. Van der Waals Centenary Number.—(*Physica*, Nov. 1937, Vol. 4, No. 10, pp. 915–1180.) Including papers on the third (Nernst) law of thermodynamics, by Simon; on the London–van der Waals attraction between spherical particles, by Hamaker (both in English); etc.

703. Elementary Particles of Matter (Twenty-Eighth Kelvin Lecture).—Chadwick. (*Journ. I.E.E.*, Dec. 1937, Vol. 81, No. 492, pp. 697–700.)

704. The Validity of the Fundamental Laws of Electromagnetism [and the Dunton "No-Torque" Motor].—G.W.O.H: Dunton. (*Wireless Engineer*, Oct. 1937, Vol. 14, No. 169, p. 526.) Prompted by Dunton's letter to *Nature*, 7th Aug. 1937.

705. Researches on the Monomolecular Layers.—Dervichian. (*Ann. de Physique*, Nov. 1937, Series 11, Vol. 8, pp. 361–466.)

MISCELLANEOUS

706. The Late Lord Rutherford of Nelson.—(*Engineering*, 29th Oct. 1937, Vol. 144, pp. 488–490.)

707. Guglielmo Marconi and the Development of Radio-Communication. — Fleming. (*Journ. Roy. Soc. Arts*, 26th Nov. 1937, Vol. 86, pp. 42–64.) For a correction (diagrams transposed) see *ibid.*, 3rd Dec., p. 83.

708. Fourier Expansions obtained Operationally [with Examples of Rectified Sine Wave, Saw-Tooth Wave Form, etc: Initial Transients].—McLachlan. (*Phil. Mag.*, Dec. 1937, Series 7, Vol. 24, No. 165, pp. 1055–1058.)

709. On Some Operational Representations of Products of Parabolic Cylinder Functions and Products of Laguerre Polynomials.—Howell. (*Phil. Mag.*, Dec. 1937, Series 7, Vol. 24, No. 165, pp. 1082–1093.)

710. The Tests for Sampling Differences and Contingency.—Jeffreys. (*Proc. Roy. Soc.*, Series A, 15th Oct. 1937, Vol. 162, No. 911, pp. 479–495.)

711. "The Elements of Mathematical Analysis" [Book Review].—Michell & Belz. (*Wireless Engineer*, Oct. 1937, Vol. 14, No. 169, p. 536.)

712. Matrices in Engineering.—Pipes. (*Elec. Engineering*, Sept. 1937, Vol. 56, No. 9, pp. 1177–1190.)

713. Spiralographic Planimeter for the Integration of Functions depending on Time.—Caufourier. (*Génie Civil*, 27th Nov. 1937, Vol. 111, No. 22, p. 462.)

714. A Device for the Solution of Systems of Linear Equations and Similar Calculations.—Poggi. (*La Ricerca Scient.*, 15th/31st May 1937, Series 2, 8th Year, Vol. 1, No. 9/10, pp. 418–422.)

715. The Importance of English to an Engineer.—Palmer. (*Elec. Engineering*, Oct. 1937, Vol. 56, No. 10, p. 1284: summary only.)

716. *L'Onde Électrique*: Editorial on the Results of a Questionnaire on the Comparative Popularity of Various Sections and Types of Article.—David. (*L'Onde Élec.*, Oct. 1937, Vol. 16, No. 190, pp. 541–546.)

717. "Fundamentals of Engineering Electronics."—Dow. (At Patent Office Library, London: Cat. No. 77 959: 618 pp.) For a review see *Review Scient. Instr.*, Oct. 1937, Vol. 8, No. 10, pp. 361–362.

718. The Mission of the Physicist in National Life.—Saha. (*Indian Journ. of Phys.*, Sept. 1937, Vol. 11, Part 4, Supp. pp. 1–15.)

719. "Radio Engineering: Second Edition" [Book Review].—Terman. (*Electronics*, Nov. 1937, Vol. 10, No. 11, p. 42.) Over three-quarters of the text has been completely re-written.

720. "Communication Engineering: Second Edition" [Book Review].—Everitt. (*Electronics*, Sept. 1937, Vol. 10, No. 9, p. 30.)

721. "Selected Bibliography of Engineering Subjects" [Notice of Pamphlets].—(*Electronics*, Nov. 1937, Vol. 10, No. 11, p. 42.)

722. "Handbook of Broadcasting" [Book Review].—Abbot. (*Electronics*, Sept. 1937, Vol. 10, No. 9, p. 30.)

723. "Legal Restrictions on the Contents of Broadcast Programs in the United States" [Book Review].—Caldwell. (*Electronics*, Sept. 1937, Vol. 10, No. 9, p. 30.)

724. The VIII International Juridical Congress on Radioelectricity, Paris, 28th Sept.–1st Oct. 1937.—(*Génie Civil*, 23rd Oct. 1937, Vol. 111, No. 17, pp. 358–359.)

725. "Patents for Inventions" [Book Review].—Haddon. (*Wireless Engineer*, Oct. 1937, Vol. 14, No. 169, p. 540.)

726. The International Organisation of Bibliography.—Bradford. (*Engineering*, 15th Oct. 1937, Vol. 144, pp. 441–442.)

727. Librafilm [Equipment comprising Copying Machine and Viewer].—Ford. (*Engineer*, 5th Nov. 1937, Vol. 164, p. 513.)

728. B.B.C. Research.—Kirke. (*Wireless World*, 9th & 16th Dec. 1937, Vol. 41, pp. 580–582 & 602–604.)

729. Electrical Communication Researches at the Research Laboratory of Electrical Communication, Tohoku Imperial University.—(*Nippon Elec. Comm. Eng.*, Aug. 1937, No. 7, pp. 193–200.) With list of published papers.

730. Publications of the R. Istituto Elettrotecnico e delle Comunicazioni della Marina, R. Accademia Navale, Leghorn: Nos. 115–131: 1936/1937.)—(*E.T.Z.*, 16th Dec. 1937, Vol. 58, No. 50, p. 1360.) List of papers only: many of them, but not all, have been dealt with in these Abstracts.

731. "Short-Wave Diathermy" [Book Review].—de Cholnoky. (*Electronics*, Aug. 1937, Vol. 10, No. 8, p. 32.)

732. Limits of A.C. Voltage which are Not Dangerous: Experimental Research.—Kervran. (*Rev. Gén. de l'Élec.*, 5th June 1937, Vol. 41, No. 23, pp. 723–728.)

733. VDE Draft Regulations for Electro-Medical High-Frequency Apparatus for Diathermy, H.F. Surgery, and Short-Wave Therapy.—Verband Deutscher Elektrotechniker. (*E.T.Z.*, 2nd Sept. 1937, Vol. 58, No. 35, pp. 965–968.)

734. REPORT ON THE FIRST INTERNATIONAL CONGRESS FOR SHORT [and Ultra-Short] WAVES IN PHYSICS, BIOLOGY, AND MEDICINE.—Stierstadt. (*Zeitschr. f. tech. Phys.*, No. 9, Vol. 18, 1937, pp. 241–251.) Various items are dealt with separately in Nov. 1937 Abstracts. For a notice of a book containing shortened versions of the papers see *ibid.*, p. 287. *See* also Thoma, *Funktech. Monatshefte*, Aug. 1937, pp. 262–263.

735. INTERNATIONAL CONGRESS FOR SHORT WAVES IN PHYSICS, BIOLOGY AND MEDICINE, VIENNA [Notes on Production of Ultra-Short Waves, Transmission, Ionospheric Research, Absorption & Dispersion in Chemical Systems, Dielectric Properties of Tissue, etc.].—(*Nature*, 28th Aug. 1937, Vol. 140, pp. 372–374.) *See* also Fritsch, *E.T.Z.*, 21st Oct. 1937, Vol. 58, No. 42, pp. 1147–1148: *also* 3984, 4040, 4046/8, 4080, and 4223/5, all of 1937.

736. BIOLOGICAL EFFECT OF CENTIMETRE WAVES [Accelerating Action of Weak 2 cm Waves on Plant Seeds].—Turlyguin. (*Comptes Rendus* (*Doklady*) *de l'Ac. des Sci. de l'URSS*, 5th March 1937, Vol. 14, No. 7, pp. 433–436: in English.)

737. THE LAW OF NERVE EXCITATION BY ALTERNATING CURRENTS [10^2–10^5 c/s approx.].—Malov. (*Comptes Rendus* (*Doklady*) *de l'Ac. des Sci. de l'URSS*, 5th March 1937, Vol. 14, No. 7, pp. 437–440: in German.)

738. AN ELECTRIC CARDIOMETER [Rugged, Mains-Driven Instrument free from Defects of the Boas Apparatus].—Henry. (*Science*, 3rd Sept. 1937, Vol. 86, pp. 229–230.)

739. THE EXAMINATION AND RECORDING OF THE HUMAN ELECTROCARDIOGRAM BY MEANS OF THE CATHODE-RAY OSCILLOGRAPH.—Robertson. (*Journ. I.E.E.*, Oct. 1937, Vol. 81, No. 490, pp. 497–509: Discussion pp. 509–514.) Among many points dealt with in the Discussion, the danger of ambiguity in the use of the abbreviation "D.C." (sometimes "direct-coupled," usually "direct-current") is brought out.

740. IMPROVEMENTS IN THE FIELD OF ELECTRO-CARDIOGRAPHY. — Boucke. (*Funktech. Monatshefte*, Oct. 1937, No. 10, pp. 319–323). For Hollmann's work, here included, *see* also 3977 of 1937.

741. A THYRATRON STIMULATOR-TIMER USED IN CONJUNCTION WITH THE CATHODE-RAY OSCILLOGRAPH [for Physiological Research].—Harris. (*Review Scient. Instr.*, Sept. 1937, Vol. 8, No. 9, pp. 345–348.)

742. PHYSIOLOGICAL LECTURE DEMONSTRATION APPARATUS [Projection Kymograph: Photocell Apparatus for Recording of Small Movements: Photoelectric Manometer for Blood Pressures].—Bell & others. (*Journ. Scient. Instr.*, Oct. 1937, Vol. 14, No. 10, pp. 330–335.)

743. THE EFFECTS OF SHORT AND ULTRA-SHORT WAVES ON ORGANISMS [Softening and Hardening of Plant Protoplasm: Effects (Not Simply Thermal) on Frogs' Hearts: on Colloidal Membranes: on Livers (*in vivo*): on Cancer and Sarcoma).—Sasada. (*Nippon Elec. Comm. Eng.*, Aug. 1937, No. 7, pp. 295–297: summary only.) For effects on chemical reactions and on bacteria *see* 2467 and 3237 of 1936.

744. THE BIOLOGY OF LIGHT-PRODUCTION AMONG THE ARTHROPODS.—Maloeuf. (*Sci. Progress*, Oct. 1937, Vol. 32, No. 126, pp. 228–245.)

745. ON THE DETECTION OF MITOGENETIC RADIATION BY PHYSICAL METHODS.—Drigo & Barbieri. (*La Ricerca Scient.*, 15th/31st July 1937, Series 2, 8th Year, Vol. 2, No. 1/2, pp. 116–117.)

746. AN EXPERIMENTAL STUDY OF THE PROBLEM OF MITOGENETIC RADIATION.—Hollaender & Claus. (*Bull. of Nat. Res. Council*, Washington, No. 100, July 1937, 96 pp.)

747. "HANDBUCH DER BIOLOGISCHEN ARBEITSMETHODEN" [including Valve-Amplifier and Photocell Technique: Book Review].—Abderhalden (Edited by). (*Zeitschr. f. tech. Phys.*, No. 11, Vol. 18, 1937, p. 495.)

748. A PHOTOELECTRIC METHOD FOR TRACING CURRENT WAVE FORMS.—Huxford & Engstrom. (*Review of Scient. Instr.*, Oct. 1937, Vol. 8, No. 10, pp. 385–390.) The full paper, a summary of which was dealt with in 3959 of 1937.

749. THE [Chilowski] PHOTO-RELAY. — (*Journ. Scient. Instr.*, Oct. 1937, Vol. 14, No. 10, p. 350.) *See* also 2839 of 1937.

750. RELAY FOR PHOTOCELL CURRENT WITHOUT AMPLIFICATION [using Johnson-Rahbeck Effect].—Wein. (*Electronics*, Sept. 1937, Vol. 10, No. 9, p. 29.) In a miscellany entitled "Questions and Answers."

751. THE USE OF THE PHOTO-RELAY IN THE STUDY OF LUNAR MICRORELIEF.—Natanson. (*Comptes Rendus* (*Doklady*) *de l'Ac. des Sci. de l'URSS*, 15th April 1937, Vol. 15, No. 2, pp. 77–78: in English.)

752. ELECTRONICS ON BROADWAY [Advertising Device giving Black-and-White Animated Cartoons by 4104 Lamps (in Groups of 4) and 1026 Photocells].—Rosenberg. (*Electronics*, Sept. 1937, Vol. 10, No. 9, p. 21.)

753. A PHOTOELECTRIC SMOKE PENETROMETER.—Hill. (*Journ. Scient. Instr.*, Sept. 1937, Vol. 14, No. 9, pp. 296–303.)

754. PHOTOELECTRIC PHOTOMETRY IN THE PRINTING OF AMATEUR NEGATIVES.—Tuttle. (*Journ. Franklin Inst.*, Sept. 1937, Vol. 224, No. 3, pp. 314–337.)

755. RECORDING LIGHT-METER [Rotations of Crookes Radiometer counted by Photoelectric Circuit].—Gerlach & Buhl. (*Physik. Zeitschr.*, 15th Oct. 1937, Vol. 38, No. 20, pp. 795–797.)

756. Spherical Reflectometer [using Self-Generating Photocells] for Light Transmission and Reflection Measurements.—General Electric Company. (*Electronics*, Oct. 1937, Vol. 10, No. 10, pp. 46 and 49.)

757. Photoelectric Measurements of the Light Scattered by Small Particles.—Iwai & Iwai. (*Electrot. Journ.*, Tokyo, Dec. 1937, Vol. 1, No. 7, pp. 195–197.)

758. An Infra-Red Spectrograph with a New Type of Recording of Heat Radiation.—Lehrer. (*Zeitschr. f. tech. Phys.*, No. 11, Vol. 18, 1937, pp. 393–396.)

759. A Light Measuring Instrument with Spherical Alkali Photocell [particularly for Daylight Measurements].—AEG. (*E.T.Z.*, 16th Dec. 1937, Vol. 58, No. 50, Supp. p. 15.)

760. The Measurement of Light Intensity by means of a Selenium Barrier-Layer Photocell.—Putseiko. (*Journ. of Tech. Phys.* [in Russian], No. 13, Vol. 7, 1937, pp. 1337–1345.)

The sensitivity curve of a selenium cell is rather similar to that of the eye except that the cell is also sensitive to infra-red and ultra-violet rays. It is comparatively easy to compensate the cell for ultra-violet rays; it is suggested in the paper that the infra-red sensitivity can also be reduced if certain precautions are taken during manufacture.

761. Some Unconventional Vacuum-Tube Applications [Self-Balancing Capacity-Operated Relay: a Specially Simple and a Specially Quick-Acting Photo-Amplifier Relay: a Sensitive Light-Balance Indicator: etc.].—Shepard. (*RCA Review*, Oct. 1937, Vol. 2, No. 2, pp. 149–160.)

762. A New Photoelectric Method for measuring Vitamin A.—McFarland & others. (Referred to in Shepard's paper, 761, above.)

763. "Double-Layer" Photocell with Almost Uniform Sensitivity over Whole Visible Spectrum.—Görlich. (In paper dealt with in 627, above.)

764. Street Lighting Control by Photocell Relays: Buffalo City.—(*E.T.Z.*, 16th Dec. 1937, Vol. 58, No. 50, p. 1346: summary only.)

765. The Importance and Wide Adoption of the Alkali Photocell in Light-Controlled Devices.—Briebrecher. (*E.T.Z.*, 16th Dec. 1937, Vol. 58, No. 50, pp. 1351–1354.)

766. Phototube aids High-Speed Printing [by controlling Drying Spray to prevent "Offset"].—(*Electronics*, Sept. 1937, Vol. 10, No. 9, p. 42.)

767. Transformer Amplifier for Barrier-Layer Photocell Applications [tuned to 120 c/s Flicker from 60 c/s Current in Small Lamp: primarily for Burglar Alarm].—Clement. (*Electronics*, Nov. 1937, Vol. 10, No. 11, p. 58.)

768. Phototube Limit Relay applied to Weighing Problems.—Barnes. (*Electronics*, Oct. 1937, Vol. 10, No. 10, pp. 40 and 42, 44.)

769. Phototubes used in Sorting and Tabulating Machine [for Business Records].—Gould. (*Electronics*, Nov. 1937, Vol. 10, No. 11, p. 50.)

770. A New Method of Optical Signalling with High Transmitting Speed [200 Letters/Minute or More: Possibility of Secrecy].—Bruscaglioni. (*La Ricerca Scient.*, 15th/31st Aug. 1937, Series 2, 8th Year, Vol. 2, No. 3/4, pp. 186–192.) On the principle of the variation of the spectroscopic composition of the beam.

771. Physical Methods of Automatic Control and Regulation [including Periodic and Aperiodic Oscillations in Sensitive Control Systems, Photocells in Control Technique, etc.].—König, Briebrecher, & others. (*Zeitschr. f. tech. Phys.*, No. 11, Vol. 18, 1937, pp. 398–434.)

772. Capacity-Operated Relay applied to Furnace Heat Control [Thermo-Couple actuates Meter whose Pointer acts as One Plate of Variable Condenser].—Machlet: Shepard. (*Electronics*, Nov. 1937, Vol. 10, No. 11, pp. 46 and 48.)

773. Testing Focal-Plane Shutters [with help of Cathode-Ray Oscillograph].—van Liempt & de Vriend. (*Physica*, Oct. 1937, Vol. 4, No. 9, pp. 811–827: in English.)

774. The Determination of the Moisture Content of Timber by Electrical Capacity Effects: a New Meter and its Application.—Thomas & Greenhill. (*Journ. of Council for Sci. & Indust. Res., Australia*, Aug. 1937, Vol. 10, No. 3, pp. 235–241 and Plate.)

775. Determination of Fibre-to-Void Ratio of Wood-Pulp [Cable] Paper by Electrical Methods [Measurements of Dielectric Constants: Assumed Distributions of Fibre and Void correlated with Experimental Values].—Greenfield. (*Phys. Review*, 1st Aug. 1937, Series 2, Vol. 52, No. 3, p. 245: abstract only.)

776. A New Galvanometric Method for the Measurement of Small Displacements [Ultra-Micrometer based on Thomson Effect of Resistance Change in Bismuth produced by Change of Magnetic Field].—Reisch. (*Elektrot. u. Masch:bau*, 12th Sept. 1937, Vol. 55, No. 37, p. 455: summary only.)

777. The Measurement of the Pressure Curves in the Extinction Chambers of Oil-less Switches at Short-Circuit [Piezoelectric Method], *and* High-Power Short-Circuit Testing.—Graul & Möckel: Brown & Ehrenberg. (*E.T.Z.*, 16th Sept. 1937, Vol. 58, No. 37, pp. 1011–1012 [summary only]: *BEAMA Journal* [formerly *World Power*], Sept. 1937, Vol. 41, No. 3, pp. 67–73: to be contd.)

778. THE DETECTION OF FLAWS, ETC., IN MACHINE PARTS BY A MAGNETIC PROCESS USING IRON FILINGS AS INDICATOR.—Wiegand. (*Zeitschr. f. tech. Phys.*, No. 9, Vol. 18, 1937, pp. 281–285.)

779. CONFERENCE DEVOTED TO MAGNETIC ANALYSIS IN MAGNETIC DEFECTOSCOPY.—(*Tech. Phys. of USSR*, No. 9, Vol. 4, 1937, pp. 754–760: in English.)

780. AN AUTOMATIC ELECTRICAL FATIGUE-TESTING MACHINE [for Wire for Steel-Wire Ropes].—Wray. (*Engineer*, 3rd Sept. 1937, Vol. 164, pp. 251–254.)

781. TENSION MEASUREMENT AND CONTROL IN COLD-STRIP MILLS [Electro-Magnetic Tensiometer].—Hathaway & Mohler. (*Elec. Engineering*, Sept. 1937, Vol. 56, No. 9, pp. 1141–1144.)

782. A SIMPLE METHOD OF MEASURING ROTATIONAL SPEEDS [*e.g.* 500–3000 r.p.s: Small Rotating Magnet inducing into Coil connected to Telephone Bridge Circuit].—Snoddy & Beams. (*Science*, 12th March 1937, Vol. 85, pp. 273–274.)

783. WELDING AND VOLTAGE CONTROL USING KATHETRONS [Control Tube with External Grid].—Craig. (*Electronics*, Sept. 1937, Vol. 10, No. 9, pp. 26–28.)

784. MECHANICAL HIGH-SPEED RESISTANCE-WELDER CONTROL.—Roby. (*Elec. Engineering*, Sept. 1937, Vol. 56, No. 9, pp. 1145–1148.)

785. CATHODE-RAY ENGINE-PRESSURE MEASURING EQUIPMENT.—Schrader. (*RCA Review*, Oct. 1937, Vol. 2, No. 2, pp. 202–212.) Incidentally, "it is often desirable to picture the rate of change of pressure diagrams: a partial-derivative curve may readily be produced by coupling the amplifier to the oscillograph through a small capacitor."

786. THE BALANCING OF SHADED-POLE MOTORS [*e.g.* Self-Starting Clock Motors: Oscilloscope and Stroboscope Technique].—Sundt. (*Electronics*, Oct. 1937, Vol. 10, No. 10, pp. 36 and 40.)

787. NEW APPLICATIONS OF THE PIEZOELECTRIC MEASURING TECHNIQUE IN BALLISTICS [particularly Recoil Investigations in Rifle and Cannon].—Illgen. (*Zeitschr. f. tech. Phys.*, No. 11, Vol. 18, 1937, pp. 470–474.)

788. NEW RESULTS OF SPARK CINEMATOGRAPHY [of Projectile Impacts: Implosion Pressure Waves from Air Bubbles, and Their Connection with Corrosion Phenomena in Cavitation].—Schardin & Struth. (*Zeitschr. f. tech. Phys.*, No. 11, Vol. 18, 1937, pp. 474–477 and Plates.)

789. A PROBLEM OF MEASURING THE GAS CONTENT OF GAS-FILLED INCANDESCENT LAMPS [H.F. Method unsuccessfully tried: Suggestions wanted].—(*Electronics*, Nov. 1937, Vol. 10, No. 11, p. 46.)

790. ELECTRONIC MICROMETER MEASURES DEPTH OF GROOVES IN BULLETS.—Wilson. (*Electronics*, Sept. 1937, Vol. 10, No. 9, pp. 38 and 40.)

791. AN INSTRUMENT FOR MEASURING THE THICKNESS OF COATINGS ON METALS [or of Foils or Paper: Electro-Magnetic Method].—Tait. (*Journ. Scient. Instr.*, Oct. 1937, Vol. 14, No. 10, pp. 341–343.)

792. A NEW ACCELEROMETER [based on Resistance Variation of Wires under Stress] AND THE MEASUREMENT OF THE STARTING PHENOMENON BY VIBROGRAPHS.—Gerloff. (*Forschung auf dem Gebiete des Ingenieurwesens*, May/June 1937, Vol. 8, No. 3, pp. 143–152.)

793. MEASURING VIBRATION VELOCITY [the Indication and Recording of Vibration Velocity, Wave Shape, and Frequency].—Greentree. (*Gen. Elec. Review*, Sept. 1937, Vol. 40, No. 9, pp. 432–437.)

794. THE SILENT ELECTRIC DISCHARGE AS THE BASIS OF GASEOUS REACTIONS, AND ITS TECHNICAL APPLICATIONS [including Production of Ozone, Treatment of Oils ("Voltol" Process), etc.].—Wiche. (*E.T.Z.*, 4th Nov. 1937, Vol. 58, No. 44, pp. 1198–1199: summary only.)

795. AMPLIFICATION BY THERMIONIC VALVES IN THE STUDY OF SINGLE ELEMENTARY PARTICLES.—Mandò. (*Nuovo Cimento*, Jan. & March 1937, Vol. 14, Nos. 1 & 3, pp. 14–44 and 119–139.)

796. INVESTIGATIONS ON THE RELEASE OF ELECTRICAL CHARGES UNDER MODERATE PRESSURE FROM PHOTOGRAPHIC PLATES AND OTHER MATERIALS.—Prosad & Chatterjee. (*Indian Journ. of Phys.*, Sept. 1937, Vol. 11, Part 4, pp. 289–294.)

797. AN ELECTRONIC pH METER [Hydrogen-Ion Concentration Measured to $\pm$ 0.02: Probable Useful Application to Other Purposes].—Finlay: Shepard. (*Electronics*, Nov. 1937, Vol. 10, No. 11, pp. 39–40.)

798. PHYSICAL MEASURING PROCESSES IN THE CHEMICAL INDUSTRY [Survey].—Gmelin. (*Zeitschr. f. tech. Phys.*, No. 11, Vol. 18, 1937, pp. 349–362.)

799. "PHYSICS IN INDUSTRY" [Symposium by American Institute of Physics: Book Notice].—(*Journ. Scient. Instr.*, Sept. 1937, Vol. 14, No. 9, p. 323.)

800. THE INTERNATIONAL EXPOSITION OF ARTS AND TECHNIQUES, PARIS 1937, AND THE PALACE OF DISCOVERY.—Bertin. (*Rev. Gén. de l'Élec.*, 25th Sept. 1937, Vol. 42, No. 13, pp. 407–414.)

801. TELEFUNKEN AT THE 14TH GREAT GERMAN RADIO EXHIBITION, BERLIN 1937.—Urbahn. (*Telefunken*, Nov. 1937, Vol. 18, No. 77, pp. 92–94.)

802. THE PROPAGATION OF H.F. CURRENTS ALONG A THREE-PHASE POWER LINE [as for Signalling Purposes].—Gints. (*See* 418.)

Some Recent Patents

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

ACOUSTICS AND AUDIO FREQUENCY CIRCUITS AND APPARATUS

473 776.—Public address equipment with a switch-over arrangement for producing a high penetrating note which serves as a distinctive warning signal.

Receiver for the Metropolitan Police District and E. C. Brown. Application date 22nd May, 1936.

AERIALS AND AERIAL SYSTEMS

473 866.—Method of mounting a frame aerial, used for direction-finding, on an aeroplane of the all-metal type.

Standard Telephones and Cables (assignees of Le Materiel Telephonique). Convention date (France) 2nd April, 1936.

474 664.—Aerial adapted to receive either long or medium and also short and ultra-short wave signals.

K. H. Barbour. Application date 4th March, 1936.

474 769.—Aerial system suitable for transmitting broadcast programmes, with a minimum of high-angle radiation.

Marconi's W.T. Co. and E. B. Moullin. Application date 6th May, 1936.

DIRECTIONAL WIRELESS

472 419.—Cathode-ray indicator for recording the critical minimum or maximum readings in a wireless direction-finder.

F. Johnske. Application date 14th April, 1936.

472 651.—Direction-finding installation comprising several aerials of the Adcock type for operation on different wavelengths.

Marconi's W.T. Co.; S. B. Smith; and E. Green. Application date 26th March, 1936.

472 733.—Direction-finding receiver for counting the number of two separate sets of signals transmitted from a rotating radio beacon.

C. Lorenz, A.G. [addition to 447 707]. *Convention date (Germany) 20th December,* 1935.

473 420.—Directional systems for enabling an aeroplane to "home" on to a wireless beacon station.

A. F. Hergenberger. Convention date (U.S.A.) 12th January, 1935.

474 015.—Blocking arrangement for cutting-out interference from a continuously-rotating direction-finder giving a visual indication of direction.

Telefunken Co. Convention date (Germany) 27th May, 1936.

474 663.—Marker beacons for guiding aircraft to an aerodrome and assisting them to land.

C. D. Barbulesco. Convention date (U.S.A.) 4th February, 1935.

474 690.—Cathode-ray indicator for direction-finding on the direct or ground wave, and adapted to cut out interference from the corresponding indirect or space-wave component of the signal.

The Plessy Co. and C. E. G. Bailey. Application date 21st May, 1936.

474 972.—Direction-finding system of the kind in which the pick-up from a directional and non-directional aerial is periodically reversed to produce two overlapping cardioid curves which indicate the line of the incoming signals.

G. G. Kruesi. Convention date (U.S.A.) 8th February, 1935.

RECEIVING CIRCUITS AND APPARATUS

(See also under Television).

471 806.—Remote control system in which the tuning and tone response of a distant wireless receiver are regulated by one knob whilst the volume is adjusted by a second knob.

K. H. Kerr. Application date 10th *February,* 1936.

472 046.—Method of assembling different types of wireless receiver from a relatively small number of standardised "unit parts."

G. W. Johnson (communicated by Philco Radio and Television Corpn.). Application date 11th March, 1936.

472 128.—System of automatic selectivity control depending upon the use of broadly tuned and narrowly tuned amplifiers.

Marconi's W.T. Co. Convention dates (U.S.A.) 14th March; 25th May; and 9th July, 1935 *(addition to* 431 755).

472 158.—Rectifying frequency-modulated signals by feeding them into a loaded transmission line having a curved "frequency" characteristic.

The Telefunken Co. Convention date (Germany) 23rd April, 1936.

472 256.—Amplifier circuit with negative feed-back to prevent non-linear distortion.

Standard Telephones and Cables and A. H. Roche. Application date 18th March, 1936.

472 502.—All-wave receiver in which the L/C ratios of the tuned circuits of the various wavebands are of the same order of magnitude, the effective value of the common tuning-condenser being adjusted to cover the full range of each band.

Hazeltine Corporation. Convention date (U.S.A.) 20th April, 1936.

472 520.—Tuning device for a wireless receiver in which both the extent and direction of any error in adjustment is indicated.

Marconi's W.T. Co. (assignees of G. Guanella and M. Lattman). Convention date (Switzerland), 23rd September, 1936.

472 590.—Thermionic amplifier of the kind in which the electrical centre of the cathode is maintained at a high potential.

Siemens and Halske A.G. Convention date (Germany), 4th April, 1936.

472 631.—Wave-range switch giving a coloured indication of each particular setting.

General Electric Co. and R. Gosden. Application date 25th February, 1936.

472 710.—Remote tuning control of a superhet receiver by varying the frequency of the local oscillator valve.

L. L. de Kramolin. Convention date (Germany) 18th May, 1935 *(addition to Patent No.* 449 240).

472 712.—Reducing distortion in a wireless receiver by a "reverse feed back" connection which can be switched out of circuit when receiving distant stations.

E. K. Cole and G. Bradfield. Application date 28th May, 1936.

472 722.—Tuning knob provided with contacts which serve to "mute" the set when bridged by the fingers of the operator.

General Electric Co. and N. R. Bligh. Application date 18th September, 1936.

472 802.—Tuning indicator dials of the kind in which the various stations are arranged in groups, according to geographical situation, or nationality.

Fab. Italiani Magneti Marelli. Convention date (Italy) 24th March, 1936.

472 922.—Noise-suppressing arrangement for a wireless receiver in which a switch on the tuning knob disables the set until the circuits are accurately in tune.

E. K. Cole and H. Hunt. Application date 29th April, 1936.

473 437.—Volume-control and tone-control circuit comprising a variable-resistance shunt and a bypass capacity inserted across the speech-coil of the loud speaker.

Johnson & Phillips and D. Douet. Application date 29th April, 1936.

473 503.—Tuning indicator in which the names of the various stations are magnified and projected optically on to an enlarged scale.

Sachsenwerk Licht-und-Kraft-Akt. Convention date (Germany) 26th October, 1935.

473 512.—Amplifier for a wide band of frequencies in which the degree of amplification—or A.V.C.—is automatically controlled by the effect of direct current flowing through iron-cored coils.

J. J. Numans. Convention date (The Netherlands) 13th November, 1935.

473 618.—System of automatic tuning in which the control is maintained effective, even during periods of "fading" and afterwards.

Marconi's W.T. Co. Convention date (U.S.A.) 16th April, 1935.

473 895.—Means for controlling the effective amplification of a valve by means of a complex load impedance inserted between the anode and the H.T. supply.

Baird Television and L. C. Bentley. Application date 21st April, 1936.

474 284.—Tuning arrangement for a wireless set in which the names of the stations are arranged in alphabetical order to facilitate selection.

W. E. Woodley. Application date 24th March, 1936.

474 382.—Band-pass or filter circuit, say for a wireless receiver, designed to maintain a constant phase relation over a relatively wide band of frequencies.

Marconi's W.T. Co.; N. M. Rust; and E. F. Goodenough. Application date 29th April, 1936.

474 682.—Automatic frequency control system, including a discriminating network, to ensure resonance with an incoming signal.

Marconi's W.T. Co. Convention date (U.S.A.) 3rd May, 1935.

474 684.—Superhet receiver for combined television and sound signals which are picked up on the same aerial and separated by means of a single local oscillator.

Baird Television and L. R. Merdler. Application date 4th May, 1936.

474 771.—Automatic tuning control system in which the correction is to some degree affected by the setting of the tuning knob, or wave-change switch, in order to make the control more efficient over a wide range of wavelengths.

E. K. Cole. Convention date (Sweden) 13th July, 1935.

474 923.—Tuning indicator for an all-wave wireless set in which each setting of the wave-change switch controls the position of an indicating beam of light.

F. G. Gillard. Application date 14th May, 1936.

474 932.—Wireless set in which the valve used to energise a cathode-ray tuning indicator is automatically switched into the main amplifying circuit when the set is used for gramophone reproduction.

E. K. Cole and A. E. Falkus. Application date 10th July, 1936.

474 967.—Automatic tuning control in which the "fine-tuning" voltage is limited within predetermined values.

E. K. Cole. Convention date (Sweden) 1st September, 1936.

TELEVISION CIRCUITS AND APPARATUS

FOR TRANSMISSION AND RECEPTION

471 817.—Electrode system with graded biasing voltages for accelerating the electron stream in a cathode-ray television receiver.

Telefunken Co. Convention date (Germany) 14th March, 1935.

471 825.—Rotating disc system for producing intermeshed scanning in television.

Cie pour la fabrication, etc., d'usines à Gaz. Convention date (France) 12th April, 1935.

472 562.—Television system in which a stereoscopic effect is produced by showing different pictures on the opposed sides of a ribbed or grated screen.

P. Eisler and F. Pevny. Application date 2nd July, 1936.

472 645.—Multi-grid valve arranged to generate two sets of saw-toothed oscillations for interlaced scanning in television.

Baird Television and G. R. Tingley. Application date 26th March, 1936.

472 686.—Method of locking together two valve generators of saw-toothed oscillations for use in television scanning.

Baird Television and P. W. Willans. Application date 28th March, 1936.

472 762.—Television system in which the background of a scene is scanned separately from the moving actors, the two sets of signals then being combined.
Baird Television and V. A. Jones. Application date 28th March, 1936.

472 834.—Balancing the self-capacities and the shunt capacity to earth of the deflecting coils used in a cathode-ray tube.
Telefunken Co. Convention date (Germany) 28th March, 1935.

472 859.—Method of intensifying the electron image produced in a cathode-ray tube of the "dissecter" type.
Farnsworth Television Inc. Convention date (U.S.A.) 1st July, 1935.

472 860.—Cathode-ray television transmitter provided with a luminescent screen and a charge-storing screen, the latter being subjected to the action of two independent electron streams.
Farnsworth Television Inc. Convention date (U.S.A.) 6th July, 1935.

472 861.—Means for intensifying the composite electron stream produced in a cathode-ray tube of the image-dissector type.
Farnsworth Television Inc. Convention date (U.S.A.) 6th July, 1935.

472 862.—Construction and electrode arrangement of a cathode-ray television transmitter.
Farnsworth Television Inc. Convention date (U.S.A.) 6th July, 1935.

472 900.—Modulator system for synchronising signals in television.
Radio-Akt. D. S. Loewe. Convention dates (Germany) 28th March and 4th November, 1935.

472 923.—Separating the synchronising signals from the framing impulses in a television receiver.
Marconi's W.T. Co.; R. J. Kemp; and D. J. Fewings. Application date 29th April, 1936.

472 992.—Filter circuit for amplifying the synchronising impulses derived from a "light-siren" as used in television.
Radio-Akt. D. S. Loewe. Convention date (Germany) 6th April, 1935.

473 006.—Cathode-ray television transmitter in which primary electrons from a sensitive cathode produce secondary electrons which are collected on a storage screen and then scanned by an electron beam.
Baird Television and V. Jones. Application date 4th April, 1936.

473 028.—Valve circuit designed to correct phase-distortion both in transmission and reception, particularly for television signals.
E. L. C. White. Application date 8th April, 1936.

473 059.—Arrangement of impedance networks for separating the line and frame synchronising signals in television.
H. R. Lubcke. Application date 31st January, 1936.

473 150.—A method of depositing mirror-films such as are used on scanning drums for television.
Baird Television and J. L. Baird. Application date 9th April, 1936.

473 166.—Method of high-speed scanning in television in which an electric field is interposed between the image and an electron collector, and is periodically modified in such a way as to let only one signal element pass at a time.
P. M. G. Toulon. Convention date (France) 6th November, 1935.

473 303.—Two-colour system of television in which the received light signals are applied to a double-refracting prism, and the two emerging rays passed through differently coloured filters.
Baird Television and J. L. Baird. Application date 9th April, 1936.

473 323.—Revolving disc used as a colour filter for the separate signals in a method of televising three-colour pictures.
Baird Television and J. L. Baird. Application date 9th April, 1936.

473 427.—Receiver for television and sound signals having a pass-band wide enough to include both sets of signals whilst giving uniform amplification of both.
W. S. Spencer. Application date 9th April, 1936.

473 464.—Television transmission system in which an electric image is formed on a light-sensitive screen formed of a high-resistance film of mercury iodide, sodium chloride, or an alloy of selenium.
Electrical Research Products Inc. Convention date (U.S.A.) 4th March, 1936.

473 554.—Television system in which an electron image of a picture is formed on one side of a screen, the other side of the same screen being coated with a fluorescent layer which feeds light to an associated photo-electric cell.
Baird Television and C. Szegho. Application date 14th April, 1936.

473 650.—Time-base circuit for a cathode-ray tube in which the deflecting voltage across one pair of plates is of equal amplitude but opposite phase, the same applying also to the second pair of deflecting plates.
V., A., and V. Kliatchko (assignees of Cie des Compteurs et Materiel d'Usines à Gaz). Convention date (France) 15th April, 1935.

473 836.—Valve for generating saw-toothed oscillations for television scanning in which an iron-cored transformer is included in the back-coupled circuit.
Ferranti and E. G. O. Anderson. Application date 31st March, 1936.

473 907.—Method of keeping the reflected ray of constant intensity, in spite of angular changes, in a mirror-drum scanner for television.
Scophony and J. H. Jeffree. Application date 23rd May, 1936.

473 910.—Television scanning system of the kind comprising fixed and stationary reflecting surfaces.
E. Traub. Application date 3rd June, 1936.

474 386.—Cathode-ray television receiver in which auxiliary anodes or "targets" are provided for separating and handling the synchronising signals.
Marconi's W.T. Co. and D. L. Plaistowe. Application date, 29th April, 1936.

474 391.—Cathode-ray television receiver fitted with two fluorescent screens in order to produce larger pictures.

Baird Television and C. Szegho. Application date 30th April, 1936.

474 399.—Cathode-ray television receiver with provision for regulating the focusing of the electron stream in accordance with the mean "brightness" level of the incoming signals.

Baird Television and L. R. Merdler. Application date 1st May, 1936.

474 623.—Generating push-pull scanning voltages for the deflecting plates in cathode ray television receiver.

A. C. Cossor; L. H. Bedford; and W. H. Stevens. Application date 9th May, 1936.

474 683.—Saw-toothed oscillation generator for television scanning comprising rectifiers which serve alternatively to pass and dissipate current pulses.

Baird Television and P. W. Willans. Application date 4th May, 1936.

474 739.—Multi-vibrator combination suitable for use in television, in which one of the two grids of each valve is cross-coupled to the anode, whilst the other grid is fed with a synchronising or "locking" voltage.

Marconi's W. T. Co. and D. A. Bell. Application date 6th May, 1936.

474 970.—Light cell for television scanning in which compression waves of supersonic frequency are set up in the liquid at an angle to the direction of illumination.

Scophony and F. von Okolicsanyi. Application dates 5th February and 15th April, 1936.

TRANSMITTING CIRCUITS AND APPARATUS

(*See also under Television.*)

471 876.—Reducing the band-width of a modulated carrier-wave by utilising sub-multiples of the signal as modulation frequencies.

Telefunken Co. [*void*]. *Convention date* (*Germany*) *10th December*, 1934.

472 106.—Condenser arrangement for short-circuiting or "earthing" the supply leads of a valve oscillator or generator, so far as H.F. currents are concerned.

C. Lorenz, Akt. Ges. Convention date (*Germany*) *5th February*, 1936.

472 214.—Modulating system for producing a single side-band effect, or a purely phase-modulated carrier-wave.

Marconi's W.T. Co. (*assignees of J. Plebanski*). *Convention date* (*Poland*) *17th September*, 1936.

472 351.—Construction of resonant "tank" circuit for a short-wave wireless transmitter.

Marconi's W.T. Co. (*assignees of A. H. Turner*). *Convention date* (*U.S.A.*) *29th August*, 1935.

472 580.—Generating short pulses of radiation for use in measuring distances.

Telefunken Co. Convention date (*Germany*) *1st February*, 1936.

472 583.—High-frequency oscillation generators particularly of the split-anode magnetron type.

Marconi's W.T. Co. (*assignees of G. R. Kilgore*). *Convention date* (*U.S.A.*) *29th February*, 1936.

472 725.—Impedance-matching couplings for transmission lines of the so-called dielectric-guide type.

Standard Telephones and Cables (*communicated by Western Electric Inc.*). *Application date 2nd October*, 1936.

472 816.—Multiplex system of carrier-wave telephony.

General Electric Co.; E. P. L. Westell; and D. A. Ley. Application date 28th February, 1936.

473 042.—Suppressed carrier-wave modulator, or frequency-changer, in which the signal voltages are applied in push-pull to a pair of co-planar grids or anodes in a single valve.

Standard Telephones and Cables. Convention date (*U.S.A.*) *11th January*, 1936.

473 116.—Filter circuit for eliminating second and third harmonics, and for balancing the impedance of the feed-line to an aerial.

Marconi's W.T. Co. (*assignees of L. J. McKesson*). *Convention date* (*U.S.A.*) *20th January*, 1936.

473 272.—Preventing "fading" by simultaneously radiating the signals from a group of differently located transmitting aerials.

J. Robinson. Application date 4th March, 1936.

473 330.—Modulating arrangement for carrier-wave signalling of the kind employing diode rectifiers.

Telephone Manufacturing Co. and L. H. Paddle. Application date 6th April, 1936.

474 385.—High-frequency feed-line for energising a wireless transmitting aerial in which means are provided for preventing "loop" resonance effects.

Marconi's W.T. Co. and C. S. Franklin. Application date 29th April, 1936.

CONSTRUCTION OF ELECTRONIC-DISCHARGE DEVICES

472 165.—Structure of external magnetic-lens system for focusing the electron stream in a cathode-ray tube.

Ferranti and M.K. Taylor. Application date 11th March, 1936.

472 343.—Construction and mounting of an indirectly-heated cathode.

E. K. Cole; R. W. Sutton; and F. W. O. Kennedy. Application date 2nd June, 1936.

472 896.—Electron-multiplier with several "target" electrodes for amplifying, detecting, and generating high-frequency oscillations.

Marconi's W.T. Co. Convention date (*U.S.A.*) *28th February*, 1935.

473 149.—Construction of thermionic cathode for producing a concentrated or directed beam of electrons in a cathode-ray tube.

V. Zeitline; A. Zeitline; and V. Kliatchko. Convention date 8th April, 1935.

473 173.—Cathode-ray tube in which the electrodes are made of chrome-iron or chrome-steel, in order to prevent degeneration of the fluorescent screen.

N. V. Philips Lamp Co. Convention date (*Germany*) *25th January*, 1936.

473 290.—Screen to protect the electrodes of a cathode-ray tube during the process of fusing them into the glass structure.

Radio-Akt. D. S. Loewe. Convention date (*Germany*) *17th April*, 1935.

473 571.—Electron multiplier in which at least one of the "impact targets" is divided into two parts of different emissivity, so as to facilitate the modulation of the output current.

General Electric Co. and W. H. Aldous. Application date 31st July, 1936.

473 844.—Conducting coating of variable resistance applied to the inner wall of a cathode-ray tube for focusing the electron stream.

Fernseh Akt. Convention date (Germany) 18th April, 1935.

473 893.—Deflecting electrode arrangement for a cathode-ray tube, in which part of the structure is pervious to the electron stream.

V., A., and V. Kliatchko (assignees of Cie des Compteurs et Materiel d'Usines à Gaz). Convention date (France) 19th April, 1935.

474 296.—Electron-discharge tube, suitable for use in television, in which a photo-electric cathode in the form of a gauze is "backed" by a negatively-charged grid of fine wires.

Baird Television; T. M. C. Lance; and V. Jones. Application date 28th April, 1936.

474 525.—Valve holder in which the sockets allow of no up-and-down movement but do permit of a limited lateral "float" and rocking motion.

C. R. Cook. Application date 4th May, 1936 (addition to 414 057).

474 616.—Method of depositing a light-sensitive layer of caesium and silver oxide on the surface of an electrode.

Baird Television and A. Sommer. Application date 4th May, 1936.

474 675.—Valve in which the static anode-grid capacity and the coupling between the supply conductors are definitely related, with the object of handling single-frequency signals, such as television.

N. V. Philips Lamp Co. Convention date (Holland) 26th July, 1935.

SUBSIDIARY APPARATUS AND MATERIALS

468 635.—Portable wireless transmitter and receiver for ultra-short waves constructed to resemble a pistol with trigger control of the circuit settings.

Julius Pintsch Akt. Convention date (Germany) 8th January, 1935.

468 805.—Discharge lamp containing a mixture of a rare gas and caesium vapour for producing infra-red radiation for television and other purposes.

The General Electric Co. (communicated by Patent Treuhand Ges.). Application date 24th March, 1936.

469 418.—Gas-filled cathode-ray tube, working on low operating voltages, and suitable for use as an indicator in a radio direction-finding set.

Marconi's W.T. Co. and G. F. Brett. Application date 24th January, 1936.

469 898.—Oscillation-generator designed to produce a continual succession of sharp pulses of constant frequency.

Marconi's W.T. Co. and S. W. H. W. Falloon. Application date 3rd February, 1936.

470 148.—Means for "monitoring" high-fidelity sound signal transmissions, such as public address systems.

Telefunken Co. Convention date (Germany) 4th November, 1935.

470 495.—Thermionic valve distributor for multiplex signalling.

A. Blumlein. Application date 14th November, 1935.

470 524.—Method of viewing objects in the dark, or in fog, by scanning the infra-red radiation and projecting it upon the screen of a television receiver.

A. M. F. P. de Limelette. Convention date (France) 15th May, 1935.

470 921.—Wire-wound resistance particularly suitable for carrying currents of the order of 50 megacycles.

Baird Television and L. R. Merdler. Application date 24th February, 1936.

471 193.—The use of cathode-ray tubes as a substitute for mechanical selectors or relays in a multiple signalling system.

Telefon Akt. L. M. Ericsson. Convention date (Sweden) 2nd March, 1935.

472 064.—Method of constructing the photo-electric cathodes used in light-sensitive cells.

British Thomson Houston Co. Convention date (Germany) 3rd May, 1935.

472 148.—Metal-film electrodes for piezo-electric crystal oscillators.

Siemens and Halske Akt. Convention date (Germany) 27th January, 1936.

473 061.—Light-valve, particularly for television, in which the intensity, colour, or state of polarisation of the light is controlled by an applied field.

A. H. Rosenthal. Application date 5th March, 1936.

473 128.—Optical system for recording sound waves and electric oscillations on a continously-moving photographic film.

G. W. Walton. Application date 4th March, 1936.

473 936.—Method of assembling the constituent parts of a moving-coil loud speaker.

General Electric Co.; A. Jones; and S. Littlemore. Application date 22nd December, 1936.

474 383.—High-frequency coupling network designed to maintain a constant overall impedance ratio, and equal but opposite phase shifts of 90°, so as to match a balanced source of supply to an unbalanced load.

Marconi's W.T. Co. and E. Green. Application date 29th April, 1936.

474 387.—Piezo-electric coupling in which mutual inductance is arranged to balance out the "carry-through" effect of the crystal.

Marconi's W. T. Co. and N. M. Rust. Application date 29th April, 1936.

474 388.—Cross-coupled valve circuit for producing a lower or divided frequency from a given input.

Marconi's W.T. Co. and D. A. Bell. Application date 29th April, 1936.

474 701.—Piezo-electric crystal cut so as to resonate to more than one fundamental frequency in the direction of its thickness, the separate frequencies being usefully related to each other.

Marconi's W.T. Co. (assignees of S. A. Bokovy). Convention date (U.S.A.) 31st October, 1935.

474 857.—Method of making high-frequency powdered-iron cores for inductance coils.

E. Michaelis. Application date 16th October, 1936.