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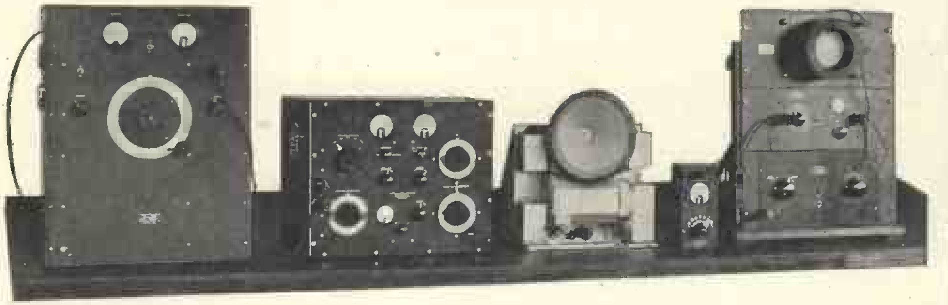

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The

WIRELESS ENGINEER

and EXPERIMENTAL WIRELESS

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THE
WIRELESS ENGINEER
AND
EXPERIMENTAL WIRELESS

VOL. IX. AUGUST, 1932. No. 107

Editorial.

Straight Sets *versus* Superheterodynes.

RECENT numbers of our sister journal, *The Wireless World*, contained constructional details of two sets each embodying the most advanced principles of design in its class; one a straight so-called five-valve receiver and the other a seven-valve superheterodyne receiver. We say "so-called" in the first case because in making up the five valves the rectifier valve is included. We are aware that this is common procedure to-day, but it is one which is open to question, for the rectifier valve forms no part of the receiver but is merely an adjunct of its power supply and a metal rectifier replacing it would at once make it indisputably a four-valve set. Then in the case of a superheterodyne, should we regard the valve used as a separate oscillator as one of the stages of the receiver? And, again, are valves in push-pull to be designated as one or as two valve stages?

These points raise the whole question of the designation of receivers in terms of the number of valves and there can be no argument as to the unsatisfactory lack of uniformity at present existing, but what is the best compromise by way of a solution?

This is, however, a side issue; our real object in drawing attention to these two sets is to raise the question of the relative merits of the two types of receiver for the general purpose of broadcast reception. Is a superheterodyne or a straight set to be preferred where it is desired to have the maximum number of stations at the same standard of quality and freedom from interference? To make the comparison fair both sets should be placed on the same footing. To aim at the same degree of selectivity with a straight set as with a superheterodyne an increase in the number of H.F. stages, or at least of the tuned circuits, seems essential, and these additions will add to the cost. If the H.F. stages of a straight set could be designed so that, either with or without a subsequent tone-correcting stage, the set would give the same degree of selectivity and sensitivity as the superheterodyne, would the cost still compare favourably with the superheterodyne?

In comparing results it must be borne in mind that one of the most important elements of quality in reception is silence of background, for however good the quality may otherwise be, a station loses its entertainment value if the pianissimo passages are lost in a general background of noise. There is also the question of second channel interference or some allied phenomenon which may occur in one or other of these types of set.

The locality in which the receiver is to be used is no doubt an important point in deciding the question, but in endeavouring to arrive at a satisfactory answer it would perhaps be necessary to put the question in this form. Given an adequate sum of money to build a first-class receiver, which type of set could be counted on to give the better performance within limits of that expenditure, the superheterodyne or the straight receiver? We do not wish to minimise the difficulties of designing and constructing the H.F. stages to maintain the necessary band-pass characteristics over the whole tuning range on both medium and long waves, nor do we wish to underrate the straight sets which have been developed in the past. We merely wish to raise the question whether the superheterodyne or the straight set is the better answer to the growing demand for quality and the increasing congestion of the ether which is today the great problem of broadcasting.

A MONTH IN THE AIR.

Wireless plays a highly important part in the Hon. Mrs. Victor Bruce's attempt on the flight duration (re-fuelling) record. The photograph shows the Marconi apparatus installed on the Windhover aeroplane which is being used in the flight. The equipment consists of a light-plane set, type A.D.22B, incorporating a telephone transmitter of 75 watts power and a three-valve receiver. In addition to the international aircraft wavelength of 900 metres, a specially allotted wavelength of 764 metres is being used.

The Theory of Distortion in Screen-grid Valves.*

By R. O. Carter, M.Sc., A.C.G.I., D.I.C.

THIS article is a mathematical investigation of distortion in screen-grid high-frequency amplifiers; it leads to several important results which are useful in the design of screen-grid valves, particularly those of the variable conductance type. The method is merely an application of well-known principles and has already been described by Ballantine and Snow.† In the present article, however, the results are worked out in rather more detail, and several important conclusions given which are not included in their paper.

The method assumes that the valves are correctly operated, sufficient H.T. voltage being applied so that the flat part of the anode volts-anode current curve is reached for all values of grid bias, and further, the load in the anode circuit is not so large as to cause the dynamic characteristic to depart from the flat part.

The impedance of the valve will then be so high that for all practical purposes the effect of the load on the characteristic can be neglected, and the only distortion produced is due to the non-linearity of the grid volts-anode current curve at the selected anode voltage.

The method could be applied to other types of high-frequency amplifier with suitable modifications, but usually the load will have an effect on the dynamic characteristic, and the calculation is complicated thereby.

The results indicate the best shape of valve characteristic for any desired purpose. As it appears that valve manufacturers can obtain almost any shape of curve by suitable construction of the electrodes of the valve, a theoretical investigation of the curve to be aimed at seems very profitable.

Consider the general case of a valve whose grid volts-anode current curve can be represented by

$$I_a = f(v_0)$$

where I_a is the anode current and v_0 the grid voltage.

If v_0 is increased to $v_0 + e_g$ we have by Taylor's theorem,

$$I_a + \Delta I_a = f(v_0) + e_g f'(v_0) + \frac{e_g^2}{\underline{|2}} f''(v_0) + \ldots$$

where ΔI_a is the corresponding increase of I_a

or
$$\Delta I_a = e_g f'(v_0) + \frac{e_g^2}{\underline{|2}} f''(v_0) + \ldots$$

$$= D_1 e_g + \frac{D_2}{\underline{|2}} e_g^2 + \frac{D_3}{\underline{|3}} e_g^3 + \ldots$$

where
$$\frac{\partial^n}{\partial v_0^n}[f(v_0)] = D_n$$

If $e_g = E_g \cos \omega t$

$$\Delta I_a = D_1 E_g \cos \omega t + \frac{D_2}{\underline{|2}} E_g^2 \cos^2 \omega t + \ldots$$

We may assume that the impedance of the tuned anode or tuned transformer coupling at frequencies remote from the resonant frequency is negligibly small compared with the impedance close to resonance. Hence, in the present case, the only components of the anode current which are capable of producing a voltage across the anode load are those of angular frequency ω (which is the angular frequency to which the coupling is tuned). In order to obtain these components, the terms in the above expression of the form $\cos^n \omega t$ can be expanded in a series of terms in ωt, $2\omega t$, $3\omega t$ . . . and only those in ωt need be retained.

Carrying out this transformation (see Appendix 1) and retaining only the desired terms, which we will denote by i_a,

$$i_a = \left[D_1 E_g + \frac{D_3}{2^2 \underline{|2}\,\underline{|1}} E_g^3 + \ldots + \frac{D_n}{2^{n-1} \underline{\left|\frac{n+1}{2}\right.}\,\underline{\left|\frac{n-1}{2}\right.}} E_g^n \right] \cos \omega t \quad \ldots (1)$$

(where n is an odd positive integer).

* MS. received by the Editor, March, 1932.

† *Proc. I.R.E.*, Dec., 1930. "Reduction of Distortion and Cross-talk in Radio Receivers by means of Variable-Mu Tetrodes."

If now $E_g = E(1 + M \cos pt)$

$$i_a = \Bigg[D_1 E(1 + M\cos pt) + \frac{D_3}{2^2\, 2!\, 1!} E^3 (1 + M\cos pt)^3 + \dots + \frac{D_n}{2^{n-1} \left(\frac{n+1}{2}\right)! \left(\frac{n-1}{2}\right)!} E^n (1 + M\cos pt)^n + \dots \infty \Bigg] \cos\omega t$$

a little reflection will show that the terms in $2\omega t$, $3\omega t$, . . . will again contribute no components within the range of the tuned anode circuit.

If $(1 + M \cos pt)^n$ is expanded, the general term is $\frac{n!}{(n-r)!\, r!} M^r \cos^r pt$ and this in turn can be expanded in a series of cosines of pt, $2pt$, $3pt$, . . . npt, the series differing slightly according as r is even or odd. If all the terms in the expression for i_a are expanded in this way, and collected in a series of terms in $\cos pt$, $\cos 2pt$, $\cos 3pt$ . . . $\cos qpt$ (see Appendix 2) we obtain for the coefficient of the term $\cos qpt \cos \omega t$ when q is even and not zero,

$$\sum_{n=q+1}^{n=\infty} \left[\frac{D_n}{2^{n-1} \left(\frac{n+1}{2}\right)! \left(\frac{n-1}{2}\right)!} E^n \sum_{r=q}^{r=n-1} \left\{ \frac{M^r\, n!}{2^{r-1} \left(\frac{r+q}{2}\right)! \left(\frac{r-q}{2}\right)! (n-r)!} \right\} \right] \quad \dots (2)$$

where n is odd and r is even.

When q is odd, n and r are both odd, and the expression is the same as for q even, except that the limits of the first summation are $n = q$ and $n = \infty$, and of the second, $r = q$ and $r = n$.

When $q = 0$, the coefficient is half the value given by the above expression for q even.

Expanding the above expressions for $q = 0, 1, 2, 3$, and denoting the coefficients by C_0, C_1, C_2, C_3 . . . we obtain

$$C_0 = D_1 E + \left(\frac{3}{4} + \frac{9}{8} M^2\right) \frac{D_3}{3!} E^3 + \left(\frac{5}{8} + \frac{25}{8} M^2 + \frac{75}{64} M^4\right) \frac{D_5}{5!} E^5 + \dots \quad (3)$$

$$C_1 = M D_1 E + \left(\frac{9}{4} M + \frac{9}{16} M^3\right) \frac{D_3}{3!} E^3 + \left(\frac{25}{8} M + \frac{75}{16} M^3 + \frac{25}{64} M^5\right) \frac{D_5}{5!} E^5 + \dots \quad (4)$$

$$C_2 = \frac{9}{8} M^2 \frac{D_3}{3!} E^3 + \left(\frac{25}{8} M^2 + \frac{25}{16} M^4\right) \frac{D_5}{5!} E^5 + \dots \quad (5)$$

$$C_3 = \frac{M^3}{16} \frac{D_3}{3!} E^3 + \left(\frac{5}{32} M^3 + \frac{5}{256} M^5\right) \frac{D_5}{5!} E^5 + \dots \quad (6)$$

and the expression for the useful component of the anode current is

$$i_a = C_0 \cos\omega t + C_1 \cos pt \cos\omega t + C_2 \cos 2pt \cos\omega t + \dots$$

The effective depth of modulation of the fundamental audio-frequency $(p/2\pi)$ is $M' = \frac{C_1}{C_0}$, and of the second and third harmonics,

$$M_2{}' = \frac{C_2}{C_0},\quad M_3{}' = \frac{C_3}{C_0}$$

Considering, first, the case when M is small, not more than 0.2 or 0.3, all powers of M in the coefficients higher than the lowest in each case may be neglected, and, very nearly,

$$M' = \frac{M D_1 E + \frac{3}{8} M D_3 E^3 + \frac{5}{192} M D_5 E^5 + \dots}{D_1 E + \frac{1}{8} D_3 E^3 + \frac{1}{192} D_5 E^5 + \dots}$$

$$\therefore \frac{M' - M}{M} = \frac{1}{4}\frac{D_3}{D_1} E^3 + \frac{1}{48}\frac{D_5}{D_1} E^5 + \dots \quad (7)$$

This represents the increase in depth of modulation, as a fraction of the depth at the input; this quantity, expressed as a percentage, is called the modulation-rise. It is seen that, for small values of M, the modulation-rise is independent of the actual value of M. A convenient value of M to use when making practical measurements is 20%.*

---

* *See W.E. & E.W.*, March, 1932, "Distortion in Screen-grid Valves," by R. O. Carter.

Again, when M is small,

$$\frac{M_2'}{M'} = \frac{\frac{3}{16}M^2D_3E^3 + \frac{5}{192}M^2D_5E^5 + \ldots}{MD_1E + \frac{3}{8}MD_3E^3 + \frac{5}{192}MD_5E^5 + \ldots}$$

or, neglecting all terms in the denominator except the first,

$$\frac{M_2'}{M'} = \frac{3}{16}M\frac{D_3}{D_1}E^2 + \frac{5}{192}M\frac{D_5}{D_1}E^4 + \ldots \quad (8)$$

$\frac{M_2'}{M'}$ is the ratio of the second harmonic to the fundamental in the audio-output (assuming a perfectly linear detector), *i.e.*, the percentage harmonic introduced by the screen-grid valve. If the modulation-rise is denoted by "x," it will be seen that $\frac{M_2'}{M'} = \frac{3}{4}Mx$ if derivatives above the third are neglected. Even if the terms in D_5 are comparable, $\frac{M_2'}{M'}$ cannot exceed $\frac{5}{4}Mx$ and usually will not be so large.

As a rule, therefore, the percentage second harmonic due to the valve will be about $\frac{3}{4}Mx \times 100$.

In a similar manner, when M is small,

$$\frac{M_3'}{M'} = \frac{1}{96}M^2\frac{D_3}{D_1}E^2 + \frac{1}{768}M^2\frac{D_5}{D_1}E^4 = \frac{M^2x}{24}$$

(approx.). (Again neglecting higher derivatives) .. .. (9)

If the terms in D_5 are important, the value will not be increased much and can in any case not exceed $\frac{M^2x}{16}$.

If we assume an input modulation depth of 20%, and if the modulation-rise is also 20%, the second and third harmonic introduced by the valve will be seen to be 3% and .03% respectively.

When M is very large and approaches unity

$$\frac{M'-M}{M} = x = \frac{5}{32}\frac{D_3}{D_1}E^2 + \frac{7}{256}\frac{D_5}{D_1}E^4 + \ldots \quad \ldots \ldots (10)$$

$$\frac{M_2'}{M'} = \frac{3}{16}\frac{D_3}{D_1}E^2 + \frac{5}{128}\frac{D_5}{D_1}E^4 + \ldots \quad (11)$$

$$\frac{M_3'}{M'} = \frac{1}{96}\frac{D_3}{D_1}E^2 + \frac{3}{2048}\frac{D_5}{D_1}E^4 + \ldots \quad (12)$$

It is seen that, as a rule, x will be smaller, and that the percentage of second and third harmonics is very nearly the same as for small values of M.

Measurement of modulation-rise, therefore, gives immediately a fairly accurate indication of the audio-frequency harmonics introduced by the H.F. stage, besides indicating directly the amount of increase in detector distortion to be expected, due to the general rise in modulation. The above figures indicate that 20% modulation-rise is a reasonable limit to allow.

Cross-modulation.

Before proceeding to apply the above theory to any concrete case, it is necessary to consider a second problem, that of cross-modulation.

This form of interference is produced by interaction of a modulated unwanted signal and the carrier of the wanted signal. The wanted carrier becomes modulated with the same audio-frequency or frequencies as already modulate the unwanted carrier, and consequently no degree of selectivity later in the H.F. amplifier is capable of removing the interference. Naturally the trouble usually occurs at the first valve, since the unwanted signal is usually too much attenuated in the later stages to produce any trouble there. By the use of sufficiently selective band-pass circuits in the aerial, the voltage of the unwanted frequency applied to the first valve can be reduced sufficiently to eliminate the trouble, whatever characteristic the valve may have; but it is not always economical to do this.

In order to simplify the problem, suppose the wanted carrier is unmodulated, and equal to $E_1 \cos \omega_1 t$. Then we have seen above that the amplitude of the anode current component of frequency $\omega_1/2\pi$ is

$$\left[D_1E_1 + \frac{D_3}{2^2\,\underline{|2}\,\underline{|1}}E_1^3 + \ldots + \frac{D_n}{2^{n-1}\,\underline{\left|\frac{n+1}{2}\right.}\,\underline{\left|\frac{n-1}{2}\right.}}E_1^n + \ldots\right]\cos \omega_1 t$$

[*see* equation (1)].

This can be written $F(v_0) \cos \omega_1 t$ since

D_1, D_2, D_3 . . . are functions of v_0, the grid bias.

If at any instant the interfering station is producing a voltage e_2 on the first grid, v_0 is replaced by $v_0 + e_2$ and

$$F(v_0 + e_2) = F(v_0) + e_2F'(v_0) + \frac{e_2^2}{\underline{|2}} F''(v_0) + \ldots \text{ (by Taylor's theorem)}$$

and if $e_2 = E_2(1 + m \cos pt) \cos \omega_2 t$,

$$F(v_0 + e_2) = C_0' \text{ (say)}$$
$$= F(v_0) + E_2(1 + m \cos pt)F'(v_0) \cos \omega_2 t + \frac{E_2^2}{\underline{|2}}(1 + m \cos pt)^2 F''(v_0) \cos^2 \omega_2 t + \ldots \quad \ldots \ldots (13)$$

Expanding this expression, we obtain approximately (*see* Appendix 3)

$$C_0' = \left(D_1 + \frac{mD_3}{2} E_2^2 \cos pt\right) E_1 \quad (14)$$

and the percentage modulation is therefore

$$\frac{mD_3}{2D_1} E_2^2$$

This quantity, divided by m, the original percentage modulation of the unwanted signal, gives the percentage cross-modulation. *i.e.*, percentage cross-modulation,

$$\tfrac{1}{2}\frac{D_3}{D_1} E_2^2 \times 100 \quad \ldots \ldots (15)$$

Although higher terms are neglected, the accuracy of this result will suffice for design purposes.

Application of Results.

Consider, in the first place, a single stage H.F. amplifier. For low detector distortion, the high frequency input to the detector should be kept constant at the optimum value. Consequently the input to the H.F. valve will be inversely proportional to the mutual conductance at the appropriate value of grid bias, *i.e.*, gE_1 = constant [where g is the mutual conductance].

Now $$g = \frac{\partial i_a}{\partial v_0} = D_1$$

The requirements then are :—

(1) Modulation-rise not to exceed a certain limit at any value of grid bias when the appropriate input is applied.

(2) Cross-modulation factor not to exceed a certain percentage, when a second modulated E.M.F. of specified carrier amplitude is applied (the frequency of the second carrier being far removed from the first).

(3) The anode current at initial grid bias* should be a minimum.

(4) The grid bias necessary to produce a given reduction of conductance should be a minimum.

Conditions (1), (3) and (4) are best satisfied when the modulation-rise is a constant quantity ; *i.e.*, referring to equation (7) and retaining only the first term, modulation-rise (x)

$$= \tfrac{1}{4}\frac{D_3}{D_1} E_1^2 = \text{constant}$$

or since D_1E_1 = constant

$$\tfrac{1}{4}\frac{D_3}{D_1^3} = \text{constant}$$

Since $D_1 = g$ and therefore $D_3 = \frac{\partial^2 g}{\partial v_0^2}$, this may be written

$$\tfrac{1}{4}\frac{\frac{\partial^2 g}{\partial v_0^2}}{g^3} = \text{constant}$$

This equation is satisfied by a curve of the form

$$g = \frac{g_0}{1 - kv_0} \quad \ldots \ldots (16)$$

[where g_0 is the mutual conductance at initial bias, v_0 the added grid bias, and k is a constant]

or, since $i_a = \int g dv_0$,

$$i_a = i_0 - \frac{g_0}{k}\log(1 - kv_0) \quad \ldots (17)$$

and the modulation-rise

$$= x = \tfrac{1}{4}\frac{\frac{\partial^2 g}{\partial v_0^2}}{g} E_1^2$$
$$= \tfrac{1}{2}\frac{k^2 g^2}{g_0^2} E_1^2$$

A little investigation shows readily that the

* NOTE.—" Initial grid bias " means the smallest value of grid bias which is ever used ; *i.e.*, just sufficient bias to prevent grid current even when a small input is applied. The actual value may vary as much as from + 1 to − 2 volts, according to the construction of the valve. In the present article the grid voltage is assumed, unless otherwise stated, to be measured relative to this point.

error due to the omission of the higher terms in the expression for x is negligibly small.

Example: Suppose the mutual conductance at initial bias is 1.5 mA/volt, the largest input voltage to be handled is 5 volts R.M.S. carrier, and the modulation-rise must not exceed 20%. Further, the impedance in the anode circuit is 50,000 ohms (or equivalent transformer) and the detector requires 1.5 volts carrier input for efficient operation. Required to determine the best characteristic.

The value of g at the appropriate bias point for an input of 5 volts will be

$$\frac{1.5}{50 \times 5} = 0.006 \text{ mA/volt}$$

and $gE_1 = 0.03$ at every point.

Also $$\frac{1}{2}\frac{k^2g^2}{g_0^2}E_1^2 = 0.2$$

$$\therefore \quad \frac{k^2}{g_0^2} = \frac{0.4}{g^2E_1^2} = 440$$

$$\therefore \quad k = 21g_0 = 31.5$$

$$\therefore \quad g = \frac{1.5}{1 - 31.5v_0}$$

and when $E_1 = 5$ or $g = 0.006$,

$$v_0 = -\frac{249}{31.5} = -8 \text{ volts (approx.)}$$

Now $$i_a = i_0 - \frac{g_0}{k}\log(1 - kv_0)$$

$$= i_0 - \frac{g_0}{k}\log_e\frac{g_0}{g}$$

i.e., $$\log_e\frac{g_0}{g} = 21(i_0 - i_a)$$

If at the maximum bias (8 volts) the value of i_a is $i_{\text{min.}}$ and these values are inserted in the above equation,

$$\log_e 253 = 5.52 = 21(i_0 - i_{\text{min.}})$$

or $$i_0 = i_{\text{min.}} + 0.26$$

If we assume $i_{\text{min.}} = 0.1$ mA (say), then $i_0 = 0.36$ mA.

This is therefore the value of the anode current at initial bias.

Turning now to the question of cross-modulation, conditions (2), (3) and (4) are best satisfied when the cross-modulation is a constant percentage under all operating conditions,

i.e., $$\frac{1}{2}\frac{D_3}{D_1}E_2^2 = \text{constant} \quad [\textit{see} \text{ equation (15)}].$$

Or since E_2 may be assumed constant,

$$\frac{D_3}{D_1} = \text{constant}$$

i.e., $$\frac{\frac{\partial^2 g}{\partial v_0^2}}{g} = \text{constant}$$

This is satisfied by

$$g = g_0e^{Av_0} \quad \ldots \quad \ldots (18)$$

when $$\frac{1}{2}\frac{D_3}{D_1}E_2^2 = \frac{1}{2}A^2E_2^2$$

Example: If the maximum amplitude of interfering signal is taken as 0.5 volt, and the cross-modulation factor must not exceed 5%,

$$\frac{1}{2}A^2 \times 0.5^2 = 0.05$$

and $$A^2 = 0.4$$

or $$A = 0.63.$$

The anode current characteristic is given by

$$i_a = \int g dv_0 = b + \frac{g_0}{A}e^{Av_0} \quad \ldots (19)$$

(where b is a constant of integration).

b can be zero, since in this case i_a tends to zero as $v_0 \to -\infty$.

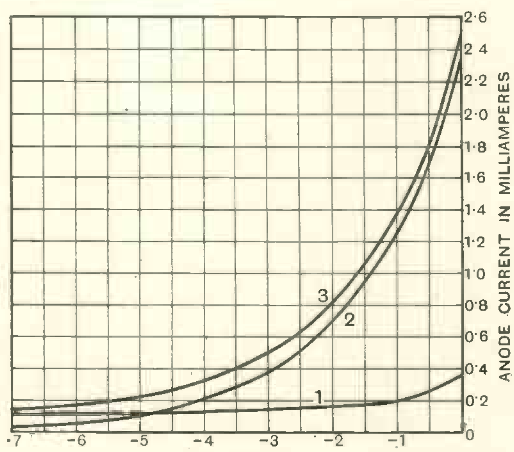


Fig. 1 (*a*).—*Grid volts-anode current curves.* (1) *For constant modulation-rise.* (2) *For constant cross-modulation factor.* (3) *Combined curve.*

In the present case the anode current at initial bias is given by

$$i_0 = \frac{g_0}{A} = \frac{1.5}{0.63} = 2.4 \text{ mA}$$

It will readily be seen that the curve for constant modulation-rise will give bad cross-modulation at low values of grid bias, while the curve for constant cross-modulation will give bad distortion of the desired signal at large values of bias.

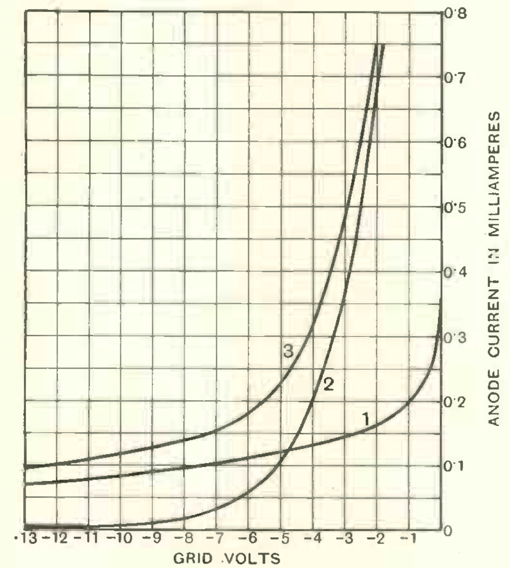


Fig. 1 (*b*).—*The same curves as in Fig.* 1 (*a*) *plotted to different scales to show the "tails."*

The ideal characteristic would combine the two, the curve being controlled by cross-modulation at small bias and modulation-rise at large bias.

Thus, if we combine the two cases calculated above the characteristic may be of the form $g = g_0 e^{Av_0}$ from initial bias to the point at which

$$\frac{1}{4g}\frac{\partial^2 g}{\partial v_0^2}E_1^2 = 0.2$$

i.e., $$\frac{1}{4}\frac{A^2}{g^2}g^2 E_1^2 = 0.2$$

or $$g = \sqrt{\frac{0.4 \times 0.03}{4 \times 0.2}} = 0.021 \text{ mA/volt}$$

This occurs at $e^{Av_0} = \dfrac{g}{g_0} = \dfrac{1}{71}$

or $$v_0 = -\frac{1}{A}\log_e 71$$
$$= -6.8 \text{ volts.}$$

Beyond this point, the curve must be of the form

$$g = \frac{g_0'}{1 - kv_0'} \quad \ldots \quad \ldots (20)$$

(For convenience we will transfer the initial bias, as far as this part of the curve is concerned, to -6.8 volts, *i.e.*, v_0' is the grid bias measured relative to this point).

Hence g_0' for equation (20) becomes 0.021 mA/volt. In order to satisfy the condition of 20% modulation-rise,

$$k = 21g_0' = 0.445$$

and the equation for g is

$$g = \frac{0.021}{1 - 0.445v_0'}$$

When $g = 0.006$ mA/volt, $v_0' = 5.7$ volts

i.e., $v_0 = 5.7 + 6.8 = 12.5$ volts.

The value of i_a can be found by integrating the equations for g and equating the values from the two expressions at the junction of the two curves.

The curves of i_a for the three cases calculated above are shown in Fig. 1, and the corresponding curves of mutual conductance are given in Fig. 2. It is interesting to note that the increase of anode current due to changing from the exponential curve (curve *B*) to the ideal curve (curve *C*) is only 0.12 mA.

Efforts are sometimes made to obtain a valve with an exponential characteristic

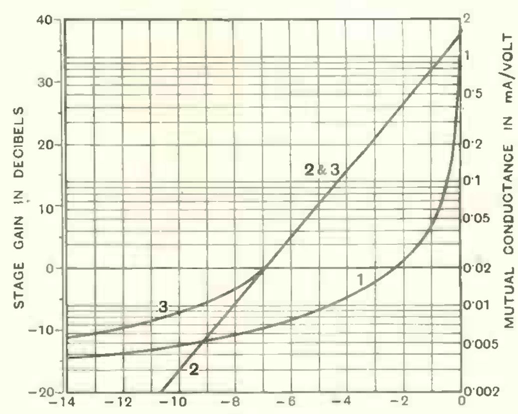


Fig. 2.—*Curves of mutual conductance against grid bias corresponding to the curves of Fig.* 1.

throughout (as curve *B*), the idea being to obtain a linear relation between the grid bias and the amplifier gain in decibels. The folly of this will be apparent if the distortion of the curve *B* with large inputs is considered. It will be found that any input greater than about 3 volts causes a modulation-rise in excess of 100%, a prohibitive

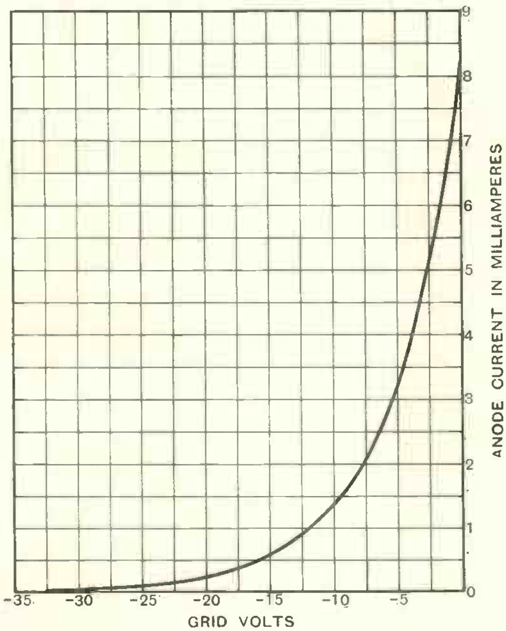


Fig. 3.—*Exponential characteristic giving less than 20 per cent. modulation-rise at all points.*

degree of distortion. Whereas, by using the ideal curve, the modulation-rise will never exceed 20%, and the increase of anode current involved is negligibly small. A better comparison is obtained by considering the exponential curve which will handle the same maximum input (5 volts R.M.S.) for the same modulation-rise. The curve, which can easily be calculated in the manner described above, is given in Fig. 3. The anode current at initial bias is 8.3 mA and the grid bias required for an input of 5 volts is 30 volts. Comparing these figures with 2.53 mA and 12.5 volts for the ideal curve, it will be seen that the price paid for an exponential characteristic, free from distortion, is rather high. If several stages are to be used, the extra drain of anode current may be quite serious, and the need for a large grid bias is always to be avoided if possible. Moreover, if the input to be handled is increased to, say, 10 volts, the anode current in the case of the exponential curve increases to 16.6 mA, whereas in the case of the ideal curve the increase is only a fraction of a milliampere. These figures show what an enormous improvement in performance results when the correct shape of tailing characteristic is obtained.

It is often stated that bad distortion must necessarily occur at the " knee " of the curve, even if the characteristic is " tailed " at large values of grid bias. That this is not so if the curve is correctly " tailed " will be apparent from the above calculations. Any quasi-hyperbolic curve *appears* to have a " knee " at some point, and the exact point depends on the scales adopted for abscissæ and ordinates.

When two stages of amplification are used, it is evident that cross-modulation will usually only be of importance in the first stage, owing to the selectivity of the inter-stage tuned coupling. On the other hand, modulation-rise may be more important in either the second or the first stage, according to whether the first stage is amplifying or attenuating.

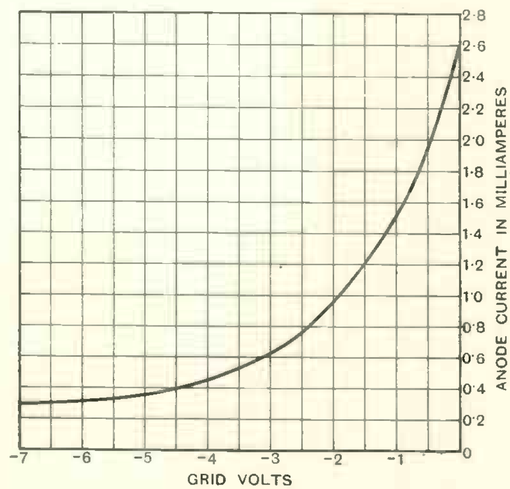


Fig. 4 (*a*).—" *Ideal* " *grid volts-anode current curve for two-stage amplifier.*

If we suppose that the valves are to have similar characteristics for simplicity, and that equal grid bias is applied to both, the best characteristic can in general be divided into three portions :

(1) A portion at small grid bias, determined by cross-modulation in the first valve.

(2) A middle portion, determined by modulation-rise in the second valve.

(3) A portion at large grid bias, where the amplifier is attenuating, determined by the modulation-rise in the first valve.

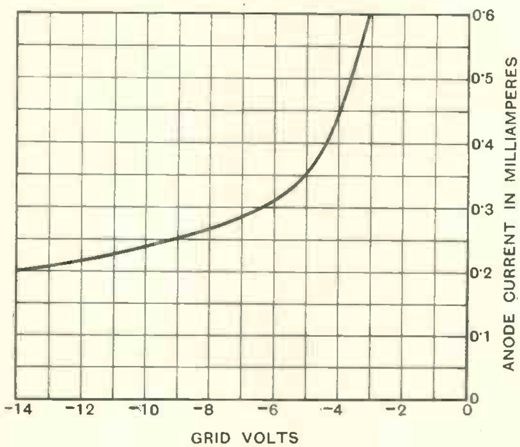


Fig. 4 (*b*).—*The same curve as in Fig.* 4 (*a*) *to different scales.*

The amplification of the two stages is now proportional to g^2, and assuming as before, constant detector input, $g^2E_1 =$ constant.

Portion (1) of the characteristic must satisfy the equation

$$\frac{1}{2}\frac{\frac{\partial^2 g}{\partial v_0^2}}{g}E_2^2 = \text{constant}$$

and therefore, as before, is of the form $g = g_0e^{Av_0}$. The input to the second valve is $gE_1 = E_1'$ (say) and hence $gE_1' =$ constant.

Portion (2) is therefore again of the form

$$g = \frac{g_0}{1 - kv_0}$$

In portion (3) the necessary condition is

$$\frac{1}{4}\frac{\frac{\partial^2 g}{\partial v_0^2}}{g}E_1^2 = \text{constant}$$

or since $g^2E_1 = \text{constant}$

$$\frac{\frac{\partial^2 g}{\partial v_0^2}}{g^5} = \text{constant}$$

This is satisfied by

$$g = \frac{g_0''}{\sqrt{1 - kv_0''}} \quad \ldots \quad \ldots \quad (21)$$

The actual characteristic will vary with the interstage couplings, the detector input, and the limiting values assumed for cross-modulation and modulation-rise. Under certain conditions, portion (2) may disappear.

An example is shown in Figs. 4 and 5 which is worked out for the following conditions :—

Mutual conductance at initial bias 1.5 mA/volt. Coupling impedance in both stages 50,000 ohms.

Detector input 1.5 volts.

Maximum input to be handled, 5 volts.

Modulation-rise not to exceed 20%.

Cross-modulation factor not to exceed 5%.

Conclusion.

In conclusion, it should be stated that the ideal curves arrived at above are only ideals to be aimed at, and in practice, especially with mass-production valves, some factor of safety must be allowed, which in general means rather greater anode current and larger range of grid bias than is indicated by the ideal curve.

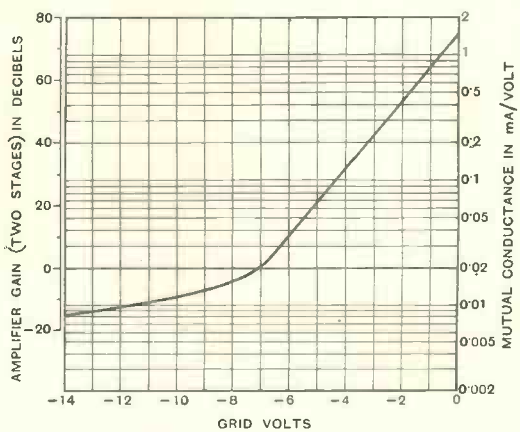


Fig. 5.—*Curve of mutual conductance against grid bias corresponding to the curve of Fig.* 4.

The important conclusions to be drawn from the investigation are :—

(1) The fallacy of striving after a characteristic which is exponential throughout its range.

(2) The fact that it is perfectly possible to obtain a valve characteristic which will handle inputs as large as 5 volts, and which gives an amplification range of 250 : 1 or

more, with negligible distortion and cross-modulation at all values of input; and that this can be obtained with quite a moderate anode current and grid bias.

In short, the variable conductance valve is definitely a valuable development, and is not a temporary advertising "stunt." Indeed, there seems very little argument for the retention of any other type of screen-grid valve.

Appendix 1.

$$i_a = D_1 E_g \cos \omega t + \frac{D_2}{2!} E_g^2 \cos^2 \omega t + \ldots + \frac{D_n}{n!} E_g^n \cos^n \omega t + \ldots$$

Using the following well-known expansions:—

When n is odd,

$$\cos^n \theta = \frac{1}{2^{n-1}} \Bigg[\cos n\theta + n \cos (n-2)\theta + \ldots + \frac{n!}{\frac{n+r}{2}!\,\frac{n-r}{2}!} \cos r\theta + \ldots + \frac{n!}{\frac{n+1}{2}!\,\frac{n-1}{2}!} \cos \theta \Bigg]$$

and when n is even,

$$\cos^n \theta = \frac{1}{2^{n-1}} \Bigg[\cos n\theta + n \cos (n-2)\theta + \ldots + \frac{n!}{\frac{n+r}{2}!\,\frac{n-r}{2}!} \cos r\theta + \ldots + \frac{n!}{\frac{n+2}{2}!\,\frac{n-2}{2}!} \cos 2\theta + \frac{n!}{2\,\frac{n}{2}!\,\frac{n}{2}!} \Bigg]$$

and substituting ωt for θ, and collecting only the terms in $\cos \omega t$, we obtain—

$$i_a = \Bigg[D_1 E_g + \frac{D_3}{2^2\, 2!\, 1!} E_g^3 + \ldots + \frac{D_n}{2^{n-1}\,\frac{n+1}{2}!\,\frac{n-1}{2}!} E_g^n \Bigg] \cos \omega t$$

where n has only odd positive integral values.

Appendix 2.

We have,

$$(1 + M \cos pt)^n = 1 + nM \cos pt + \ldots + \frac{n!}{(n-r)!\,r!} M^r \cos^r pt + \ldots + M^n \cos^n pt$$

Considering the general term

$$\frac{n!}{(n-r)!\,r!} M^r \cos^r pt$$

this can be expanded by the formulae given in Appendix 1, thus

$$\cos^r pt = \frac{1}{2^{r-1}} \Bigg[\cos rpt + r \cos (r-2) pt + \ldots + \frac{r!}{\frac{r+q}{2}!\,\frac{r-q}{2}!} \cos qpt + \ldots + \frac{r!}{\frac{r+1}{2}!\,\frac{r-1}{2}!} \cos pt \Bigg]$$

when r is odd. When r is even, the expansion is the same, except that the last term becomes $\frac{1}{2} \frac{r!}{\frac{r}{2}!\,\frac{r}{2}!}$

Hence the term in $\cos qpt$ obtained from

$$\frac{n!}{(n-r)!\,r!} M^r \cos^r pt, \text{ is}$$

$$\frac{n!}{(n-r)!\,r!} \frac{M^r}{2^{r-1}} \frac{r!}{\frac{r+q}{2}!\,\frac{r-q}{2}!} \cos qpt = \frac{n!}{2^{r-1}\,\frac{r+q}{2}!\,\frac{r-q}{2}!\,(n-r)!} M^r \cos qpt$$

(except when $q = 0$ when the term is half the value given by this expression).

It should be noted that q and r must either both be odd or both even.

The total coefficient of $\cos qpt$ in $(1 + M \cos pt)^n$ is therefore—

$$\sum_{r=q}^{r=n} \left\{ \frac{n!}{2^{r-1}\,\frac{r+q}{2}!\,\frac{r-q}{2}!\,(n-r)!} M^r \right\}$$

when q is odd; or, when q is even, the upper limit of summation should be $r = n - 1$.

This follows since, necessarily, $n > r > q$.

Summing the terms in $\cos qpt$ obtained for all values of n, the total coefficient becomes, when q is odd,

$$\sum_{n=q}^{n=\infty} \Bigg[\frac{D_n}{2^{n-1}\,\frac{n+1}{2}!\,\frac{n-1}{2}!} E^n \sum_{r=q}^{r=n} \left\{ \frac{n!\,M^r}{2^{r-1}\,\frac{r+q}{2}!\,\frac{r-q}{2}!\,(n-r)!} \right\} \Bigg]$$

When q is even, the limits of the first summation should be $n = (q + 1)$ to $n = \infty$ and, of the second, $r = q$ to $r = (n - 1)$. An exceptional case is $q = 0$, when the coefficient is half the value given by the formula.

Appendix 3.

$$C_0' = F(v_0) + E_2(1 + m\cos pt)\,F'(v_0)\cos\omega_2 t$$
$$+ \frac{E_2^2}{\underline{|2}}(1 + m\cos pt)^2 F''(v_0)\cos^2\omega_2 t + \dots$$
$$+ \frac{E_2^n}{\underline{|n}}(1 + m\cos pt)^n F^{n\prime}(v_0)\cos^n\omega_2 t$$

All the terms except the first can be expanded in a series of terms in $\cos\omega_2 t$, $\cos 2\omega_2 t$, $\cos 3\omega_2 t$ . . . but only the even powers of $\cos\omega_2 t$ will give a term independent of $\omega_2 t$, when so expanded. No term of the form $\cos n\omega_2 t\cos\omega_1 t$ will in general give a component of angular frequency near ω_1 and these terms are therefore of no interest. Referring to Appendix 1, the constant term in the expansion of

$$\cos^n\omega_2 t \text{ is } \frac{\underline{|n}}{2^n\,\underline{\left|\frac{n}{2}\right.}\,\underline{\left|\frac{n}{2}\right.}}$$

and hence the constant term provided by the term in E_2^n in the expression for C_0' is

$$\frac{E_2^n(1 + m\cos pt)^n}{2^n\,\underline{\left|\frac{n}{2}\right.}\,\underline{\left|\frac{n}{2}\right.}}F^{n\prime}(v_0)$$

[where n is an even positive integer], and

$$C_0' = F(v_0) + \frac{E_2^2(1 + m\cos pt)^2}{2^2\,\underline{|1}\,\underline{|1}}F''(v_0) + \dots$$
$$+ \frac{E_2^n(1 + m\cos pt)^n}{2^n\,\underline{\left|\frac{n}{2}\right.}\,\underline{\left|\frac{n}{2}\right.}}F^{n\prime}(v_0) + \dots$$

Since $\frac{\partial}{\partial v_0}D_1 = D_2$, and $\frac{\partial}{\partial v_0}D_2 = D_3$, etc. . . .

and $F(v_0) = D_1E_1 + \frac{D_3}{2^2\,\underline{|2}\,\underline{|1}}E_1^3 + \dots$

$$+ \frac{D_n}{2^{n-1}\,\underline{\left|\frac{n+1}{2}\right.}\,\underline{\left|\frac{n-1}{2}\right.}}E_1^n + \dots$$

we can insert the values of $F(v_0)$, $F'(v_0)$ in the expression for C_0' and hence

$$C_0' = \Bigg[D_1E_1 + \frac{D_3}{2^2\,\underline{|2}\,\underline{|1}}E_1^3 + \dots + \frac{D_n}{2^{n-1}\,\underline{\left|\frac{n+1}{2}\right.}\,\underline{\left|\frac{n-1}{2}\right.}}E_1^n + \dots\Bigg]$$
$$+ \frac{E_2^2(1 + m\cos pt)^2}{2^2\,\underline{|2}\,\underline{|1}}\Bigg[D_3E_1 + \frac{D_5}{2^2\,\underline{|2}\,\underline{|1}}E_1^3 + \dots + \frac{D_{n+2}}{2^{n-1}\,\underline{\left|\frac{n+1}{2}\right.}\,\underline{\left|\frac{n-1}{2}\right.}}E_1^n + \dots\Bigg]$$
$$+ \dots + \frac{E_2^r(1 + m\cos pt)^r}{2^r\,\underline{\left|\frac{r}{2}\right.}\,\underline{\left|\frac{r}{2}\right.}}\Bigg[D_{r+1}E_1 + \frac{D_{r+3}}{2^2\,\underline{|2}\,\underline{|1}}E_1^3 + \dots + \frac{D_{r+n}}{2^{n-1}\,\underline{\left|\frac{n+1}{2}\right.}\,\underline{\left|\frac{n-1}{2}\right.}}E_1^n + \dots\Bigg]$$

If m is small, and we omit terms in $2pt$, $3pt$, etc.,

$$C_0' = [D_1E_1 + \tfrac{1}{8}D_3(2E_2^2E_1 + E_1^3) + \dots]$$
$$+ m\cos pt\left[\frac{D_3}{2}E_1E_2^2 + \frac{D_5}{16}(E_1^3E_2^2 + E_1E_2^4) + \dots\right]$$

i.e., approximately (omitting derivatives above the third)

$$C_0' = \left(D_1 + \frac{mD_3}{2}E_2^2\cos pt\right)E_1$$

Preservation of Instruments of Historical Importance.

In recent numbers of the lay Press letters have appeared over the signatures of Lord Rutherford and others asking for the co-operation of anyone possessing pieces of apparatus likely to be of historical importance.

In 1925 the Institute of Physics appointed a committee to advise on the preservation of such apparatus. This committee is anxious to trace any pieces with which fundamental research in physical science has been carried out, and to arrange for their preservation. The committee has also entered upon the task of drawing up a catalogue of such pieces. Several pieces of great historical importance have already been secured for the nation, and are now housed in the Science Museum at South Kensington, and the response to the letters recently published has brought to light several other important pieces. Some articles describing and cataloguing such pieces are published from time to time in the Journal of Scientific Instruments.

Many of our readers may have such apparatus in their possession or under their charge, and the Secretary of the Institute of Physics, 1 Lowther Gardens, Exhibition Road, London, S.W.7, will be grateful for any information that will assist in tracing such pieces or in completing the catalogue.

For the benefit of future historians of physical science it is desirable to have as complete a record as is possible of the work of British Physicists, and it is to this end that this task has been undertaken.

On the Frequencies of Double Circuit Screen-grid Valve Oscillators.*

By N. W. McLachlan, D.Sc.

1. Introduction.

An oscillation wavemeter radiating a modulated continuous wave is distinctly advantageous. A receiver can be tuned to any desired frequency—within its compass—without the aid of a transmitting station, for the wavemeter performs the same function as the latter. If the station is operating, its frequency can be determined by zero beat, which occurs when the audio-frequency due to the modulation sounds purest. The apparatus can be used in the manufacture and testing of receiver, *e.g.*, ganging condensers, matching high-frequency coupling circuits, etc.

The influence of the screen-grid valve on the oscillation frequency of a single circuit was treated in *The Wireless Engineer*† some time ago, and the conditions for constancy and accuracy clearly defined. Accepting such conditions, *i.e.*, a properly designed L.C. circuit, a fairly high valve resistance and a small amplitude of oscillation, the problem arises as to the mutual influence of two oscillatory circuits—one radio the other audio—on each other. Mutual inductance is excluded, since we are solely concerned with direct connection of the two elements and their association with the valve.

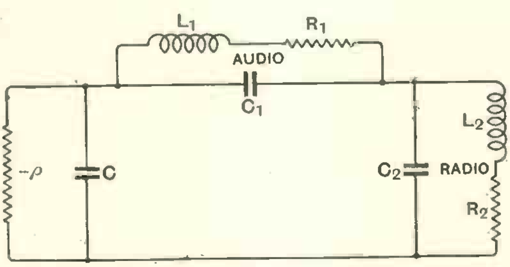


Fig. 1.—*Equivalent circuit of double-circuit screen-grid valve oscillator. C is the anode to screen-grid capacity.*

The analysis and experimental work described herein were done some years ago in connection with patent specification 310,915. Little interest, however, has been shown in the negative resistance properties of screen-grid valves until recently.

2. Analysis of Circuit.

The equivalent circuit of the device under consideration is illustrated in Fig. 1. If we assume the valve to have an infinite linear characteristic the problem permits of mathematical solution. We shall, therefore, determine the frequency when the oscillation is growing on this type of characteristic.*

When the various analytical relationships for the circuit of Fig. 1 are combined, the result is the following differential equation of the fourth order:—

$$\{\alpha D^4 + \beta D^3 + \gamma D^2 + \delta D + \theta\}v = 0 \quad .. \quad (1)$$

where $\alpha = L_1L_2\{C(C_1 + C_2) + C_1C_2\}$ (2)

$$\beta = (C_1 + C_2)\left\{C(R_1L_2 + R_2L_1) - \frac{L_1L_2}{\rho}\right\} + C_1C_2(R_1L_2 + R_2L_1) \quad .. \quad (3)$$

$$\gamma = -(C_1 + C_2)\{(R_1L_2 + R_2L_1)/\rho\} + L_1C_1 + L_2C_2 + R_1R_2C_1C_2 + C\{R_1R_2(C_1 + C_2) + L_1 + L_2\} \quad .. \quad .. \quad (4)$$

$$\delta = -\frac{1}{\rho}\{R_1R_2(C_1 + C_2) + L_1 + L_2\} + R_1C_1 + R_2C_2 + C(R_1 + R_2) \quad .. \quad (5)$$

$$\theta = 1 - (R_1 + R_2)/\rho \quad .. \quad .. \quad .. \quad (6)$$

By inserting appropriate values of the coefficients in formulae (2) to (6) and substituting in (1), we get a differential equation with numerical coefficients, which is soluble.

3. Example showing Mutual Influence of Two Circuits.

Let $L_1 = 2$ Henries, $C_1 = 2 \times 10^{-8}$ Farad, $R_1 = 500$ ohms — Audio Circuit, $f \doteqdot 796\sim$.

$L_2 = 2 \times 10^{-4}$ Henry, $C_2 = 1.5 \times 10^{-10}$ Farad, $R_2 = 4$ ohms — Radio Circuit, $f \doteqdot 9.19 \times 10^5\sim$.

* MS. received by the Editor, April, 1932.

† March, 1932, p. 130.

* A linear characteristic is assumed in deriving the formulae and in making the calculations throughout the paper. This is simulated in practice when the oscillation is weak, *i.e.* near the critical condition.

$\rho = 10^5$ ohms. The anode to screen-grid capacity will be omitted for the present, but its influence will be examined later.

Using the above data and formulae (1) to (6), we obtain a fourth order differential equation. Owing to the large magnitude of the coefficients, *e.g.*, the constant term is 8.33×10^{20}, the roots cannot readily be obtained with adequate accuracy for our present purpose.

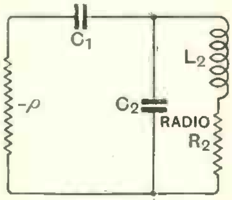


Fig. 2.—*Equivalent circuit of double-circuit oscillator, omitting anode to screen-grid capacity, the radio frequency being by-passed by the audio condenser C_1.*

On inspection of the circuital values we see that the impedance of C_1 to radio frequencies and that of $L_2 R_2$ to audio frequencies is low. Consequently, in investigating the radio-frequency circuit we shall assume the impedance of $L_1 R_1$ to be infinite. The circuit now degenerates into that of Fig. 2. Then, with the foregoing data, we obtain a differential equation of the third order, which can be solved quite readily.

This equation is

$$(D^3 + aD^2 + bD + c)v = 0 \quad .. \quad (7)$$

where
$$a = \frac{R_2}{L_2} - \frac{1}{\rho}\left(\frac{1}{C_1} + \frac{1}{C_2}\right)$$
$$b = \frac{1}{L_2C_2} - \frac{R_2}{\rho L_2}\left(\frac{1}{C_1} + \frac{1}{C_2}\right)$$
$$c = -\frac{1}{\rho L_1 L_2 C_2}$$
$$D = \frac{d}{dt}$$
v = voltage (a.c.).

Performing the requisite sequence of operations for solving (7), we find to a high degree of accuracy that

$$\omega^2 = \frac{1}{L_2C_2} - \frac{1}{4}\left\{\frac{R_2}{L_2} + \frac{1}{\rho}\left(\frac{1}{C_1} + \frac{1}{C_2}\right)\right\}^2 + \frac{1}{2\rho C_1}\left\{\frac{R_2}{L_2} - \frac{1}{\rho}\left(\frac{1}{C_2} - \frac{1}{2C_1}\right)\right\} \quad .. \quad (8)$$

When $C_1 = \infty$ we revert to the case of a single oscillatory circuit, and (8) reduces to the well-known formula :—

$$\omega^2 = \frac{1}{L_2C_2} - \frac{1}{4}\left(\frac{R_2}{L_2} + \frac{1}{\rho C_2}\right)^2 \quad .. \quad (9)$$

Since the second *correction* term in (8) is less than 1 per cent. of the first, it can be ignored. Thus the influence of the audio upon the radio circuit is represented by the difference between the first correction term in (8) and that in (9). If in the second term of (9) $\frac{1}{C_2}$ is replaced by $\left(\frac{1}{C_1} + \frac{1}{C_2}\right)$ we reproduce the second term of (8). Now $\frac{1}{C_1}$ is less than 1 per cent. of $1/C_2$, so that from a practical viewpoint the influence of the audio circuit on the radio frequency is negligible. It should be observed that the change in the correction term in (8) is equivalent to putting C_1 and C_2 in series across the coil L_2.

In like manner it is trivial to prove that the radio circuit has no appreciable influence on the audio frequency. These results follow from the mutual by-passing action of C_1 and L_2.

When the frequency ratio becomes *much* lower than that in the above example the problem requires investigation. This can be conducted by aid of the preceding analysis. The mutual by-passing action would cease to exist, and each circuit would impede the oscillations of the other.

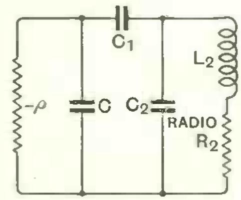


Fig. 3.—*As in Fig. 2, but anode to s.g. capacity included.*

4. Influence of Anode to S.G. Capacity on Radio Frequency.

The effect of this capacity is obviously to reduce the radio frequency, since it augments the capacity C_2 (Fig. 3). By incorporating the quantity C in deriving equation (7) we obtain the following solution :—

$$\omega^2 = \frac{1}{L_2(C_2 + C')} - \frac{1}{4}\left\{\frac{R_2}{L_2} + \frac{1}{\rho(C_2 + C')}\right\}^2 \quad .. \quad (10)$$

where
$$C' = \frac{CC_1}{C + C_1}$$
$= C$ and C_1 in series.

As in previous work we assume C_1 to by-pass the radio frequency, so that R_1L_1 is taken as being infinite. An additional correction term similar to that in formula (8) has been omitted, since it is so small.

The value of C' is equal to the sum of C and C_1 in series, the reason for which can be seen from Fig. 3. The impedance of C is 1/9 that of the valve at $f = 9.19 \times 10^5\sim$ so that the influence of the latter in shunting C can be disregarded. Thus from a capacitive standpoint C and C_1 are in series across the coil L_2.

The influence of C on the frequency is found with adequate accuracy from the first term in expression (10), viz., the term

$$\frac{1}{L_2(C_2 + C')}$$

Moreover, the ratio with and without C is evidently

$$\frac{\omega_2'^2}{\omega_2^2} = \frac{L_2(C_2)}{L_2(C_2 + C')} = \frac{C_2}{C_2 + C'} = \frac{1}{1 + \dfrac{C'}{C_2}}$$

The frequency ratio, being the square root of the above, is

$$\frac{f_2'}{f_2} = \sqrt{\frac{1}{1 + C'/C_2}} \doteq \left(1 - \frac{C'}{2C_2}\right) \quad (11)$$

Since $C' = \dfrac{CC_1}{C + C_1}$, expression (11) can be put in the form

$$\frac{f_2'}{f_2} = \left\{1 - \frac{CC_1}{2C_2(C + C_1)}\right\} \quad .. \quad (12)$$

Taking our previous data we compute the correction term in (12) to be 4.96×10^{-2}. Thus, the influence of the valve capacity C is to reduce the radio frequency by 4.96 per cent.

5. Variation in Radio Frequency when Audio is Suppressed.

When using a double circuit wavemeter to heterodyne a carrier, it is sometimes desirable to eliminate the audio frequency by short-circuiting the condenser C_1. This is accompanied by a slight change in radio frequency, which we shall now examine. Since C_1 becomes infinite on short-circuit, the correction term in (12) can be written $\dfrac{C}{2C_2}$. Numerically this is 5×10^{-2}, so that the effect of suppressing the modulation is to lower the radio frequency $(5 - 4.96) = 0.04$ per cent. or 1 part in 2,500. At $10^6\sim$ this amounts to a change of $400\sim$, a value whose order of magnitude is in accord with experimental observation.

For accurate work it is preferable to use a valve* where the anode-screen-grid capacity C is only 2.5×10^{-12} farad, this being $\frac{1}{6}$ the usual value. With such a valve the frequency change due to C, as found in section 4, is reduced to $\dfrac{4.96}{6} = 0.82$ per cent., and the alteration due to short-circuiting C_1 is now 1 in 15,000 or $67\sim$.

6. Effective Capacity of Single Circuit Oscillator.

The influence of the valve resistance in lowering the frequency of oscillation of a single circuit can be considered, from an analytical viewpoint, to arise from an addition to the capacity across the coil L_2. Near the critical condition when the system just oscillates we have

$$\omega^2 = \frac{1}{L_2C_2} - \frac{1}{C_2^2\rho^2} \quad .. \quad .. \quad (13)$$

where C_2 includes the valve capacity C.

Writing $\omega^2 = \dfrac{1}{L_2C_0}$, where C_0 is an effective capacity, we have, by hypothesis, the relationship

$$\frac{1}{L_2C_0} = \frac{1}{L_2C_2} - \frac{1}{C_2^2\rho^2}$$

From this expression it follows that the effective capacity of a single circuit oscillator is given by

$$C_0 = C_2\left(\frac{1}{1 - \dfrac{L_2}{C_2\rho^2}}\right)$$

$$\doteq C_2\left(1 + \frac{L_2}{C_2\rho^2}\right) \quad .. \quad .. \quad (14)$$

The non-critical case where the frequency correction term is $\frac{1}{4}\left(\dfrac{R_2}{L_2} + \dfrac{1}{C_2\rho}\right)^2$ can be treated in a similar way.

With the above numerical data formula (20) gives $C_0 = C_2(1 + 1.33 \times 10^{-5})$, so that when the oscillation is feeble the equiva-

* *Wireless Engineer*, March, 1932, p. 134.

lent addition to C_2 due to the valve resistance is about 13 parts per million.

7. Influence of Variation in ρ on Frequency.

By differentiating formula (9) with respect to ρ, and using the approximation $\omega^2 = 1/L_2C_2$ in the appropriate place, we find that the change in frequency with variation in ρ can be put in the form

$$\frac{\Delta f}{f} = \frac{\Delta\rho}{\rho}\left\{\frac{1}{4\rho}\left(R_2 + \frac{L_2}{C_2\rho}\right)\right\} \quad \ldots (15)$$

where $\Delta\rho$ = small change in valve resistance,

Δf = corresponding change in frequency.

$\frac{1}{4\rho}\left(R_2 + \frac{L_2}{C_2\rho}\right)$ = frequency variation for a corresponding small alteration in ρ.*

Applying (15) to our present case, we find that a variation of 1 per cent. in ρ causes a change in frequency of 4.33×10^{-5} per cent. This applies to the radio circuit, but expression (15) can also be used for the audio-circuit by altering the subscript from 2 to 1. From (15) we deduce that to minimise variation in frequency, R_2 should be small and $C_2\rho$ large, *i.e.*, a low loss coil is required. The critical valve resistance is approximately three times the value used in the preceding calculation. Moreover, when the oscillation is feeble, the influence of change in ρ on f will be about one-half the above value, *i.e.*, 2 in 10 million for 1 per cent. in ρ.

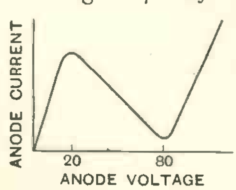


Fig. 4a.—*Showing general form of s.g. valve characteristic.*

8. Dynamic Resistances of Oscillatory Circuits.

So far as the radio-frequency unit is concerned, its dynamic resistance must obviously be adequate to promote oscillation. The circuit resistance should be as low as possible, thereby permitting the use of a large condenser and a high value of ρ. But these are by no means the only conditions to be satisfied, although they certainly conform to the hypothesis on which our argument is based.

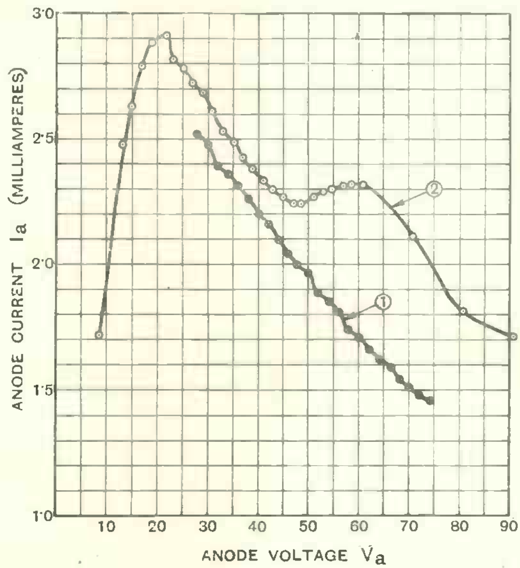


Fig. 4b.—*Showing peculiarities which sometimes occur in s.g. valve characteristics.*

It is usually easier to obtain a high dynamic resistance for the audio than for the radio circuit. In an enthusiastic effort to get deep modulation of the radio frequency, one is tempted to overstep the mark and make the dynamic resistance of the audio circuit too high. And what are the consequences of this procedure ? The valve is driven to operate on the curved portion of its characteristic, so that the generation of radio frequency occurs all over the characteristic. Sometimes it may be sinusoidal for a cycle or so, but in general it is not. In other words, the distortion varies from cycle to cycle. Hence, for purity of wave form, the dynamic resistance of the audio circuit must be inadequate to cause a swing beyond the linear portion of the characteristic.

Lastly, we have the question of modulation. So far as modern detectors are concerned we can accept 100 per cent. modulation, since the distortion will be small. But that ought to be the limit ; *i.e.*, the audio voltage must not exceed the radio voltage.

* See W. T. Percival, *Wireless Engineer*, page 78, February, 1932, who gives a formula for the critical case when $\frac{R_2}{L_2} = \frac{1}{C_2\rho}$. Then (15) becomes $\frac{\Delta f}{f}\Big/\frac{\Delta\rho}{\rho} = \frac{R_2}{2\rho}$, a condition which is approached when the oscillation is feeble and the valve operates over the linear part of its characteristic.

9. Graphical Illustration of Section 8.

To lend a little practical colour to the statements in the preceding section we shall show pictorially the influence of improper valve adjustment and bad circuit design on the oscillation wave form. In each case the curves refer to the oscillation after linear rectification by a receiver. The curves were not actually photographed, but a freehand record showing the type of distortion was made, which is adequate for our present purpose.

(*A*) *Low Anode Voltage.*

When the anode voltage is only 20 volts, operation occurs near the upper bend where the valve characteristic is convex upwards (Fig. 4a). In Fig. 5 are shown three stages of distortion corresponding to $v_a = 20$, $v_{sg} = 100$, and $v_g = +6$ volts, for decreasing values of the dynamic resistance of the audio circuit R_d. The decrease in R_d can be effected by increasing the condenser or putting a resistance R across it. Both methods are illustrated in Fig. 5. With the normal working condenser of 0.015 μF and $R = \infty$, R_d is so high that the wave form is triangular (*a*). When $C_1 = 0.365\ \mu$F the wave form approaches a sine shape, but has a cusp (*b*), whilst with $R = 3 \times 10^4$ ohms the wave form is nearly sinusoidal (*c*). The distorted waves are asymmetrical about the time axis because the characteristic is asymmetrical about the point $v_a = 20$.

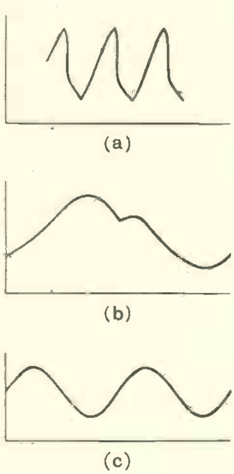


Fig. 5.—*Diagrams showing shape of wave form —after rectification—of double-circuit (radio cum audio) wavemeter with various adjustments.*

(*a*) $v_a = 20$ *volts*
$C_1 = 0.015\ \mu F$
R = *Resistance across* $C_1 = \infty$

(*b*) $v_a = 20$ *volts*
$C_1 = 0.365\ \mu F$
$R = \infty$

(*c*) $v_a = 20$ *volts*
$C_1 = 0.015$
$R = 3 \times 10^4$ *ohms*

In case (*c*), the value of R being only 3×10^4 ohms means that the valve resistance must have been even less than this. Consequently the frequency of the radio circuit is reduced accordingly. If the moistened fingers of the hand are placed across the audio circuit a marked change in pitch occurs.

(*B*) *High Audio-frequency Dynamic Resistance.*

Using an anode voltage of 38, which was not quite large enough for a good sine wave, the amplitude exceeded that in (*A*), and the oscillation swept well over the upper bend of the characteristic. The wave form is illustrated in Fig. 6 (*a*), where R_d is the same as in Fig. 5a. The effect of reducing R_d by adding a 0.005 μF condenser is shown at (*b*), whilst at (*c*) purity is obtained by aid of a shunt of 9×10^4 ohms across the normal 0.015 μF condenser, this resistance being three times the value used when $v_a = 20$.

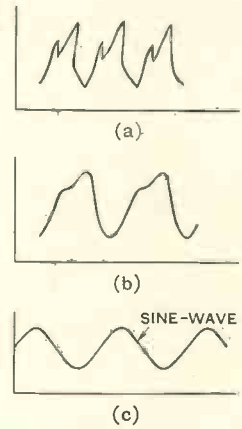


Fig. 6.—*As in* 5, *but*

(*a*) $v_a = 38$ *volts*
$C_1 = 0.015\ \mu F$
$R = \infty$

(*b*) $v_a = 38$ *volts*
$C_1 = 0.02\ \mu F$ (0.015 + 0.005)
$R = \infty$

(*c*) $v_a = 38$ *volts*
$C_1 = 0.015\ \mu F$
$R = 9 \times 10^{-4}$ *ohms*

Similar results were obtained when the anode voltage approached the lower bend of the characteristic. In one case purity of wave form could not be secured under any conditions. This was due to the valve characteristic having an irregular form (Fig. 4b, curve 1). One characteristic had a marked kink midway between the upper and lower bends (Fig. 4b, curve 2). For accurate wavemeters the characteristic must be known, and the operating anode voltage carefully chosen for purity of output.

Although we have concerned ourselves chiefly with high accuracy and purity of output, satisfactory results for general purposes can be obtained with excessive values of R_d. The rectified output is impure, but this is not necessarily a drawback.

10. Miscellaneous Experiments.

(*A*) *Measurement of Anode to Screen-grid Capacity.*

A beat note of 1,000 ~ is obtained with two single circuit radio oscillators, receiver and loud speaker. The note is checked against a standard tuning fork, or, if this is not available, zero beat can be used. The valve-holder of one oscillator is connected by an adaptor to a double holder having the normal working valve and that under test, both filaments being lighted. A short piece of wire (5 cm. or so) is connected to the anode at the top of the working valve, by which it can be paralleled with that under test. A small condenser calibrated in fractions of $\mu\mu$F is in parallel with the condenser of the meter. The anode connection is then made which causes a change in beat note. This is restored to 1,000 ~ by aid of the auxiliary condenser whose capacity variation gives the capacity of the valve. The additional valve reduces the value of ρ, but, if each oscillator is used with a dull filament, errors in this direction are small. Greater accuracy can be attained if in both settings the filaments are adjusted for bare maintenance; then ρ is identical in the two cases. Alternatively the test valve can be added without its filament being lighted, but this departs from working conditions. For high accuracy a low loss coil is required, thus allowing a large value of ρ to be used.

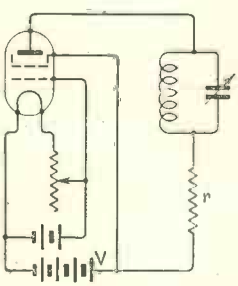


Fig. 7.—*Diagram illustrating constant current oscillator.*

An approximate calculation shows that if the oscillator in section 3 is near the critical condition, and ρ is halved due to the addition of a valve with $C = 2.5 \times 10^{-12}$ farad, the radio frequency changes* 7,670 ~. The valve capacity is responsible for 7,660 ~, whilst the remaining 10 ~ are due to the reduction in valve resistance. The order of accuracy is therefore adequate for general purposes. There are, of course, other methods of measurement. The above is simple and can be used under working conditions. It was employed over four years ago in connection with the design of modulated c.w. meters.

* The original setting corresponds to the data herein, viz., $f \doteqdot 9.19 \times 10^5$ ~.

(*B*) *Constant Current Indicator.*

Consider the circuit of Fig. 7. If r is very large the current through it and the valve will be sensibly constant over a wide range of filament brightness. With normal brightness the major volt drop is across r, and ρ will be positive. With a very dull filament ρ will be negative, but too high for oscillation to occur. It is possible to adjust V and r so that oscillation occurs at only one value of filament current. Any suitable aural or optical means can be used for demonstrating the effect.

(*C*) *Transient Oscillations.*

In Fig. 8 the anode voltage is too high for oscillation to occur, since ρ is positive. If the switch S is opened, the 50 μF condenser discharges and oscillation occurs when its voltage falls to the requisite value. The first oscillation is followed by a pause, then by a second oscillation, then by silence! Owing to continuous variation in ρ the frequency changes considerably and the noise effect is quite weird. If the noise level is adequate, and if L_1C_1 and the filament brightness are suitably adjusted, the acoustics of the jungle can be simulated from the king of beasts* upwards—in pitch.

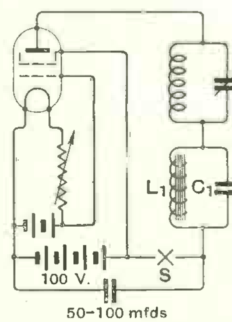


Fig. 8.—*Diagram illustrating circuit for obtaining transient oscillations with screen-grid valve.*

* The Bell Telephone Laboratories do not appear to have published information relating either to the energy output or the frequency spectra of jungle noises. Distorted versions of these noises can be heard in cinemas occasionally, although one is able to get a closer approximation at the Zoo.

Grid Bias from Anode Current.*

Some Necessary Precautions.

By F. J. A. Pound.

IN the various articles which have from time to time dealt with the problems connected with the provision of "free" grid bias the writer has not so far noticed any reference to one effect which may attain unwelcome proportions. It is now a matter of common knowledge that the necessary grid bias is obtained by the voltage drop in a resistance which is inserted between the

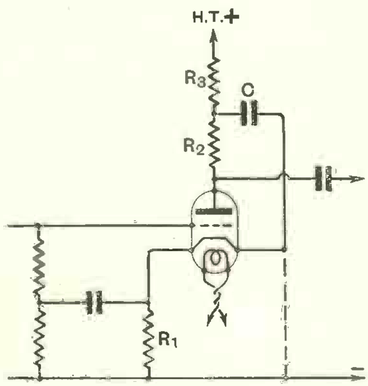


Fig. 1.

cathode of the valve and H.T. negative and which carries the steady anode current, but it must be remembered that this resistance also in certain cases carries the audio frequency component which is superposed on the steady current.

This will not be the case with the circuit of Fig. 1, provided the decoupling condenser *C* is returned to the cathode of the valve, or with that of Fig. 2, if the low tension side of the loud speaker is connected to the centre tap of the filament winding. With the circuits of Fig. 3 or 4, or if in those of Figs. 1 and 2 the return leads are connected as shown by the dotted lines, the resistance R_1 forms part of the audio frequency circuit and will cause a loss of output.

With resistance coupling the loss will be approximately even over the frequency scale and its effect may be estimated roughly by considering the valve impedance as being augmented by the valve of R_1. Under ordinary conditions this will result in a reduction of amplification which may amount to as much as 20 per cent.

Where the useful external impedance is inductive the virtual increase in the impedance of the valve will result mainly in a reduction in the lower frequencies which may reach undesirable proportions. This loss may be minimised by shunting R_1 with a condenser, but it must be remembered that this condenser is in series with the transformer primary and that the two will form a resonant circuit.

This effect was dealt with comprehensively in the articles in the *Wireless World* entitled "The Parallel-Fed L.F. Amplifier," in the issue of December 11th, 1929, and "Recent Influences in Receiver Design," in the issue of February 12th, 1930. In case these articles are not available they may be summed up briefly by stating that a condenser exceeding $2\mu F$ will normally produce a characteristic which is level or falls slowly at the lowest frequencies used in music, but that a somewhat smaller value (notably from $1\mu F$ to $0.5\mu F$) will pitch the

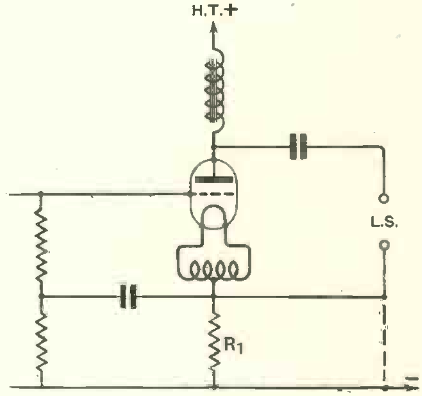


Fig. 2.

resonant frequency so as to give a rising characteristic at the lower end of the musical scale.

* MS. received by the Editor, January, 1932.

It should be noted that this effect is quite distinct from that dealt with by the article on "Grid Circuit Decoupling," in the issue of the *Wireless World* of September 23rd, 1931. The reason for decoupling the grid circuit when automatic grid bias is provided is to ensure that the voltage difference between the grid and filament (or cathode) of the valve shall not be varied by the audio frequency component in the anode circuit and is a matter entirely separate from the one discussed in this article.

Incidentally the same considerations show that to prevent attenuation of the lower frequencies with the circuit of Fig. 1, the impedance of the decoupling condenser C should not become comparable with the useful anode resistance R_2 at any frequency which it is desired to receive. It is not sufficient that C should possess low impedance compared with the decoupling resistance R_3 which is the necessary precaution to avoid feed back. This is often easily attainable with a moderate value of C where a high voltage is available, but the ratio between R_2 and $\frac{1}{2\pi fC}$ must also be considered if loss of the lower frequencies is to be avoided.

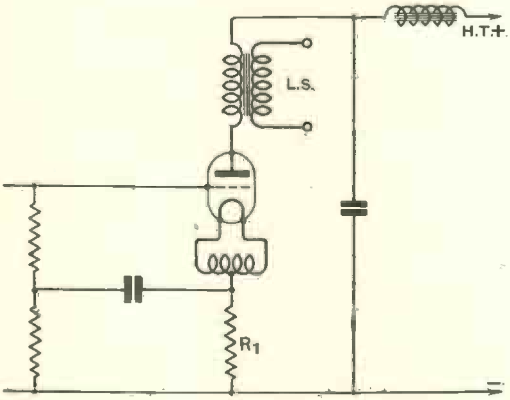


Fig. 3.

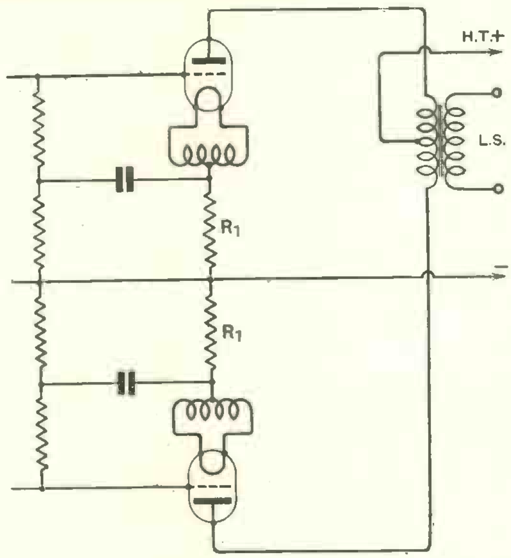


Fig. 4.

Correspondence.

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

The Dynatron Oscillator.

The Interdependence of its Frequency Variation and the Content of Harmonics.

To the Editor, The Wireless Engineer.

SIR,—Having been occupied lately with the problem of generating constant frequency oscillations I have studied with the greatest interest the papers and correspondence on this matter published in *The Wireless Engineer*.

With reference to the paper on the Dynatron Oscillator, published in your issue of Nov. 1931, I would like to make some remarks concerning the relation between frequency variation and the content of harmonics in the dynatron oscillator for, although this relation is fundamental, until now it has not been considered. I hope my observations will throw some light from the physical point of view upon the nature of the phenomena. As long as the consideration is confined to the operation on ideal linear and infinite characteristics under the critical condition, there is no difficulty in determining the frequency of the system. Any method which gives the solution of an alternating current circuit can be employed for this purpose and will give accurate results.

But if we require to draw conclusions from these results regarding the behaviour of the dynatron beyond this critical condition, difficulties arise and one must be rather cautious in extrapolating the formulae obtained for other conditions.

The oscillations occurring on the ideal characteristics are purely sinusoidal. But as soon as actual characteristics are considered—and only such characteristics correspond to practical conditions—harmonics appear. Equations based only on the fundamental frequency do not represent sufficiently the energy exchanges of the system; but only these exchanges can be taken as a basis, in considering a system whose frequency is determined by conditions, in which the free oscillations of electric charge are occurring.

Hence an investigation based on the energy equations allows the relation which exists between the frequency variation and the operative conditions of the dynatron oscillator to be determined.

It can be proved that the frequency variation is related strictly to the content of harmonics, which appear when the dynatron oscillator passes beyond the critical condition. The frequency diminishes, namely, with the rise of the amount of harmonics. In the stable state of operation the negative resistance of the dynatron supplies the real energy which is absorbed in the real resistances R and S of the oscillatory circuit $2 < \frac{-R-L-}{-S-C-} > 6$.

The imaginary energy, however, which corresponds to the oscillation of the electric charge between the capacity C and the inductance L of this circuit, must be balanced within the circuit itself. Hence the imaginary energy (reversible) during one period of the oscillation ought to be equal in both branches, R L and S C of the circuit.

On this assumption one can obtain the relation

$$-\frac{\Delta f}{f} = \text{prop. } \partial^2$$

where:

$\frac{\Delta f}{f}$ = the ratio of the variation of the fundamental oscillation frequency to the critical frequency, and

∂ = the coefficient of the content of harmonics

$$\partial = \sqrt{\frac{V_2^2 + V_3^2 + V_4^2 + \ldots}{V_1^2}}$$

V_1, V_2, V_3, are the amplitudes of the fundamental, 2nd, 3rd, 4th, etc., harmonics of the voltage measured on the terminals of the oscillatory circuit.

Physically, the influence of the content of harmonics on the frequency variation can be explained as follows. If the oscillations are purely sinusoidal, the fundamental frequency (assuming $R = S$) is determined by

$$f_0 = \frac{1}{2\pi\sqrt{LC}}$$

and therefore the energy distribution in both branches is equal. When the harmonics appear, the currents corresponding to them are flowing chiefly through the branch S C and therefore they increase the electrostatic energy of this branch in comparison with the branch L R.

In order to keep the energy equality in both branches, the fundamental frequency must slightly diminish itself in respect to f_0. The current in the branch L R increases then slightly in order to allow its electromagnetic energy to increase suitably.

It seems this principle is quite general. It applies to all oscillating systems in which the frequency is determined by the constants of the system. For instance, similar relations can be obtained when analysing the oscillations of a pendulum.

On the completion of the experimental work undertaken in the Radio Institute, the corresponding theoretical considerations will be published.

Radio Institute. JANUSZ GROSZKOWSKI.
Warsaw, Poland.

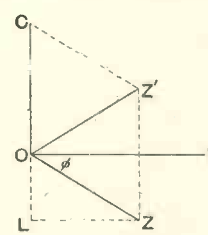
Measurement of Impedances.

To the Editor, The Wireless Engineer.

SIR,—I have read with interest Mr. A. T. Starr's article in the June WIRELESS ENGINEER dealing with a method for measuring impedances, but should like to draw attention to two points.

The first of these points is the use of the variable resistances R_1 and R_2 which, it is suggested, constitute an economy as compared with a "costly variable condenser standard." This statement is, no doubt, correct so long as the frequency is not sufficiently high to cause errors. For higher frequency working, two variable resistances whose *high frequency* values are accurately known would not be cheap.

The second point concerns Mr. Starr's method of determining the sign of ϕ. He states that a large condenser should be used and that its value is immaterial so long as its reactance is "small compared with the reactance of Z." This statement is incorrect. If Z has capacitive reactance *any* value of added condenser will cause the voltmeter to read less across Z than it does across R_1 whilst, if the capacity of the condenser is larger than that which makes its admittance more than twice the *quadrature component* of the admittance of Z at the frequency in use, the reading of the voltmeter across Z will be less than that across R_1 even if Z is inductive. This is apparent from my vector diagram in which O V represents the P.D. across Z and O Z is the admittance of Z. The condenser admittance O C is, as I have drawn it, equal to twice O L, the quadrature component of the admittance of Z and the resultance admittance O Z' is the same as before. Any *larger* value of the condenser will increase the length of O C which will increase O Z', *i.e.*—will decrease the combined impedance resulting in *less* P.D. across Z than across R_1. The condenser must, therefore, be *less* than that which gives us O C. In the extreme case a condenser of infinite capacity would consitute a short circuit across Z and would give a *zero* voltmeter reading.



For example, suppose Z has a resistance of 2,000 ohms and an inductive reactance of 6,000 ohms at a frequency of 950 cycles per second.

The impedance is $2{,}000 + 6{,}000j$ and the admittance is the reciprocal of this viz.:—

$$\frac{2{,}000}{2{,}000^2 + 6{,}000^2} - \frac{6{,}000j}{2{,}000^2 + 6{,}000^2}$$

The quadrature component is $\frac{6}{40 \times 10^3}$ so that, at the frequency in question, the capacity of the added condenser must be less than that which make $\omega C = \frac{12}{40 \times 10^3}$

Thus C must be less than $\frac{12}{40 \times 10^3 \times 2\pi \times 950}$ *i.e.* —less than 1/20 of a micro-farad.

Since the quadrature admittance of Z is presumably unknown the best procedure in practice would probably be to use the *smallest* condenser which gives a readable difference between the voltages across Z and R_1.

H. F. Trewman, M.A., M.I.E.E., A.Am.I.E.E.,
Professor Mech. and Elec. Engineering.
Military College of Science,
Woolwich, S.E.18.

Acoustic Nomenclature and Definitions.

To the Editor, The Wireless Engineer.

Sir,—In Prof. Howe's editorial pages for June, 1932, mention is made of a proposal to substitute the word "phon" for "decibel." The former has actually been used in Germany for some years, and the Siemens Barkhausen audiometer is graduated in terms of this unit. But, as hitherto defined, the phon is not identical with the decibel. A tone has an intensity-level of P phons above the threshold-intensity at 800 ~ when the intensity is $2^{2P} - 2.38 \times 10^{-12}$ ergs/sec. For two intensity-levels P_1 and P_2, the intensity ratio is $2^{2(P_1 - P_2)}$, whence it follows that db = phons × 6. The essential difference between the two systems is that at the threshold of audibility, the intensity level is zero db but 1 phon.

I think it should be emphasised that loudness or differences in loudness cannot be *measured.* A tone of given frequency and intensity-level may be judged to be as loud as a reference tone of some selected frequency at a different intensity-level, but only when the reference tone lies within certain narrow frequency-limits does this equivalent intensity-level (expressed in db) happen to correspond, with limitations, to the number of perceptible loudness steps above the threshold of audibility. Care is needed, therefore, to guard against confusion between intensity-levels expressed in decibels and loudness-levels expressed in decibels above threshold or some arbitrary physical intensity for a reference tone of suitable pitch.

C. F. Kemp.

As Mr. Kemp says, the word "phon" has been used in Germany for some years and the Siemens and Halske-Barkhausen apparatus which was described by Barkhausen at the Naturforscher Aammlung in 1926 was graduated in "phons." The scheme of units which we described in the Editorial has been put forward by a specially appointed Committee of which Professor Barkhausen is a member, and it appears that this Committee recommend that the word "phon" be given a new meaning. It is no longer based on powers of 2 but on powers of 10. Mr. Kemp's statements appear to be based on the old meaning which the Committee wish to supersede. The comparison frequency is also changed from 800 to 1,000. If Mr. Kemp is in any doubt as to the change suggested, we feel sure that the following quotation will remove the doubt: "If N_1 and N_2 are two intensities of the standard sound, the corresponding loudnesses will differ by 10 log N_1/N_2 phons." In comparing the loudness of sounds of different character one is dealing with a physiological problem very similar to that of comparing the illumination produced by lights of different colour. We can only take the average eye and the average ear and do our best.

G. W. O. H.

NEW BOOKS.

Alternating Current Bridge Methods.

By B. Hague. Pp. xiv + 424, 122 Figs. Third Edition. Pitman, 15s.

The fact that we reviewed the second edition of this book in January, 1931, and that a third edition has now been called for is sufficient proof of its usefulness. In view of the thorough revision of the second edition, the text has been reprinted unaltered except for a few minor alterations. In the preface, however, the author states that a surprisingly large amount of new work on the subject has been published during the interval and, in order to keep the book up to date, some account of these recent developments has been given in Supplementary Notes at the end of the volume. In these Notes the author has also given a fuller treatment of certain subjects in response to requests by users of the book. As we said of the second edition, this book is indispensable to anyone interested in A.C. bridge measurements.

G. W. O. H.

The British Radio Annual, Vol. 1, 1931.

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The Cathode-ray Oscillograph in Radio Research.

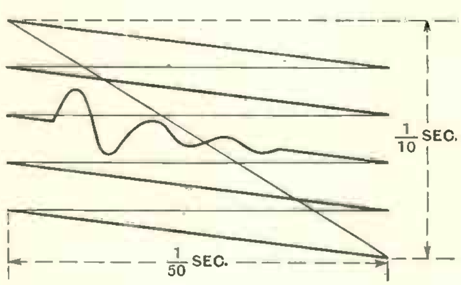
Royal Society Demonstration and Lecture.

A VERY complete demonstration of the application of the cathode-ray oscillograph to many purposes of radio research and measurement was given at the May Soirée of the Royal Society on 11th May. The demonstration was given by the staff of the Radio Research Station at Slough, and was implemented by two discourses on the above title-subject given during the evening by Mr. R. A. Watson Watt, superintendent of the station.

In opening his remarks, the speaker said that experimental investigations came down effectively to one of two things, *i.e.*, a knowledge of how one e.m.f. varies with time or the comparison of two voltages and the time relations between them. These require a measuring instrument very rapid in operation, giving deflections proportional to the applied forces, capable of giving permanent record for later reference and study, but still available for visual working before and during the process of recording. Additionally the second class of problem mentioned above demands that it must also respond to both e.m.f's simultaneously applied.

The discourses were accompanied by running demonstrations illustrative of the principles and practices described, while further standing demonstrations were shown in an adjoining room.

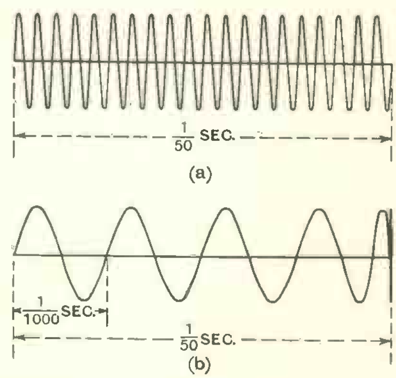
In the course of the lecture, Mr. Watson Watt developed the methods of obtaining vertical and horizontal deflections of the electron beam. Two new linear time-base circuits (giving saw-tooth voltages) were shown, using mercury vapour triodes of the "thyratron" type. One of these was smoothly variable over a range of frequencies and was suitable for the examination of recurrent phenomena such as many normal types of wave-form delineation. This was shown in operation



Two saw-tooth voltages combined to permit examination of single 1/50 second periods.

delineating the wave form of an oscillating source (of 1,000 c/s), while a slight modification permitted the phenomenon to be locked to a perfectly stationary picture. The other time-base circuit was used on supply from the a.c. mains and was arranged to give a recurrence-rate controlled by the mains-frequency. It was especially suitable for the study of phenomena whose recurrence could be controlled (*e.g.*, at another place) by the same frequency. This was shown in operation on short-duration impulses produced synchronously with the a.c. mains, demonstrating the property of locking on the same supply-frequency without any other connection between the phenomena. Another valuable property was illustrated, viz., that while maintaining the recurrence at 50 per second, the duration of the time-stroke could be cut down to a few milliseconds with a standstill period for the remainder of the 20 milliseconds until released by the next impulse from the controlling supply.

A further application of these two saw-tooth voltages was described and demonstrated, with a view to permitting the examination of single

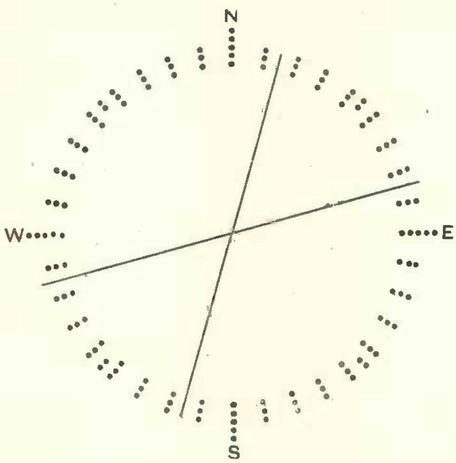


A.C.-Controlled linear time base. (a) Normal, base occupying 20 milliseconds. (b) Base occupying 4 milliseconds with standstill period before next impulse.

time-sweeps such as 1/50 second. If 1/50 sec. sweep is applied horizontally, visual persistence causes the various sweeps to overlay, but if a vertical sweep of 1/10 second is also applied, each 1/50 sec. sweep is separately seen and the events of each 1/50 sweep can be seen before the same path is retraced 1/10 sec. later.

A new application of the cathode-ray tube was also described and demonstrated, in the form of an automatic-release oscillograph for recording wave-forms of random transients. The incidence of the transient was used to release a timing voltage which moved the spot horizontally across the screen in a controlled time-movement, thus delineating the wave-form of the transient, which could be photographed during the sweep.

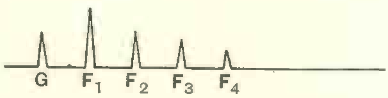
The lecturer also described the principles of the use of the oscillograph to visual direction-finding, *i.e.*, by applying two components of the signal



Cathode-ray oscillograph calibrated for directional reception, showing two key-speed signals simultaneously visible.

to the two pairs of plates and causing the spot to trace a resultant path which makes the angle of the signal-azimuth. This was demonstrated with illustrations of the effect of phase and dephase between the two components.

Various photographic applications of the oscillograph were described and illustrated by means of cinema films, taken from working operations. One film showed records of atmospheric directions, as determined by the device just mentioned. Another was of the directional recording of short-wave signals, showing the signal varying through many ellipsed forms in accordance with phase-variations between the downcoming components. Since this apparatus permits analysis of the polarisation of the downcoming waves, it was described by the lecturer as a " radio polarimeter." A third film showed the reception at King's College of short-duration radio impulses sent out from East London College. The records showed the reception of the ground ray, with varying echoes according to the number of times the signal pulse had been up and down to the upper layer.

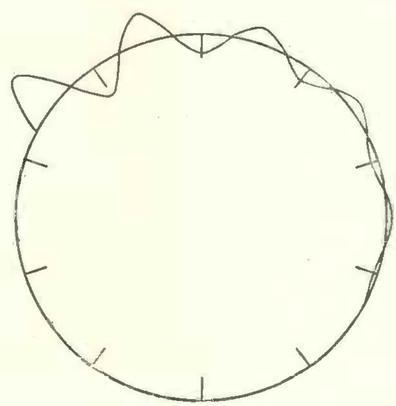


Reception of short-duration impulses on cathode-ray oscillograph. G = ground-ray impulse. F_1 to F_4 = various echo impulses from F region.

These films were apparently taken by direct cinema-photography of the screen of the tube, and were projected by means of an ordinary home-cinema type of projector.

In addition to the above demonstrations which accompanied the lecture, the short-wave " radio polarimeter " was demonstrated in operation in an adjoining room, along with the reception of short-duration signals from East London College, similar to those already illustrated in the film. The spot was opened horizontally by a linear time base, which showed the arrival of the ground-ray and echoed impulses. A notable feature of this demonstration was the extremely high local noise-level, despite which the visual type of reception still left it quite possible to trace the incidence of the ground ray and its succeeding echoes. Another demonstration showed the use of the oscillograph for the directional reception of signals or of atmospherics, an interesting feature being the ease with which the direction of two simultaneous signals could still be determined.

Finally, the demonstration included a new circular time-base. In this case the spot was made to trace a circle, from which the phenomena under observation caused radial deflections. The frequency of the circular trace being known, the radial departures could be measured, while the considerable length of the circumference gave a time-scale capable of minute subdivision. The circumference could further be marked off in 10ths or other subdivisions.



Circular time base subdivided into tenths, with transient superposed.

The oscillographs used in the demonstration were the new type of tube made by Messrs. A. C. Cossor, Ltd. Looking round the exhibits, several different screen materials appeared to be in use. One tube was very definitely green in colour, and was said to be a material useful for visual fluorescence at low voltages. Others were of a lighter green colour, of mixed material, suitable for either visual or for certain types of photographic work, while one oscillograph gave a blue fluorescence (calcium tungstate), particularly suitable for photography.

The accompanying sketches give impressions of some of the patterns shown in the various demonstrations.

Some Acoustic and Telephone Measurements.

Paper by H. R. Harbottle, B.Sc., A.M.I.E.E., read before a Joint Meeting of the Instrument and Meter Section and the Wireless Section, I.E.E., on 8th April, 1932.

ABSTRACT.

THE paper deals with test work carried out in the Research Section of the British Post Office, and is devoted almost entirely to testing of commercial telephone apparatus. Part 1 of the paper is devoted to electro-acoustic and acousto-electric measurements of instruments. Part 2 to various voice-ear measurements on microphones and receivers. Part 3 deals with mechanical tests by means of which rapid acceptance tests and estimates of the commercial life of instruments can be made. Part 4 discusses the measurement of the efficiency of apparatus actually in use.

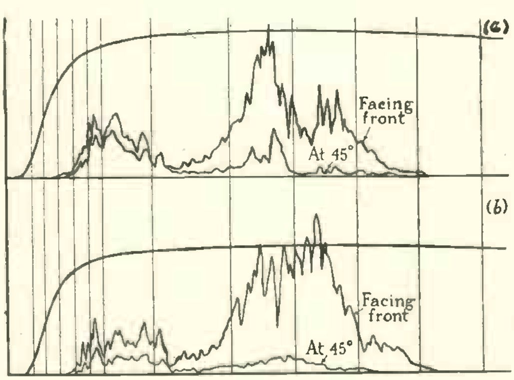
The portions of radio interest relate chiefly to the testing of loud speakers. These are tested in a specially deadened acoustic room which is described and illustrated in the paper. The loudspeaker is placed in the acoustic room and its output measured by means of a condenser microphone previously calibrated. The output from the condenser microphone and its amplifier is measured on the recorder described above. The output from the heterodyne oscillator is made to actuate the loud speaker *via* the grid of the valve with which the loud speaker should be associated, the loud speaker being suitably connected to the anode of this valve.

When once the testing circuit has been set up and made free from induction by suitable disposition of earths and necessary balancing, it is a simple matter to perform these tests. Sample curves taken in this manner on some commercial types of loud speaker at different angles to the flare are reproduced in Fig. 13.

By a slight modification of the circuit it is possible to obtain the performance of the loud speaker alone, its impedance, the electrical power given to it, and its electro-acoustic efficiency, using the 3-voltmeter method. The output from a moving coil receiver when held to the artificial ear, together with its impedance obtained as above, are given in Fig. 14.

Another item of wireless interest concerns the measurements of speech volume. The arrangement is shown in Fig. 21.

Essentially it is a vacuum-tube rectifier with a rapid-action d.c. meter in the plate circuit. It is operated on a part of the characteristic such that the rectified plate current is roughly proportional



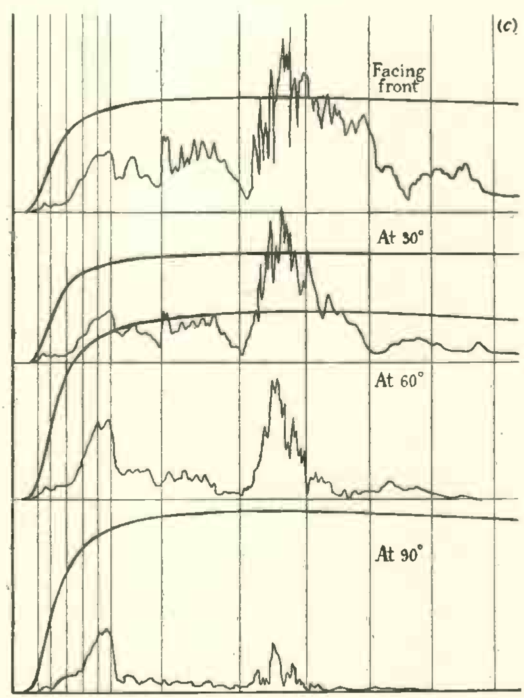


Fig. 13.—*Loud speaker frequency characteristics. (a) Reed-driven cone in cabinet; back closed; cone angle about 120°. (b) Reed-driven cone in cabinet; back closed; annular guard-rings in front; cone angle about 120°. (c) Moving coil in box baffle about 18 in. cube, with metal flare extending cone to front of box.*

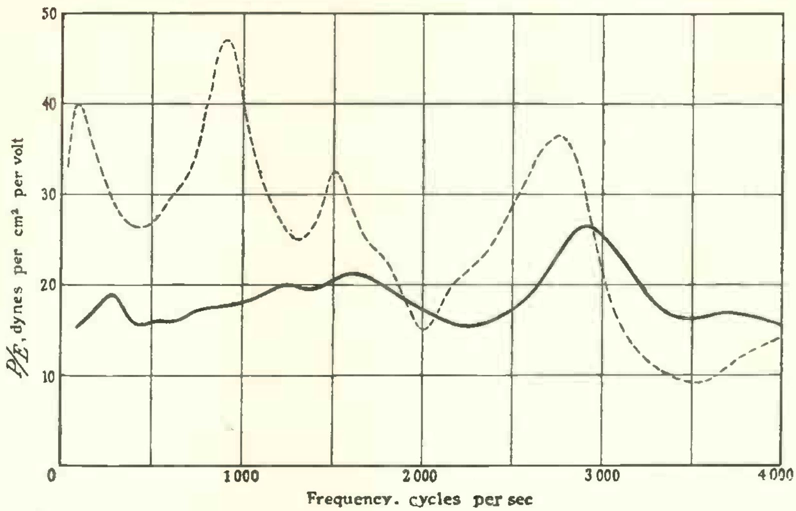


Fig. 14.—*Performance of moving-coil loud speaker fitted with earcap held to artificial ear. Full curve = impedance, broken curve = sound output.*

to the square of the speech voltage. The rectifier is preceded by an amplifier of adjustable gain. For the speech-level under measurement the gain is adjusted to such a value that the fluctuating meter deflections attain a prescribed maximum value on the average of once in about three seconds. That value of gain expressed in decibels with respect to a certain normal value of gain gives the volume indicator measure of the speech-level. The meter, combined with the electric circuit, has a dynamic characteristic, which gives the maximum deflection as a function of the duration of the a.c. input. For inputs lasting more than about 0.18 second, the maximum remains the same. Since the average syllable duration is of the order of 0.2 second, it follows that the maximum deflection of the "volume indicator" is approximately proportional to the mean power of the syllable. The volume indicator is thus a type of valve voltmeter. It is calibrated with alternating current at a fixed frequency of 1,000 cycles per sec.

Discussion.

In the discussion which followed the reading of the paper, Lt.-Col. A. S. Angwin referred particularly to the volume indicator, which had arisen out of radio practice and was an instrument of sufficient importance to have become an international standard.

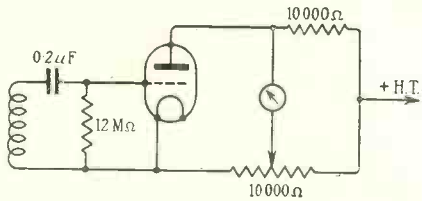


Fig. 21.—*Rectifier circuit for speech meter.*

Capt. B. S. Cohen referred to the difficulties of early telephonic measurements and to the advances of technique made in recent years. Mr. Voigt described a peak voltmeter method of volume indication, demonstrating the apparatus in operation. While Mr. Hughes discussed the polar curves of loud speakers and microphones and their effect in "talkie" reproduction in the simulation of "depth."

Abstracts and References.

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PROPAGATION OF WAVES.

MESSUNGEN IM STRAHLUNGSFELD EINER IN IHRER GRUNDSCHWINGUNG ERREGTEN VERTIKAL-ANTENNE ZWISCHEN ZWEI VOLLKOMMEN LEITENDEN EBENEN (Measurements in the Field Radiated by a Vertical Antenna, Excited in its Fundamental Oscillation, between Two Perfectly Conducting Planes).—L. Bergmann and W. Doerfel. (*Ann. der Physik*, 1932, Series 5, Vol. 13, No. 4, pp. 409–429.)

The experiments described in this paper were undertaken with a view to testing the theory worked out by R. Weyrich (January Abstracts, p. 28) for the propagation of electromagnetic waves from a vertical antenna between two horizontal perfectly conducting planes. Theoretical expressions are found for the root mean square values of the horizontal and vertical components of the electric field (which are measured in the experiments) from Weyrich's formulae involving the time. The emitter and receiver used are described; a wavelength of 33.1 cm was chosen, with a half-wave aerial at the emitter. The connections were carefully screened and the horizontal polar diagram of the aerial in free space was found to be the circle required by the theoretical assumptions. The antenna at the receiver was of considerably less than half a wavelength. The conducting planes were squares of side 3.76 m; the distance between them was variable. Measurements of the vertical and horizontal components of the electric field were made (1) with variable distance of the receiving antenna from the emitter, (2) with variable height of the receiving antenna; the results agreed well with theoretical predictions. Three-dimensional representations of the two components are illustrated. Variation of the distance between the conducting planes showed that very large changes in field occur for small variations of the distance. The cylindrical wave predicted when the distance between the planes is less than half a wavelength was also demonstrated experimentally, though the waves reflected from the edges of the planes caused considerable disturbance in this case.

DIE ABSORPTION KURZER WELLEN IN GEBÄUDEN (The Absorption of Short [and Ultra-Short] Waves in Buildings).—F. Ollendorff. (*E.N.T.*, May, 1932, Vol. 9, pp. 181–194.)

In previous papers the writer has dealt with the effects of various obstructions on wave propagation in cities: on waves long in comparison with the dimensions of ordinary houses, only such things as masts, towers, or sky-scrapers have an appreciable effect (Abstracts, 1931, p. 376) or large groups of receiving aerials (July, p. 397), while the ordinary mass of buildings produces negligible absorption: the masonry acts macroscopically as a homogeneous insulator with real dielectric constant and thus may alter the phase velocity but produce no absorption.

The case is completely changed for short waves of the same order of magnitude as the dimensions of the houses, as was found by Gerth and by Schröter (1931, p. 397 and 629). The present writer develops a preliminary theoretical investigation of the absorption effects then liable to occur, considering only the ground wave and assuming this to pass with normal incidence through a series of equal rooms separated from each other at intervals D by walls of thickness d constituting a homogeneous isotropic dielectric. The solution of the differential equations thus obtained leads to the result that below a certain critical wavelength (*see* equation 40a), which is of the order of $2D$, a marked absorption can take place, which is to be regarded as similar to optical total reflection. Thus for ordinary buildings, where D is about 5 m, the critical wavelength is of the order of something under 10 m. Other critical wavelengths are integral fractions of this longest critical wavelength. An expression is found for the maximum damping of waves below the critical length: in the example taken it amounts to 0.70.

The writer then deals in a similar way with the case of a periodically broken chain of such rooms, the air gap between two "blocks" being s. The longest critical wavelength is now given by equation 57, and if s is taken for practical purposes as 30 m, critical waves are found at 100, 50, 33.3 m and so on: but the absorption is smaller. A final section deals with the lower range limits derived from the above results, the limit being taken as reached when the amplitude falls to 1%. The critical waves according to equation 57 are found to have a range of the order of 2 km; those according to equation 40a, of 170 m only. A more general treatment of the problems is promised.

SUR LES PROPRIÉTÉS DES GAZ IONISÉS EN HAUTE FRÉQUENCE (On the Properties of Ionised Gases at High Frequencies).—A. Rostagni. (*Comptes Rendus*, 30th May, 1932, Vol. 194, pp. 1906–1908.)

In connection with the hypothesis of H. and C. Gutton regarding a quasi-elastic force between the electrons (*cf.* Appleton and Chapman, July Abstracts, p. 398) the writer gives a preliminary report on the theoretical part of researches of his own. He considers a flat plate condenser containing an ionised gas sufficiently rarified for the collisions between the charged particles to be neglected. The plates are perpendicular to the axis Ox of the abscissae for $x = 0$ and $x = D$. The internal space is divided into three regions: a central region A, from $x = s'/2$ to $x = D - s'/2$, uniformly ionised, containing n electrons and n positive ions per cm^3, lying between two regions, B, from $x = 0$ to $x = s'/2$, and B′, from $x = D - s'/2$ to $x = D$, containing positive ions distributed according to a fixed law. D is equal to $s + s'$ and s' to $an^{-\frac{1}{2}}$.

Assuming the potential applied to the plates to be of very high frequency, only the electrons will follow its variations, and if its amplitude is sufficiently small for the electron displacements ξ to be small compared with s, s' and D, ξ may be considered equal for all the electrons. Neglecting the magnetic effect, the analysis leads to an expression for the resonance wavelength $\lambda^2 n^{\frac{1}{2}} =$ const. If, in accordance with Langmuir, $i = kn^y$ instead of $i = kn$ (y being less than 1 and here assumed to be $\frac{2}{3}$), this gives the relation $\lambda^2 i^{\frac{3}{4}} =$ const. obtained empirically by Gutton. The ionised gas under the conditions indicated behaves like a system composed of an inductance L' and a capacity C' in series, shunted across the vacuum capacity $C = \frac{1}{4\pi D}$; of these, $L' = \frac{D^2}{s^2} \cdot \frac{ms}{n\epsilon^2}$ and $C' = \frac{s}{D} \cdot \frac{1}{4\pi s'}$, where m and ϵ have their usual meanings. The form of the relation between the impedance and n agrees well with the experimental results: for increasing ionisations, starting with values smaller than those for which the discharge can be maintained, the apparent capacity decreases at first to zero and negative values (at a point where the inductance becomes predominant): it then suddenly becomes positive and very large, and later decreases. Obviously, for great ionisations the effects of conductivity, neglected in the theory, will modify the results.

Ricerche sperimentali sulla Propagazione di un'Onda elettromagnetica in un Mezzo jonizzato magneto-attivo (Experimental Researches on the Propagation of an Electromagnetic Wave in a Magnetically Active Ionised Medium.)—G. Todesco. (*Alta Frequenza*, March, 1932, Vol. 1, No. 1, pp. 68–85).

The full paper, a preliminary letter on which was dealt with in April Abstracts, p. 216.

Charts of Distance Range of Radio Waves: Day and Night Frequency Characteristics.—U.S. Bureau of Standards. (*Electronics*, May, 1932, p. 163.)

Cf. July Abstracts, p. 398: graphs only are given.

Echo Signals in Transatlantic Picture Telegraphy.—H. M. Dowsett. (*Marconi Review*, March–April, 1932, No. 35, pp. 15–21.)

First part of the paper already dealt with in April Abstracts, pp. 216–217.

Studies in Radio Transmission [Short Waves: based on Facsimile Telegraphy and Received Signal Strength Measurements on Long-Distance Channels].—T. L. Eckersley. (*Wireless Engineer*, June, 1932, Vol. 9, No. 105, pp. 331–333.)

Summary of an I.E.E. paper. "The paper is a very lengthy one, dealing largely with determinations of layer height, density, recombination, etc., made on facsimile transmissions on long-distance channels and from measurements of received signal-strength made on similar routes." A number of important results and deductions are given in the summary; also a number of criticisms taken from the subsequent discussion.

Der Einfluss der Erdbodeneigenschaften auf die Ausbreitung elektromagnetischer Wellen (The Influence of the Properties of the Earth on the Propagation of Electromagnetic Waves [Comprehensive Survey]).—M. J. O. Strutt. (*Hochf:tech. u. Elek:akus.*, May and June, 1932, Vol. 39, pp. 177–185 and 220–225.)

Including references to 44 papers ranging from Abraham-Föppl, 1923, to Ratcliffe, Vedy and Wilkins, 1932.

Sur l'Affaiblissement des Ondes moyennes et intermédiaires se propageant de Jour sur Mer (The Attenuation of Medium and "Intermediate" Waves [150, 215 and 700 Metres] by Day over Sea).—J. Bion and P. David. (*Comptes Rendus*, 17th May, 1932, Vol. 194, pp. 1723–1724.)

Sommerfeld showed theoretically that the attenuation over a distance d was a function only of the "numerical distance," $d/\sigma\lambda$: hitherto, experimental confirmation such as that of Eckersley and van der Pol has been based on overland tests in which σ has been taken at its average value 10^{-13}; where, for mountainous regions, smaller values such as 10^{-15} have been used, these values have been deduced from the Sommerfeld formula and obviously cannot be used to verify it. The writers, therefore, have made use of the fact that the conductivity of the sea is well known, being for all practical purposes 10^{-11}. According to the formula, waves between 200 and 700 m should not be attenuated over sea any more rapidly than 2 000–7 000-m waves over land.

Tests in January and February, 1932, from a ship in the Mediterranean progressively increasing up to 1 050 km its distance from the receiving station near Toulon, are tabulated. The table shows that the attenuation was very regular and considerably greater than that given by the formula. At 1 000 km, for instance, the ratio of the calculated to the observed transmission coefficients is about 7 : 1 for the 700-m wave, and much more for the shorter waves. The discrepancy is far beyond any possible errors of measurement and leads to the conclusion that the formula and its derivatives are not applicable to such waves over sea. The Austin formula, on the other hand, gives figures very close to the observed results.

Theory on the Propagation of Low-Frequency Electromagnetic Waves [Change from Metallic to Dielectric Reflection, etc.].—E. Yokoyama and S. Namba. (*Journ. I.E.E. Japan*, Feb., 1932, Vol. 52 [No. 2], No. 523. English summary, pp. 20–21, Japanese text, pp. 143–152.)

"It is emphasised that the reflection characteristics at the layer change gradually from a daylight state as shown in Fig. 1 to a night state as shown in Fig. 2 at the time of sunset; that is, the reflection passes from metallic to dielectric: that at a certain instant between, when the angle of incidence of the waves just coincides with the Brewster's angle of the reflecting layer, the reflection efficiency and the phase vary markedly; and that this particular property of reflection at the Brewster's angle contributes to the interpretation of the well-known phenomena of sunset and sunrise, night errors of d.f., etc.

"It is shown that the ground wave does not contribute much to the field strength as hitherto considered, and that the effective range of ground waves does not exceed 250 km for the transmitter for l.f. waves here treated, when transmission takes place over land.

"A brief account is given of the ground reflection of a down-coming wave. It is also noted that the appearance of the strong horizontal electric force in a receiving wave at short-distance night transmission is yet an unsolved problem for which the authors' theory might require some modifications, when applied to a short-distance night transmission."

Correlation between Long-Wave Radio Signal Strength and the Passage of Storms.—S. J. Briggs: Bureau of Standards. (*Electronics*, May, 1932, p. 169.)

"The results show that in general there is a definite falling off in signal intensity in front of the advancing area of low pressure. This is followed by an increased intensity which persists from one to two days after the storm centre passes. This indicates some real relationship between received signal strength of long waves and weather, over that part of the path traversed by the wave shortly before reaching the receiving station."

A Radiometer Sensitive to Hertzian Waves [and Useful in Exploring Electromagnetic Fields].—Beauvais. (*See* under "Subsidiary Apparatus and Materials.")

Transparency of the Pure Atmosphere: On the Transparency of the Air.—J. Duclaux and M. Hugon: P. Chofardet. (*Comptes Rendus*, 23rd May, 1932, Vol. 194, pp. 1842–1844: 1844–1846.)

Sound Rays as Extremals [Calculation of Propagation through Atmospheric Layers of Different Qualities, particularly of Different Wind Velocities].—H. Bateman. (*Journ. Acous. Soc. Am.*, Special Number, No. 4, Vol. 2, pp. 468–475.)

The Action of Cylinders in an Electromagnetic Wave Field.—Kikuchi (*See* under "Aerials and Aerial Systems.")

ATMOSPHERICS AND ATMOSPHERIC ELECTRICITY.

Der Einfluss des Erdwiderstandes auf den Blitz (The Influence of Earth Resistance on Lightning [Mathematical Investigation]).—F. Ollendorff. (*Physik. Zeitschr.*, 1st May, 1932, Vol. 33, No. 9, pp. 368–376.)

Author's summary:—As the lightning strikes towards the earth its path forms an unclosed current in the Maxwellian sense, which together with displacement currents makes a total current of zero divergence. The paths of the displacement currents pass partly through the earth and cause high voltage drops therein. The magnitude of the earth potential is first given for an oscillating Hertzian doublet, which can be regarded as an element of the lightning flash. The total earth potential of the flash as it passes to earth is found from this by spatial and temporal integration. The earth potential is found to depend (apart from the strength of the current in the flash) chiefly on the velocity with which the head of the flash approaches earth and on the electrical properties of the earth's surface. The breakdown line of the flash is constructed on a semi-empirical basis, which, together with the temporal course of the earth potential, permits a degree of insight into the mechanism of the flash on its downward journey; when the current is sufficiently strong the flash splits into several branches before it reaches the earth. The number and side displacements of these branches can be qualitatively predetermined from the earth's properties. The theoretical predictions agree with experiment to the degree of approximation assumed in the rough numerical calculations made.

Über Verlagerungen der Einschlagstelle eines längeren elektrischen Funkens ohne Veränderung der Funkenstrecke (On Displacements of the Striking Point of a Fairly Long Electric Spark with Unchanged Spark Gap).—B. Walter. (*Ann. der Physik*, 1932, Series 5, Vol. 13, No. 4, pp. 483–504.)

The writer finds that the leads to the electrodes of the spark gap, in particular that to the negative electrode, determine the striking point of the spark produced. The negative pole of the inductor giving the high voltage for the discharge also seems to exert an influence on displacements of the striking point.

Berechnung der elektrischen Durchbruchfeldstärke von Gasen mit Hilfe des Nernstschen Wärmetheorems (Calculation of the Electrical Breakdown Field Strength of Gases by means of Nernst's Heat Theorem).—O. Mayr. (*Archiv f. Elektrot.*, 18th May, 1932, Vol. 26, No. 5, pp. 252–361.)

The Absolute Values of the Mobility of Gaseous Ions in Pure Gases: Mobility Experiments in Gaseous Mixtures and Ageing Experiments in Pure Gases.—N. E. Bradbury. (*Phys. Review*, 15th May, 1932, Series 2, Vol. 40, No. 4, pp. 508–523: 524–528.)

Ionisation at High Gas Pressures.—R. M. Sievert. (*Nature*, 28th May, 1932, Vol. 129, pp. 792–793.)

Cosmic-Ray Energies and Their Bearing on the Photon and Neutron Hypotheses.—R. A. Millikan and C. D. Anderson. (*Phys. Review*, 1st May, 1932, Vol. 40, No. 3, pp. 325–328.)

The energies of cosmic ray tracks have been measured by photographing their magnetic deflectibility in air. The incident cosmic rays are found to be absorbed *primarily* by the nucleus, rather than by extra-nuclear electrons. The incident rays act like photons in that (1) they appear to make occasional Compton encounters with electrons, (2) they give rise to more tracks that come from the nucleus than from extra-nuclear encounters. The energies measured range from 7 million electron volts to 500 and perhaps 1 000 million volts. "Nine-tenths of all the observed encounters yield energies which lie within the ranges computed from the Einstein equation and the atom-building hypothesis." Only the photon, and *not* the neutron, hypothesis seems to fit the facts.

COSMIC RADIATION AS NEUTRON RADIATION.—R. Swinne. (*Zeitschr. f. tech. Phys.*, June, 1932, Vol. 13, pp. 279–280.)

In a survey entitled "Neutron, the Zero Element," which includes a bibliography of 30 items.

ÜBER DIE DURCH ULTRASTRAHLUNG HERVORGERUFENEN ZERTRÜMMERUNGSPROZESSE (On the Disintegration Processes Caused by Cosmic Radiation). — W. Heisenberg. (*Naturwiss.*, 20th May, 1932, Vol. 20, No. 21, pp. 365–366.)

This letter discusses the conclusion arrived at by Steinke and Schindler (July Abstracts, p. 401) that the primary cosmic radiation cannot consist of electrons. The writer gives reasons based on the quantum theory which show that this conclusion is not necessarily correct.

THEORETISCHE ÜBERLEGUNGEN ZUR HÖHENSTRAHLUNG (Theoretical Considerations on Cosmic Radiation).—W. Heisenberg. (*Ann. der Physik*, 1932, Series 5, Vol. 13, No. 4, pp. 430–452.)

THE PRODUCTION OF MULTIPLE SECONDARIES IN LEAD BY COSMIC RADIATION.—T. H. Johnson and J. C. Street. (*Phys. Review*, 15th May, 1932, Series 2, Vol. 40, No. 4, pp. 638–639.)

The authors have observed a phenomenon similar to that described by Rossi (July Abstracts, p. 401) of triple coincidences in three lead-surrounded cosmic ray counters placed out of line.

FACTORS INFLUENCING IONISATION PRODUCED BY COSMIC AND GAMMA-RAYS.—J. C. Stearns and W. Overback. (*Phys. Review*, 15th May, 1932, Series 2, Vol. 40, No. 4, pp. 636–637.)

The authors are studying the effect of the following factors on the ionisation produced by cosmic rays: "pressure, temperature and molecular weight of the gas used in the ionisation chamber; the material of inner walls as well as the volume and interior area of, and the voltage applied to, the ionisation chamber." Comparison of the effects on cosmic ray ionisation and that caused by gamma rays indicates that "the process of ionisation is the same for cosmic as for gamma rays and that the cosmic rays are gamma in nature."

A CALCULATION CONCERNING THE NATURE OF THE SECONDARY CORPUSCULAR COSMIC RADIATION.—T. H. Johnson. (*Phys. Review*, 1st May, 1932, Vol. 40, No. 3, pp. 468–469.)

This letter contains a more rigorous interpretation of the transition curves obtained by Schindler (April Abstracts, p. 219) for the ionisation in a thin-walled vessel placed behind shields of various materials.

RECENT RESEARCHES ON THE PENETRATING RADIATION: THE ABSORPTION CURVE OF THE PENETRATING CORPUSCULAR RADIATION [COSMIC RAYS].—B. Rossi. (*La Ricerca Scientifica*, 29th February, 1932, Vol. 3, No. 4, pp. 249–250: 15th–30th April, 1932, Vol. 3, No. 7–8, pp. 435–449.)

ON THE DEGREE OF HOMOGENEITY OF THE FILTERED GAMMA RAYS OF ThC″ AND THE VERIFICATION OF THE KLEIN-NISHINA FORMULA.—D. Skobelzyn. (*Comptes Rendus*, 2nd May, 1932, Vol. 194, pp. 1568–1572.)

THE PHYSIOLOGICAL EFFECTS OF ATMOSPHERIC ELECTRICITY.—C. Dorno. (Summary in *Physik. Ber.*, 1st May, 1932, Vol. 13, No. 9, pp. 907–908.)

IL LIMITE TEORICO DELL'ATMOSFERA TERRESTRE (The Theoretical Limit of the Earth's Atmosphere).—G. Roncali. (*La Ricerca Scientifica*, 15th March, 1932, Vol. 3, No. 5, p. 335.)

PROPERTIES OF CIRCUITS.

CAPACITIVE OUTPUT COUPLING [BETWEEN OUTPUT VALVE AND ACOUSTIC LOAD].—L. G. A. Sims. (*Wireless Engineer*, June, 1932, Vol. 9, No. 105, pp. 314–319.)

In the tapped inductance type of coupling the condenser in series with the load is usually regarded as a necessary evil, reducing the current and power especially at the lower acoustic frequencies: it is therefore generally made very large, a common value being 2 microfarads. The writer shows that under certain conditions which obtain in practice the condenser, so far from reducing the power, may actually increase it if a suitable value (much below the 2 μF) is chosen. In the case of a pentode output valve the reduction of the condenser from its original commercial value of 2 μF to 0.26 μF gave a much flatter frequency curve, the output at the lower frequencies being progressively augmented. An explanation is indicated based on the formation of a "rejector" circuit.

THE AMPLIFICATION RATIO OF RESISTANCE-COUPLED VALVE COMBINATIONS: CORRECTIONS.—P. Kapteyn. (*Hochf:tech. u. Elek:akus.*, April, 1932, Vol. 39, p. 154—inset.)

Corrections to printers' errors in formulae in the paper dealt with in June Abstracts, pp. 338–339.

THE ANALYSIS AND DESIGN OF A CHAIN OF RESONANT CIRCUITS.—M. Reed. (*Wireless Engineer*, May and June, 1932, Vol. 9, Nos. 104 and 105, pp. 259–268 and 320–324.)

The first part contains an analysis of a chain of resonant circuits consisting of two, three and four links, respectively. The second part deals with the factors influencing the design of the above systems. It is shown that the design of chains consisting of an odd number of links must be treated differently from those containing an even number. The choice of the number of links for a given degree of selectivity is discussed in the final section.

Generation of Combination and Harmonic Frequencies by Linear and Non-Linear Vacuum Tube Circuits.—C. P. Boner and M. O. Boner. (*Phys. Review*, 1st March, 1932, Series 2, Vol. 39, No. 5, p. 863.)

Abstract only. " . . . Results indicate that there is no 'beat tone' generated in a receiving system, linear or non-linear. Further, the output of a vacuum-tube amplifier stage contains a far smaller per cent of harmonic and combination frequencies when high quality transformer coupling is used than when resistance coupling is used, provided transformer secondaries carry no load."

Harmonic Analysis of the Plate Current in a Vacuum Tube Circuit.—S. Leroy Brown. (*Phys. Review*, 1st March, 1932, Series 2, Vol. 39, No. 5, p. 863.)

Abstract only. The harmonic components of the plate current are obtained from the analysis of a cathode ray oscillogram.

"Apparent Demodulation": Another Viewpoint.—Mallett. (*See* under "Reception.")

The Calculation of Detection Performance in a Vacuum Tube Circuit for Large Signals.—J. P. Woods. (*Phys. Review*, 1st March, 1932, Series 2, Vol. 39, No. 5, p. 863.)

Abstract only. " . . . The plate detection performance of a tube having a given curve for its static characteristic can be calculated from the extended power series which represents the characteristic. . . ."

Eigenschaften eines freischwingenden Kreises der Selbstinduktion, Kapazität und Verlustwiderstand in Reihenschaltung enthält (The Properties of a Freely Oscillating Circuit containing Inductance, Capacity and Ohmic Resistance in Series).—M. Osnos. (*Hochf:tech. u. Elek-akus.*, May, 1932, Vol. 39, pp. 173–177.)

Further development of the work dealt with in 1931 Abstracts, pp. 553–554. From the author's summary :—" It is shown that in a freely oscillating circuit (L, C and R—Fig. 1), in contrast to a forcedly oscillating tuned circuit, the capacitive and the inductive resistances are not equal, the capacitive resistance $\frac{1}{\omega C}$ being greater than the inductive resistance ωL [for ordinary coils the difference is very small : thus for a coil with a normal degree of damping, 3×10^{-3}, the ratio of the difference to the inductive resistance is only 2.25×10^{-6}]. A general resistance equation and a resistance diagram for this circuit are given. From these, an analogy appears between such a freely oscillating circuit and a forcedly oscillating undamped circuit such as Fig. 3, made up of L, C and $R/2$, fed by an external source across C, and forming for this source a dissipative resistance." This latter circuit is used as the equivalent circuit for the freely oscillating circuit, and various new conclusions are deduced, such as that the circuit is tuned in respect to the current with which it oscillates freely but not in respect to a pure sine or cosine current of the same frequency : and that in addition to zero and maximum currents it has two definite currents, the "half-time" current and the "initial" current, equations for which are derived.

Sur l'Entretien en Oscillations du Reseau passif le plus général (On the Maintenance in Oscillation of the Most General Passive Network).—Ph. Le Corbeiller. (*Comptes Rendus*, 2nd May, 1932, Vol. 194, pp. 1564–1566.)

The writer concludes : " However, on account of the restrictions given in section (i) the operators $\mathfrak{P}$ are of a special nature and consequently an equation of type (11)

$$\left[\frac{-\mathfrak{P}_3}{\epsilon k\mathfrak{P}_2 + \mathfrak{P}_3}\,\mathfrak{P}_1 e + F(e) = 0\right]$$

is only a very special case of the general equation of the same order. Now the physical origin of this equation suggests that its solutions would undoubtedly possess relatively simple asymptotic properties. Radioelectric technique continually employs stable, periodic, and quasi-periodic oscillations, furnished by systems of the type described (or by equivalent systems which correspond by duality with them), so that it would seem that the general equation (11) which governs them should be announced."

Courant transitoire dans un Circuit bouchon (The Transient Current in a Rejector Circuit [and Application of Results to Telephonic Filters]).—J. B. Pomey. (*Rev. Gén. de l'Élec.*, 21st May, 1932, Vol. 31, pp. 691–693.)

The writer, taking first the simple case of the rejector circuit and applying his results to the more complex telephonic filters, concludes that in the case, for example, of a band pass filter, while the *sustained* sounds outside the band are effectively stopped, the phenomena are different in the case of non-periodic telephonic currents due to sound modifications such as the articulation of consonants. Their expression as a function of time can be put in the form of a Fourier integral, each element representing what may be called a "sonorous radiation" of the spectrum thus obtained. The emission produces characteristic movements of the network, each electrical movement being susceptible of two forms : the first consists of a periodic oscillation with a coefficient $e^{-\alpha t}$, where α is the index representing the damping : the second consists of a non-periodic "elongation" starting from zero and returning there at the end of a time which is theoretically infinite. The relative intensities of these different movements represent the exciting emission with more or less fidelity ; but no direct relation exists between the attenuation of the forced vibrations (for the frequencies within the pass band) and the decrements of the free oscillations, *i.e.*, those produced by the transitory excitations of articulation. Therein, it is believed, lies the reason why one can recognise the voice of a person speaking on the far side of a filter which only passes (in the steady régime) the frequencies above (or below) the middle voice frequency.

Ideale Transformatoren und lineare Transformationen (Ideal Transformers and Linear Transformations [Theoretical Investigation]).—W. Cauer. (*E.N.T.*, May, 1932, Vol. 9, pp. 157–174.)

Berichtigung und Ergänzung zu der Arbeit: "Gekoppelte Schwingungsgebilde" (Correction and Supplement to the Paper "Coupled Oscillatory Circuits").—H. Hecht: Petržílka. (*E.N.T.*, April, 1932, Vol. 9, pp. 143–146.)

In Petržílka's paper dealt with in 1930 Abstracts, p. 625, the writer reaches conclusions disagreeing with some of the results in Hecht's 1926 paper. Hecht now explains the apparent discrepancy.

A Common Error [in Connection with the Use of the Term "Beat Note" in the Combination of Two Sinusoids of Different Frequencies].—W. F. Floyd. (*Wireless Engineer*, May, 1932, Vol. 9, No. 104, p. 274.)

Is the Relation $\mathfrak{D} = \epsilon\mathfrak{F}$ in the Electrostatic Field Always Valid?—P. Andronescu. (*Bull. de l'Assoc. suisse des Élec.*, 13th May, 1932, Vol. 23, No. 10, pp. 223–232.)

In fields where only metallic bodies with or without "true" electric charges exist, the relation is always valid. Where, in addition, insulating bodies without "true" charges exist, it is only valid under certain conditions. The complex case of the third type of field, where there are also insulating bodies with "true" superficial and spatial charges, is not yet fully understood.

Effet de l'Hystérésis dans le Chauffage par Champ magnétique oscillant (The Effect of Hysteresis in Heating by an Oscillating Magnetic Field).—A. Blondel. (*Comptes Rendus*, 17th May, 1932, Vol. 194, pp. 1700–1703.)

TRANSMISSION.

Sur l'Existence d'Oscillations de haute Fréquence dans le Courant secondaire des Magnétos à haute Tension (On the Existence of H.F. Oscillations in the Secondary Current of H.T. Magnetos).—J. Jaffray and P. Vernotte. (*Comptes Rendus*, 30th May, 1932, Vol. 194, p. 1902.)

An h.t. magneto was connected to a spark-gap and a thermo-element–galvanometer combination, in order to measure the effective intensity of the discharge current. "The phenomena are extremely complex, but the following results appear to prove the existence of h.f. in the circuit.—(i) the introduction of an inductance of the order of 10^{-5} henry into the discharge circuit causes a considerable decrease of effective intensity—sometimes by 25%. If the inductance is then doubled, only a negligible decrease is observed. It may be concluded that an inductance of 2×10^{-5} henry quenches an h.f. component. (ii) If such h.f. currents exist, they should be found in appreciable amounts in capacitively coupled parallel circuits, *e.g.*, in the galvanometer circuit, through the vacuum thermo-couple. This actually happens: if a second, more sensitive, thermo-couple is connected to one of the thermo-couple terminals leading to the galvanometer, it yields a current reaching several milliamperes. This current decreases on the introduction of the inductances into the discharge circuit.

Phase Modulation and Secret Communication.—T. Kuzirai and T. Sakamoto. (*Journ. I.E.E. Japan*, April, 1932, Vol. 52 [No. 4], No. 525. English summary pp. 62–63, Japanese text pp. 340–345.)

"If three branches of an impedance bridge are resistances, of which two are equal in value and the remaining one is capacitance, the p.d. between the output terminals has a constant amplitude, *i.e.*, half of the applied voltage. When the capacity is changed, the output voltage changes its phase but not its amplitude. By this principle a voltage having a constant amplitude and a variable phase can be obtained. This can be used for phase-modulated secret communication." The writers have tested the method for secret telegraphy and telephony, with "fairly reasonable results." The constant amplitude and variable phase voltage is only obtainable when the bridge is under no load. In practice some load cannot be avoided, though it is small when the voltage is applied between the grid and filament of a valve. Two methods (a back-coupled circuit and an unbalanced bridge) are considered for obtaining a constant voltage in the loaded condition.

The Modulation System of the Russian High-Power Station at Schtschelkowo: Correction.—H. Wigge. (*Hochf:tech. u. Elek:akus.*, April, 1932, Vol. 39, p. 141.)

In the paper dealt with in March Abstracts, p. 162, it might have been understood that the grids of the amplifier valves were worked in push-pull. This is incorrect; the grids must be in parallel, only the r.f. anode potential acts in push-pull.

Der Widerstand des Röhrengenerators (The Resistance of the Valve Generator).—S. I. Zilitinkevitch. (*E.N.T.*, April, 1932, Vol. 9, pp. 132–136.)

Cf. May Abstracts, p. 286. (i) Defining the dissipative resistance of any circuit as the square of the applied potential divided by the power set free in it, the total dissipative resistance of the oscillating triode, R_t, is given by $R_t = \frac{E_a^2}{P_t} = \frac{E_a}{I_o}$, where E_a is the constant component of the anode voltage, P_t is the full power taken from the anode current source, and I_o is the constant component of the fundamental wave of the anode current; P_t is the sum of the mean power P_a lost at the anode and the useful (oscillatory) power P_n.

(ii) The useful (dissipative) resistance R_n is given by $R_n = \frac{E_a^2}{P_n}$, which is shown to be equal to R_t/η, while (iii) the anode loss resistance R_a is shown to be equal to $R_t/(1 - \eta)$; η in these expressions is the efficiency, and is equal to

$$\frac{\xi}{4} \cdot \frac{2\theta - \sin 2\theta}{\sin\theta - \theta\cos\theta}.$$

Here ξ is the "utilisation factor" of the anode potential, and occurs in the expression for the instantaneous value of the anode potential $e_a = E_a(1 - \xi \sin \omega t)$; while θ is the "cut off angle" representing, in parts of a period, the half duration time of the flow of anode current. It is seen from the above that $\frac{1}{R_t} = \frac{1}{R_n} + \frac{1}{R_a}$: from this relation an equivalent circuit for the valve generator can be derived (Fig. 2) in which R_n and R_a are connected in parallel. Various other relations can also be derived (equations 12–14).

Section 3, dealing with the three corresponding dynamic resistances, involves the a.c. component of the anode potential in place of E_a, the constant component hitherto considered. The writer ends by emphasising the value of the equivalent circuit before mentioned (Fig. 2) and the corresponding Fig. 3 of section 3, for the development and testing of valve generators, since they give a specially clear view of the physical processes.

Operating Mechanisms of Negative Resistance Oscillators (III): Analytical Studies on the Fundamental Characteristics of Triode Oscillators.—R. Usui. (*Journ. I.E.E. Japan*, March, 1932, Vol. 52 [No. 3], No. 524. English summary pp. 44–47, Japanese text pp. 276–287.)

Further development of the work referred to in June Abstracts, p. 342. "Analytical studies of triode oscillators are fully treated in this paper. Amplitudes of controlling and operating voltages are expressed in terms of the conductance ratio P or the stiffness of oscillation N,

$$\left[N = \frac{1}{P} = \frac{\mu M - L}{R\rho C}\right],$$

with the parameter of the operating point X_0. These curves of amplitudes with respect to P must be very convenient for quick estimations of oscillation power, etc., of triode oscillators in general. Also the mechanisms of frequency variations are studied from a new direction by using the elongation of oscillation periods."

Valve Resistance in Oscillation Generators [Reduction of Negative Resistance by Auxiliary Positive Resistance: Influence on Oscillation at Very High Frequencies, etc.].—N. W. McLachlan. (*Wireless Engineer*, June, 1932, Vol. 9, No. 105, p. 319.)

A letter supplementing the paper dealt with in June Abstracts, p. 342, and stressing the importance of the method "C" on p. 134 of that paper.

On the Variation of the Resistance of Thermionic Valves at High [and Ultra-High] Frequencies.—Mitra and Sil. (*See* under "Valves and Thermionics.")

On the Production of Various Electron Oscillations [Ultra-Short—Decimetre—Waves] by an Electron Tube: T.V.V. Type D.K.: Cymotron U.F.-101.—S. Sonada and T. Takayama. (*Journ. I.E.E. Japan*, Feb. and April, 1932, Vol. 52 [Nos. 2 and 4], Nos. 523 and 525. English summaries pp. 22–23 and 61–62, Japanese text, pp. 153–155 and 331–339.)

Construction of an Ultra-short Wave (8 m) Transmitter with Tourmalin Crystal Control. (*Rad., B., F. f. Alle*, June, 1932, pp. 254–259.)

Practical 5-Metre [Ultra-Short-Wave] Working.—H. L. O'Heffernan and S. G. Morgan. (*Wireless World*, 8th June, 1932, Vol. 30, pp. 590–593.)

The authors give details of practical tests which they have carried out with a fixed transmitter and a mobile receiver, of which technical data are given. The super-regenerative type of receiver proved to be particularly effective on the 5-metre wavelength and under the particular conditions of the tests.

Kurzwellensender kleinster Abmessungen (The Smallest Short Wave Transmitter [for Balloon Work]).—B. Thieme. (*Zeitschr. V.D.I.*, 28th May, 1932, Vol. 76, No. 22, pp. 539–540.)

The valve, which has a built-in control crystal, is of the size of an ordinary amplifier valve: tuning coils are wound round its stem, and including the socket the height is only 10 cm. The heating accumulator is only about 7 cm high. With a 2-watt input on a 60-m wave, day and night ranges at all times of the year are from 100 to 500 km (100 km telephony).

On the Maintenance in Oscillation of the Most General Passive Network.—Le Corbeiller. (*See* under "Properties of Circuits.")

Beitrag zum Studium der elektrischen Schwingungen des Kohle-Lichtbogens (Contribution to the Study of the Electrical Oscillations of the Carbon Arc).—A. Kotecki. (Summary in *Physik. Ber.*, 1st May, 1932, Vol. 13, No. 9, p. 904.)

RECEPTION.

[Chicago] Trade Show Sees New Sets, Circuits, Tubes.—(*Electronics*, June, 1932, pp. 186–187 and 206.)

"Greater use of two speakers in a single set seems assured. Distortion to a very great figure exists in most sets of the present vintage due to loud-speaker overloading, *i.e.* non-linearity of excursion on strong signals. At the same time that the distortion from over-loaded speakers is decreased, an apparent binaural effect is attained. In addition there is much improvement in the transient effect preventing loud-speaker hangover, thus giving cleaner reception."

Class B amplification: the use of the 46-type valve (designed for class B amplification) in a class A circuit. "Thus the 46 either as class A or class B may hasten the demise of the pentode. The projected 3-grid tube described below will aid in this process" (this is a special pentode with its grids so proportioned and spaced that if the two grids nearest the plate are connected together a triode for class A operation is formed, while if the grid nearest the plate is connected to the heater-type cathode a pentode results, and if the two grids nearest the cathode are connected together a valve suitable for class B amplification is produced. An output of 2–3 watts will be available).

The new RCA duplex-diode triode unipotential cathode detector valve type 55 : this is a combined detector, amplifier and automatic volume control valve, with two diodes and a triode in one envelope and a single cathode having one surface for the diodes and another for the triode. The two diodes can be used for full-wave rectification with the circuit balanced for carrier input so that no carrier frequency filtering is theoretically necessary : or they can be paralleled to give twice the output.

An anti-regeneration circuit using a combination of electrostatic and electromagnetic coupling is mentioned (Fordham University), such that "not only are the noises incidental to uncontrolled regeneration eliminated, but by a dial the operator can narrow or widen the band of frequencies accepted by his set. As many as six or more stages may be cascaded without danger of oscillation . . ." Another set mentioned uses six very small valves ($2\frac{1}{2} \times \frac{3}{4}$ inch) and a Rochelle salt loud-speaker. Expensive remote-control receivers are having excellent sales : "thus one of those things which 'can't be done' is being accomplished with considerable success."

IMPROVED FIDELITY OF TWO-SPEAKER RADIO RECEIVERS.—Knowles. (*See* under "Acoustics and Audio-frequencies.")

DEVELOPMENTS IN THE TESTING OF RADIO RECEIVERS.—H. A. Thomas. (*Wireless Engineer*, May, 1932, Vol. 9, No. 104, pp. 269–272.)

Long abstract of an I.E.E. paper and of the subsequent discussion. A long second part deals with a proposed method of specifying the performance of broadcast receivers.

"APPARENT DEMODULATION": ANOTHER VIEWPOINT.—E. Mallett. (*Wireless Engineer*, May, 1932, Vol. 9, No. 104, pp. 248–252.)

"It is a pity . . . that the presentation of the problem has involved so much mathematics and so little physics . . . the physical explanation of the problem would appear to be delightfully simple." The writer treats the strong carrier as an alternating biasing voltage and shows how this throws the rectifier completely out of action, so far as the weak signal voltage is concerned, during part of the time (depending on the relative amplitudes of the signal and biasing voltages) and how, even during those parts of the time when it is active, the rectification of the weak signal is reduced. He objects to the term "apparent demodulation": the modulation of the weak wave is unaltered by the presence of the strong wave.

WEAK SIGNAL DEMODULATION BY A STRONG CARRIER.—E. V. Appleton. (*Electronics*, May, 1932, pp. 171 and 182.)

Cf. the longer paper by the writer and Boohariwalla, dealt with in June Abstracts, p. 343 : also *see* July Abstracts, pp. 405–406.

GRAPHICAL SOLUTION OF DETECTOR PROBLEMS.—W. A. Barclay : Lucas. (*Wireless Engineer*, May, 1932, Vol. 9, No. 104, pp. 273–274.)

A criticism of Lucas's method (July Abstracts, p. 406).

THE SELECTIVITY OF BROADCAST RECEIVERS I.E.E. DISCUSSION : A CORRECTION.—H. L. Kirke. (*Wireless Engineer*, May, 1932, Vol 9, No. 104, p. 274.)

The writer points out that the report of some of his remarks, given in the summary referred to in July Abstracts, p. 405, gave a somewhat misleading impression of his opinion, and might convey the idea that he was not in favour of the reproduction of the higher audio-frequencies.

TONE CORRECTION AND DISTORTION.—N. W. McLachlan. (*Wireless World*, 8th June, 1932, Vol. 30, pp. 602–604.)

Stressing the fact that when any modulated radio-frequency wave is amplified and the side bands attenuated by highly selective tuning circuits, it is essential when restoring the upper audio frequencies by tone correction that the detector should have a linear characteristic. Should harmonics be developed in the valve circuits, distortion may be serious, especially if the degree of tone correction is high : "even the 11th harmonic is dangerous."

MEASUREMENT OF CLASS B AMPLIFIER DISTORTION [PLOTTING THE FORM FACTOR AS INDICATOR OF DISTORTION].—C. L. Farrar. (*Electronics*, June, 1932, pp. 196–198.)

THE MODERN STRAIGHT FIVE.—W. I. G. Page and W. T. Cocking. (*Wireless World*, 22nd and 29th June, 1932, Vol. 30, pp. 640–644 and 665–669.)

A five-valve a.c. mains operated receiver for the amateur constructor. The principal features are : —two r.f. stages in which variable-mu valves are employed, and single dial control of four tuned circuits, including constant peak band pass filter.

THE SCHALECO-SUPER-DX RECEIVER.—Schackow, Leder and Company. (*Hochf:tech. u. Elek: akus.*, April, 1932, Vol. 39, pp. 153–154.)

Description, photos and diagram of this six-valve (including rectifier) short and broadcast wave receiver, with screen-grid input stage, reaction audion resistance-coupled to l.f. stage, and push-pull pentode output ; single-dial control, and careful design to obtain a smooth reaction control. A special wave-band selector is incorporated, the various ranges being 15–30, 30–55, 55–95, 200–425, 425–600, 600–1 400 and 1 400–2 000 metres.

BROADCAST RECEIVERS USING THE "MICROMESH" VALVES.—Standard Telephones & Cables. (*See* under "Valves and Thermionics.")

UNSER REISE-EMPFÄNGER (A Single-Valve Portable Receiver for Pedestrians).—H. Prinzler. (*Die Sendung*, 20th May, 1932, Vol. 9, No. 21, pp. 445–446.)

THE REIMANN "SYNCHRONOUS" RECEIVER.—Reimann. (*Rad., B., F. f. Alle*, June, 1932, p. 241.)

More editorial comments on the receiver (utilising the zero-beat point when special selectivity is needed) dealt with in June Abstracts, p. 344.

LICENCES UNDER THE AMPLIFIER PATENTS.—(*Electronics*, May, 1932, pp. 152–153 and 182.)

RECEIVER ATTACHMENT FOR CUTTING-OUT INTERFERENCE FROM APPARATUS AND MACHINES.—E. Gloor. (*Rad., B., F. f. Alle*, June, 1932, pp. 243–244.)

Editorial comments on reports from Zurich of a successful device by which the "undamped" signals are unaffected while the "damped" interference is eliminated. "The aerial must receive the electrical component, and the frame [embodied in the device] the magnetic component, of the interfering oscillations." The attachment does not include any valves.

DISTANT CONTROL OF A RECEIVER BY AUTOMATIC TELEPHONE DIAL.—(*Rad., B., F. f. Alle*, June, 1932, pp. 241–242.)

HIGHER FIDELITY STANDARDS ARE HERE!—(*See* under "Acoustics and Audio-frequencies.")

REGENERATION WITH DIFFERENTIAL CONDENSER: INTRODUCTION OF 1 000 OHMS RESISTANCE IN SERIES WITH SMALLER CAPACITY.—(Summary of German Patent in *Electronics*, June, 1932, p. 205.)

Allows the corresponding part of the condenser to be reduced in size "so that with decrease of regeneration no noticeable weakening of the higher audio-frequencies occurs."

LAMP RESISTANCES FOR D.C. RECEIVERS.—Henderson. (*See* under "Subsidiary Apparatus and Materials.")

SYNCHRONOUS ELECTRIC CLOCK FOR INCORPORATION IN RADIO RECEIVERS.—Ferranti, Ltd. (*Electrician*, 27th May, 1932, Vol. 108, pp. 736.)

THE PADDING CONDENSER: GRAPHIC SOLUTION OF A SINGLE-DIAL SUPERHETERODYNE PROBLEM.—B. F. McNamee. (*Electronics*, May, 1932, pp. 160–161.)

LA RIVELAZIONE DELLE MICROONDE (The Detection of Micro-Waves [Ultra-Short — Decimetre — Waves]).—N. Carrara. (*Alta Frequenza*, March, 1932, Vol. 1, No. 1, pp. 6–15.)

As a result of researches to determine the optimum conditions for a triode used for the reception of these waves, it is found that under these conditions (a high positive grid voltage and a plate voltage slightly inferior to that of the positive end of the filament) the triode behaves simply as a rectifying diode with its electrodes much closer to each other than can be attained in practice. The result is opposed to the general belief that the triode should, for best reception, be under nearly the same conditions as for generating oscillations, so that the signals on arriving may cause oscillation.

GENERATION OF COMBINATION AND HARMONIC FREQUENCIES BY LINEAR AND NON-LINEAR VACUUM TUBE CIRCUITS.—Boner and Boner. (*See* under "Properties of Circuits.")

THE CALCULATION OF DETECTION PERFORMANCE IN A VACUUM TUBE CIRCUIT FOR LARGE SIGNALS.—Woods. (*Ibid.*)

AERIALS AND AERIAL SYSTEMS.

ÜBER DIE ELEKTRISCHEN EIGENSCHWINGUNGEN STABFÖRMIGER LEITER (On the Free Electrical Vibrations of Rod-Shaped Conductors).—K. F. Lindman. (*Ann. der Physik*, 1932, Series 5, Vol. 13, No. 3, pp. 358–372.)

The writer has re-examined his former (1908–1910) measurements of the fundamental wavelength given by an electrical oscillator in the form of a rod and supplemented them by new ones. He finds that they agree well with the theory given by Abraham and, for thicker conductors, with that of Oseen. The values calculated on Hallén's theory (1931 Abstracts, p. 269) are consistently larger than those observed. Values of logarithmic decrement and frequencies of harmonics agree with Abraham's theory. *See* also 1929 Abstracts, p. 574.

THE ACTION OF CYLINDERS IN AN ELECTROMAGNETIC WAVE FIELD.—H. Kikuchi. (*Journ. I.E.E. Japan*, March and April, 1932, Vol. 52 [Nos. 3 and 4], Nos. 524 and 525. English summaries pp. 35–40 and 49–54.)

Part I begins with the direct solution, from Maxwell's equations, of the distribution of the wave field around a long circular cylinder placed perpendicularly to a plane polarised wave field. The groups of interference parabolas are discussed. The "re-radiation coefficient" and "angle of re-radiation" of a cylinder are defined and examined theoretically and experimentally, with regard to its material, radius and length: a good conductor has a large re-radiating power: the angle of re-radiation due to the material and radius of a cylinder "can scarcely be observed"—"salt water shows the effect but the observation will not be reliable": change in the cylinder length causes variation both of the coefficient and of the angle of re-radiation.

Part II first considers two metallic cylinders in a line perpendicular to the direction of propagation, the distance between them being varied from $\lambda/4$ to 3λ. The experimental results show that if the length of the cylinders is shorter or longer than the true resonance length, the transmitting power of the grating increases or decreases, and the shielding power decreases or increases. It is proportional to the re-radiating power of a cylinder: moreover, the transmitting power is proportional to, and the shielding power inversely proportional to, the distance between the two cylinders.

Next, the effect of several cylinders in a row perpendicular to the direction of propagation is considered. The field disturbance (reflection, refraction, shielding) is the superposition of the disturbances caused by individual cylinders: it is determined by (*a*) material, (*b*) radius and (*c*) length of each cylinder. The reflection is increased when the number of cylinders per unit width is increased: the reflection, transmission and diffraction caused by cylinders in such a row is equivalent to a continuous plate when the distance of each cylinder [is less ?] than half the wavelength. The effect of several cylinders in a row parallel to the direction of propagation is then dealt with: here again the effects caused are a superposition of the individual effects of each cylinder. When a cylinder is longer than the resonance length, strong reflection is found in front of the series and shielding behind the series; when it is shorter than the resonance length, weak reflection is found in front and transmission (strengthening) behind the series. Finally, the effect of several cylinders situated on the interference parabola facing the direction of propagation is examined, and the collection of the incoming 387-cm waves at the focus demonstrated, the cylindrical rods used being 202 and 225 cm in length.

MULTI-HERTZIAN OSCILLATORS.—H. Kikuchi. (*Journ. I.E.E. Japan*, April, 1932, Vol. 52 [No. 4], No. 525. English summary pp. 55–58, Japanese text pp. 314–319.)

Continuation of the above work. 1.—The electric wave field due to a main oscillator and an auxiliary oscillator: theory, leading to equations for groups of interference parabolas of the first and second kind, and the corresponding polar diagrams; change in the phase angle of the auxiliary oscillator affects the polar diagram: experimental; change in the length of the auxiliary produces different polar diagrams.

2.—Effect of several (2 to 8) auxiliary oscillators. Experimental results:—A series of rods shorter than the true resonance length act as "directors," a series of rods longer than the resonance length act as "reflectors." A series of the shorter rods in front of the main oscillator, and a series of the longer rods behind it, give the diagrams of Fig. 2 (6), the better diagram being given by 157 and 180 cm rods, the inferior diagram by 135 and 225 cm rods—the main oscillator being 140 cm in both cases ($\lambda = 387$ cm).

3.—New interference-parabolic reflector: the most efficient type of reflector for this wavelength is a parabola consisting of numerous 225 cm copper rods along the first parabola of a group of interference parabolas of the second kind, its equation being

$$\frac{r}{\lambda} = \frac{1}{2(1 - \cos \phi)}.$$

ON THE STRAIGHT WIRE [SHORT-WAVE] RECEIVING ANTENNA WITH DISTRIBUTED E.M.F.—H. Iwakata. (*Journ. I.E.E., Japan*, March, 1932, Vol. 52 [No. 3], No. 524. English summary, pp. 42–44, Japanese text and bibliography, pp. 263–275.)

The general equation for the field intensity, taking into account the polarisation, is obtained analytically. It is assumed that with a short-wave aerial whose length is comparable with the length of the incoming wave the e.m.f. is distributed on each element of the conductor, so that if the simple relation between the phase angle of the adjacent e.m.fs is found the receiving voltage can be calculated.

On the assumption that the e.m.f. impressed on the aerial elements is composed of three parts—the down-coming space wave, the reflected space wave and the ground wave—complex hyperbolic expressions are arrived at for the receiving voltage and current due to the first component. Under suitable approximations these can be transformed into a simple trigonometric form for numerical calculation (see Japanese text). The reflected space wave and the ground wave are similarly treated, and the three results added vectorially give the required resultant values. "The most remarkable result in my calculation is that the fading phenomena with short waves are proved theoretically, as shown in Fig. 2," which shows the characteristics of the straight vertical aerial. The fading is attributed to the "unstableness of phase difference of the two space waves, the inclination of the polarised wave and the incident angle of the [down-] coming wave, though these amplitudes are constant, and Fig. 2 shows that the receiving voltage is conspicuously affected by the variety of the incident angle of the [down-] coming wave. So the same results are obtained for the other types of antenna such as the horizontal ones."

CHAMPS PRODUITS PAR UNE LIGNE PARCOURUE PAR UN COURANT ALTERNATIF AVEC RETOUR PAR LE SOL, ET PAR UNE ANTENNE HORIZONTALE (The Fields produced by a Line traversed by an Alternating Current, with Earth Return, and by a Horizontal Aerial).—F. Pollaczek. (*Rev. Gén. de l'Élec.*, 30th April and 7th May, 1932, Vol. 31, pp. 587–594 and 631–639).

A French version of Pollaczek's paper.

MEASUREMENTS IN THE FIELD RADIATED BY A VERTICAL ANTENNA, EXCITED IN ITS FUNDAMENTAL OSCILLATION, BETWEEN TWO PERFECTLY CONDUCTING PLANES.—Bergmann and Doerfel. (*See* under "Propagation of Waves".)

VALVES AND THERMIONICS.

BROADCAST RECEIVERS USING THE "MICROMESH" VALVES.—Standard Telephones and Cables. (*Electrician*, 13th May, 1932, Vol. 108, p. 679.)

Brief details of types of receiver shortly to be put on the market by Standard Telephones and Cables, Ltd., and a description of their new "Micromesh" valves (May Abstracts, p. 300). Improvements in the characteristic are obtained by extremely close spacing between cathode and grid. Mechanical rigidity is ensured by constructing the valve as a unit with the elements secured into upper and lower mica insulators which have been accurately punched. To prevent the cathode from heating the grid to such a temperature that deposited cathodic material would emit electrons, the grid is designed with a large fin for radiating purposes. At present, three types have been designed—detector, power, and full-wave rectifier. "Micromesh" screen-grid valves are also to be produced. Amplification factor, impedance, and mutual conductance at 100 v anode potential and zero grid volts are: for the detector, 80, 10 000 ohms and 8 mA/v; for the power type, 12.6, 1 050 ohms and 12 mA/v. The rectifier gives 60 mA at nearly 300 v with an input of 250–0–250 r.m.s. volts.

SPECIAL THREE-GRID VALVE FOR ALTERNATIVE PURPOSES [PENTODE, CLASS A AND CLASS B TRIODE].—(*See* abstract on Chicago Show under "Reception".)

THE RCA 55: A DUPLEX-DIODE TRIODE UNIPOTENTIAL CATHODE DETECTOR VALVE.—(*Ibid.*)

AN IMPROVED 120-VOLT D.C. AUDIO AMPLIFIER [TRIPLE TWIN TYPE 291 VALVE].—C. F. Stromeyer. (*Electronics*, June, 1932, pp. 194–195.)

Cf. May Abstracts, pp. 285–286.

VARIABLE-MU VALVES.—W. I. G. Page. (*Wireless World*, 15th June, 1932, Vol. 30, pp. 630–632.)

The author gives a brief summary of the advantages of the variable-mu valve, together with the tabulated data of the working characteristics of six available types.

SPECIAL VALVE FOR ULTRA-SHORT WAVES (5 WATTS AT 3-METRE WAVELENGTH).—Telefunken Company. (*Rad., B., F. f., Alle*, June, 1932, pp. 270–271.)

Type RS 280. At 15 metres it gives an output of 20 watts. Its life is over 1 000 hours. The indirectly heated oxide-coated cathode is very strong and will stand vibration in portable sets. The valve is said to be "particularly well adapted to crystal control."

RECORDING THE EQUIPOTENTIAL LINES OF THE FIELD IN A VALVE.—McArthur. (*See* abstract under "Subsidiary Apparatus and Materials.")

A HEAVY-DUTY INDUSTRIAL AMPLIFIER TUBE [TYPE RJ-563, AMPLIFICATION FACTOR 4, ANODE CURRENT 0.20 A AS D.C. AMPLIFIER, 0.10 A AS A.C. AMPLIFIER].—C. B. Upp: Westinghouse Company. (*Electronics*, May, 1932, p. 162.)

PHOTOCELL CONTROL OF TEMPERATURE FOR FILAMENT-COATING OVENS.—W. P. Koechel. (*Electronics*, May, 1932, pp. 170 and 182.)

MEASUREMENT OF CLASS B AMPLIFIER DISTORTION [PLOTTING THE FORM FACTOR AS INDICATOR OF DISTORTION].—C. L. Farrar. (*Electronics*, June, 1932, pp. 196–198.)

BRITISH STANDARD SPECIFICATION FOR THE DIMENSIONS OF RADIO VALVES AND VALVE-SOCKETS.—(No. 448—1932: May, 1932, 11 pp.)

ON THE VARIATION OF THE RESISTANCE OF THERMIONIC VALVES AT HIGH [AND ULTRA-HIGH] FREQUENCIES.—S. K. Mitra and B. C. Sil. (*Phil. Mag.*, June, 1932, Series 7, Vol. 13, No. 88, pp. 1081–1098.)

This paper describes experiments "made to determine the variation of conductivity of the plate-grid space of a triode valve within the frequency range of 10^7 to 6×10^7 cycles per sec. The results show that, in going from the lower to the higher frequency, the conductivity decreases by more than 100 per cent." A theory of the variation of resistance is developed, assuming the electrons within the plate-grid space to have a Maxwellian velocity distribution. On this velocity is superposed an oscillatory motion due to the alternating field applied between the plate and the grid. The theory gives good agreement with the experimental results.

VALVE RESISTANCE IN OSCILLATION GENERATORS.—McLachlan. (*See* under "Transmission.")

THE DEVIATION OF ANODE CURRENTS IN DIODES FROM THE THREE-HALVES POWER LAW.—A. Gehrts. (*Phys. Review*, 1st May, 1932, Vol. 40, No. 3, pp. 434–439.)

THE MOBILITY OF CAESIUM ATOMS ADSORBED ON TUNGSTEN.—I. Langmuir and J. B. Taylor. (*Phys. Review*, 1st May, 1932, Vol. 40, No. 3, pp. 463–464.)

ON ONE KIND OF VARIATION OF THERMIONIC EMISSION FROM WEHNELT CATHODE.—Y. Takamura. (*Proc. Phys.-Math. Soc. Japan*, No. 10, Vol 13, Series 3, pp. 282–286.)

The writer shows that when the glass wall or a metal electrode of a discharge tube is heated, gaseous impurities are given off which alter the emissive properties of an oxide-coated cathode in the same container. This alteration is attributed to the fact that the gases form layers on the cathode surface which change the work function.

THE PHOTOELECTRIC AND THERMIONIC PROPERTIES OF PALLADIUM.—W. W. Roehr and L. A. Du Bridge. (*Phys. Review*, 1st March, 1932, Series 2, Vol. 39, No. 5, p. 866.)

Abstract only.

ACOUSTICS AND AUDIO-FREQUENCIES.

HIGHER FIDELITY STANDARDS ARE HERE!—(*Electronics*, June, 1932, p. 183.)

"Suddenly, all along the whole line of electronic devices, this matter of tone fidelity becomes of first commercial importance. A new day is breaking for greater tone accuracy. At the Radio Show at Chicago, the new models showed a much higher degree of fidelity, made possible by the new tubes and circuits and by the trend to double loudspeakers. In phonograph recording, accuracy in reproduction out to 9 000 cycles is now achieved.

The new films have sound tracks of remarkably full tone range. Last month a new theatre opened at Providence, with recordings running from 40 to 8 000 cycles with complete faithfulness of tone. . . . Already the broadcasters have driven their side-bands out beyond 7 500 cycles. . . . " *See* also article on Chicago Show, under " Reception."

BROADCAST REPRODUCTION.—H. A. Hartley. (*Wireless World*, 4th and 11th May, 1932, Vol. 30, pp. 442–446 and 487–491.)

The author tackles the problem of reproduction from the beginning, explaining what a musical sound is, the peculiar characteristics of various instruments and how these sounds may or may not be distorted in their reception or amplification. Curves are given showing the distinction between loudness and intensity effects, and the behaviour of the ear when dealing with sounds of different frequencies.

WHAT THE EAR HEARS [FREQUENCY RANGE FOR FAITHFUL REPRODUCTION]. (*Wireless World*, 15th June, 1932, Vol. 30, pp. 614–616.)

Full data are given concerning recent Bell Laboratories' researches to determine the frequency range required for the most recognisably faithful reproduction of speech, music and certain noises. Conclusions are given in considerable detail. *See* also Feb. Abstracts, pp. 98–99.

IMPROVED FIDELITY OF TWO-SPEAKER RADIO RECEIVERS.—H. S. Knowles. (*Electronics*, May, 1932, pp. 154–156.)

" The idea is prevalent that the use of two speakers in a radio receiver is largely for the betterment of the frequency response. This advantage, however, is not all. A better overload characteristic, improved transient response, and increased energy efficiency all are secured." The writer develops this theme, beginning by criticising present practice, particularly in sets where the cabinet size is reduced, and where the makers demand a loud speaker depending for its virtue on its apparent sensitivity and bass response, not on its fidelity. " Two speakers show an average improvement of 3 db, except near the resonant peaks of the two which may differ by about 20 cycles. Near these frequencies the diaphragms are slightly out of phase. This improvement is equivalent to increasing the output of a pair of '45's from 4.9 to 9 watts. Actually the improvement is even more important because the speaker has more distortion than the tubes at low levels; hence there is less steady state distortion at room levels. . . . With the use of two speakers properly staggered to reduce the steady state and transient distortion, and possibly an additional single small speaker to give the highs—which can then be minimised as objectional modes in the large diagrams—the present-day fidelity can be appreciably improved. Multiple speaker units can be made with high absolute efficiencies at the low end and yet with a combined impedance which is uniform between ± 15 % from 30 to 8 000 cycles, minimising the transient distortion from working into a 4 or 5 to 1 impedance ratio load."

THE USE OF TWO LOUD SPEAKERS IN A SINGLE SET, IN U.S.A.—(*See* abstract on Chicago Show under " Reception.")

BINAURAL HEARING.—G. W. Stewart. (*Journ. Acous. Soc. Am.*, No. 3, Vol. 1, 1930, pp. 344–347.)

PIEZOELECTRIC LOUD-SPEAKERS AND MICROPHONES [ROCHELLE SALT: THE DEVELOPMENT OF THE BIMORPH PRINCIPLE].—A. L. Williams. (*Electronics*, May, 1932, pp. 166–167.)

" As many as ten crystal loud speakers may be operated on the same volume as one electrodynamic or magnetic speaker at a given power input, making this type of speaker invaluable for multi-speaker installations in schools, theatres, hotels, etc." In parallel with a dynamic type it increases the acoustical range, improves the power factor and helps to keep the load impedance constant at all frequencies. Characteristic curves of such a combination, and of a Brush crystal microphone, are given.

THE LOUD SPEAKER COIL OF OPTIMUM MASS: CORRECTIONS.—N. W. McLachlan. (*Wireless Engineer*, June, 1932, Vol. 9, No. 105, p. 319.)

Correcting printers' errors in the letter referred to in June Abstracts, p. 351.

ELECTRO-MECHANICAL RECTIFICATION: A MOVING-COIL L.S. PHENOMENON.—N. W. McLachlan. (*Wireless Engineer*, June, 1932, Vol. 9, No. 105, pp. 329–330.)

Examination of an effect originally noticed in the case of a freely suspended diaphragm having little axial constraint: as the frequency of the constant exciting voltage was reduced, the amplitude of vibration of the diaphragm increased and a point was reached when it moved axially out of the magnet, had to be restored to its original position by an appreciable force, and shot out again on the removal of this force. The explanation is based on the distribution of the gap flux along the magnet axis. The significance of the effect in the operation of loud speakers is discussed.

DYNAMIC SPEAKER DESIGN—PART I.—A. R. Barfield. (*Electronics*, June, 1932, pp. 188–190.)

Analysis dealing with the design of the magnetic circuit and the driving coil, limited to the problem of obtaining the greatest possible force at frequencies between 250 and 500 c/s. The reasons for taking this as a working basis are given.

ÜBER DIE AKUSTISCHE STRAHLUNGSLEISTUNG VON STRAHLERGRUPPEN, INSBESONDERE DER KREIS- UND KUGELGRUPPEN (The Acoustic Radiated Power of Radiator Groups, particularly the Circle and Sphere Groups [Application of a Rayleigh Formula]).—F. A. Fischer. (*E.N.T.*, April, 1932, Vol. 9, pp. 147–155.)

Author's summary:—The radiated power of the circle group, with and without artificial phase displacement, and of the compensated sphere group, is calculated. Since, in the calculation of the circle group, the direct integration over the square of the directional characteristic [*cf.* Stenzel, 1931 Abstracts, pp. 214–215] presents difficulties, a general formula due to Rayleigh is used, by which the radiated power can be arrived at without the directional characteristic having to be calculated. This formula leads to analytical and numerical expressions which are convenient to use.

CAPACITIVE OUTPUT COUPLING [BETWEEN OUTPUT VALVE AND ACOUSTIC LOAD : IMPROVEMENT OF FREQUENCY CURVE BY SUITABLE CHOICE OF CAPACITY].—Sims. (*See* under " Properties of Circuits.")

DER TEILNEHMER-ENDVERSTÄRKER : I. TEIL.—BETRACHTUNGEN ÜBER DIE DIMENSIONIERUNGSGRUNDLAGEN VON FERNSPRECHANLAGEN MIT LAUTHÖREINRICHTUNGEN (The Subscriber Output Amplifier : Part I.—Considerations on the Fundamental Design Calculations of Telephone Sets with Loud Speaker Equipment).—R. Winzheimer and H. Reppisch. (*Hochf:tech. u. Elek:akus.*, May, 1932, Vol. 39, pp. 155–159.)

By members of the Berlin Post Office staff. The subject matter is indicated by the title.

ALL GERMAN BROADCASTING STATIONS TO USE CONDENSER MICROPHONE (NEUMANN TYPE) IN PLACE OF REISS MARBLE-BLOCK MICROPHONE.—(*Rad., B., F. f. Alle*, June, 1932, pp. 275–276.)

On account, it is said, of its better characteristic and freedom from background noise. The type developed by G. Neumann and already used for two years in Bavaria is " not much bigger than a five-mark piece, but for broadcasting purposes is always built in with a metal-enclosed single-valve l.f. amplifier."

TONFILMTECHNISCHER RÜCKBLICK AUF 1931 (Sound Film Engineering in 1931 : a Retrospect).—P. Hatschek. (*Fernsehen u. Tonfilm*, No. 2, Vol. 3, 1932, pp. 70–75.)

Including references to the Bell laboratories' return to the Edison hill-and-valley recording : the mixed variable-area variable-density sound-on-film recording demonstrated by Janowsky (*cf.* Crowther Fidelytone system, January Abstracts—West) : nickel membrane recording method (Müller, June Abstracts, p. 354) : the Lignose-Breusing variable-density recording system using a cathode ray tube : American " noiseless " systems and lens-slit without any actual slit : and the Lorenz " patina " photoelectric cell (a gas-filled alkali cell with a practically straight characteristic and a glow discharge voltage of as much as 1 000 v : audibility is good in telephones without any amplification, and in the cinema the input amplifier can be dispensed with. *See* also Noack, under " Phototelegraphy and Television.")

TONFILM UND FERNSEHEN ([The Intimate Connection between] Sound Films and Television).—R. Thun. (*Fernsehen u. Tonfilm*, No. 1, Vol. 3, 1932, pp. 1–7.)

THE SOUND RECORDING CAMERA [SOUND-ON-FILM RECORDING SYSTEMS].—W. H. O. Sweeny. (*Wireless World*, 15th and 22nd June, 1932, Vol. 30, pp. 617–620 and 645–647.)

NOISY AUDIENCE LIMITS SOUND-PROOFING OF THEATRE.—S. K. Wolf and J. E. Tweeddale. (*Sci. News Letter*, 21st May, 1932, p. 324.)

The limit to which modern engineering can sound-proof a building is set by the noise of the audience itself. In an ordinary quiet auditorium this amounts to 25–30 decibels above audibility. Street noise, amounting to 60–70 decibels for New York traffic, can easily be reduced to less than that made by the audience. Internal noises from apparatus, etc., can be similarly reduced.

TONEINSATZ UND ELEKTRISCHE MUSIK (Electrical Music and the Building-Up of Tones).—F. Trautwein : Backhaus. (*Zeitschr. f. tech. Phys.*, No. 5, Vol. 13, pp. 244–246.)

Backhaus, in his paper dealt with in May Abstracts, p. 289, remarks that the attempts to evolve, by electrical means, an instrument which shall be able to produce any desired timbre are likely to be partially unsuccessful until means are found to modify greatly the nature of the building-up processes. Trautwein here refers to his own " tone former " hypothesis (Abstracts, 1930, p. 575, and 1931, pp. 101 and 112) based on the inadequacy of the periodic processes and the need of assuming shock excitation, and to his successful use of microphonic contacts for producing the required effects in practice.

AN AUDIO OSCILLATOR OF THE DYNATRON TYPE.—Don Hale. (*Review Scient. Instr.*, May, 1932, Vol. 3, pp. 230–234.)

The circuit consists of a four-electrode valve coupled by an a.f. transformer to an amplifying triode which delivers the output through a second a.f. transformer. Frequencies from a few c/s up to the limits of the human ear can be obtained by varying the filament current.

GENERATORE A BATTIMENTI PER FREQUENZE DA 30 A 10 000 PER SEC. (A Beat Frequency Generator for Frequencies from 30 to 10 000 c/s).—(*Alta Frequenza*, March, 1932, Vol. 1, No. 1, pp. 146–148.)

To avoid pull-in effect when the two oscillations are very nearly the same, the oscillators are screened and the coupling to the rectifier is by means of a special resistance bridge.

THE MEASUREMENT OF [LOW AUDIO-FREQUENCY] A.C. POTENTIALS BY MEANS OF DRY-PLATE RECTIFIERS [A METHOD INDEPENDENT OF WAVE-FORM AND FREQUENCY].—Focaccia. (*See* under " Measurements and Standards.")

A VALVE VOLTMETER METHOD OF HARMONIC ANALYSIS.—W. Greenwood : Suits. (*Wireless Engineer*, June, 1932, Vol. 9, No. 105, pp. 310–313.)

The method of Suits (1930 Abstracts, p. 225) " has been considerably improved by using two identical valves with their grids in push-pull and their anodes in parallel, thereby overcoming a number of disadvantages . . . and extending considerably the possible applications of the method."

AUDIO FREQUENCY AMPLIFICATION [AND THE USE OF A SPECIAL TRANSFORMER-COUPLED AMPLIFYING CIRCUIT].—L. A. Meyerovitch and P. A. Lossizky. (*Westnik Elektrot.*, No. 8, 1931, Sec. I, pp. 261–267 : in Russian.)

For high amplification, constant over a considerable frequency interval. Magnetisation of the transformer cores by the d.c. components is avoided by condenser and shunting resistance. Results can be improved still further by making use of potential resonance in the intermediate transformer.

ON THE DEPENDENCE OF THE EQUIVALENT IRON LOSS RESISTANCE OF A [TELEPHONE] TRANSFORMER ON THE CURRENT.—G. A. Tschaianov. (*Westnik Elektrot.*, No. 2, 1931, Sec. I, pp. 64–71 : in Russian.)

A mathematical investigation, confirmed by experiment. If the external circuit contains resistance and inductance, the loss resistance decreases with increasing current and becomes zero at a short circuit. If the circuit contains capacity, the loss resistance increases with the current and reaches its maximum at resonance of the secondary circuit.

BEKÄMPFUNG DER GERÄUSCHAUSBREITUNG IN LÜFTUNGSANLAGEN (Measures for Preventing the Transmission of Noise in Ventilating Systems).—J. Lindner. (*Zeitschr. f. tech. Phys.*, June, 1932, Vol. 13, pp. 289–291.)

REPORT ON NOISES AND THEIR MEASUREMENT.—P. Chavasse. (*Bull. Soc. franç. des Élec.*, Feb., 1932, pp. 151–181.)

Including descriptions of the apparatus used by the French Postes et Télégraphes.

MEASUREMENT OF NOISE.—G. W. C. Kaye. (*Engineering*, 13th May, 1932, Vol. 133, pp. 564–567.) *See* Jan. Abstracts, p. 41.

ACOUSTIC NOMENCLATURE AND DEFINITIONS.—G. W. O. H. (*Wireless Engineer*, June, 1932, Vol. 9, No. 105, pp. 307–309.)

Editorial on a Report by a sub-committee of the German E.V. suggesting standard definitions of some thirty commonly employed terms. One of the most important points is the German adoption of the common logarithm system, the committee recommending the use of phons in place of nepers. The phon differs from the decibel in that, by an arbitrary fixing of the 70 phon level to correspond to a r.m.s. pressure of 1 dyne/cm^2, the zero of the phon scale corresponds very closely to the threshold of audibility, so that actual loudness and not only difference in loudness can be measured in phons.

THEORIE DER SCHALLDURCHLÄSSIGKEIT VON EINFACHEN UND ZUSAMMENGESETZTEN WANDEN (Theory of the Acoustic Conductivity of Simple and Composite Partitions).—E. Wintergerst. (*Schalltech.*, No. 6, Vol. 4, pp. 85–91.)

SCHALLABSORPTIONSMESSUNGEN IN GASEN BEI HOHEN FREQUENZEN (Measurements of High Frequency Sound Absorption in Gases).—E. Grossmann. (*Ann. der Physik*, 1932, Series 5, Vol. 13, No. 6, pp. 681–702.)

This paper describes a new method of measuring sound absorption in gases at frequencies between 3×10^4 and 3×10^5 c.p.s., using piezo-quartz crystals as emitters and receivers of sound. The absorption coefficient of air is found to be fairly constant, but those of SO_2 and CO_2 vary with frequency, in contrast to the predictions of the Stokes-Kirchhoff theory. The absorption coefficient of CO_2 has a maximum at 10^5 c.p.s., where its value is more than 300 times that given by theory.

SOUND VELOCITY IN REACTIVE MIXTURES OF REAL GASES.—D. G. C. Luck. (*Phys. Review*, 1st May, 1932, Vol. 40, No. 3, pp. 440–444.)

FURTHER STUDY OF EFFECTS OF INTENSE AUDIO-FREQUENCY SOUND.—N. Gaines and L. A. Chambers. (*Phys. Review*, 1st March, 1932, Series 2, Vol. 39, No. 5, p. 862.)

Short abstract only of paper on the biological effects of intense sound waves.

ASYMMETRY OF SOUND VELOCITY IN STRATIFIED GEOLOGIC FORMATIONS.—B. McCollum and F. A. Snell. (*Phys. Review*, 1st March, 1932, Series 2, Vol. 39, No. 5, p. 868.) Abstract only.

SOME PROPERTIES OF THE SOUND EMITTED BY AIRSCREWS.—C. F. B. Kemp. (*Proc. Physical Soc.*, 1st March, 1932, Vol. 44, Part 2, No. 242, pp. 151–165.)

THE TRANSMISSION OF SOUND THROUGH SEA WATER.—H. G. Dorsey. (*Journ. Acous. Soc. Am.*, No. 3, Vol. 3, 1932, pp. 428–442.)

AUSBREITUNGSGESCHWINDIGKEIT ULTRAAKUSTISCHER SCHWINGUNGEN IN ZYLINDRISCHEN STÄBEN (Velocity of Propagation of Ultra-Acoustic Oscillations in Cylindrical Rods).—K. Röhrich. (*Zeitschr. f. Phys.*, 1932, Vol. 73, No. 11/12, pp. 813–832.)

THE THEORY OF ACOUSTIC FILTRATION IN SOLID RODS.—R. B. Lindsay and F. E. White. (*Phys. Review*, 1st April, 1932, Series 2, Vol. 40, No. 1, p. 125.)

DOPPLER-EFFEKT AN PIEZOQUARZEN (Doppler Effect with Piezo-Quartz Crystals).—H. Müller and T. Kraefft. (*Physik. Zeitschr.*, 1st April, 1932, Vol. 33, No. 7, pp. 305–306.)

An acoustic demonstration of the Doppler effect is obtained with the difference tone of ultrasonic vibrations from two piezo-quartz crystals by varying the distance between the crystals.

ÜBER AKUSTISCHE FILTER (On Acoustic Filters).—E. Waetzmann and F. Noether. (*Ann. der Physik*, 1932, Series 5, Vol. 13, No. 2, pp. 212–228.)

Über die Eigenschwingungen offener Pfeifen (The Natural Vibrations of Open Pipes).—H. P. Leopold. (*Zeitschr. f. tech. Phys.*, No. 5, 1932, Vol. 13, pp. 222–223.)

Correction to the Paper: "The Dispersion of High-Frequency Sound Waves in Carbon Dioxide."—H. O. Kneser. (*Ann. der Physik*, 1932, Series 5, Vol. 12, No. 8, pp. 1015–1016.) *See* April Abstracts, p. 229.

Über die Verwendbarkeit von Hitzdrähten zu Messungen im Ultraschallgebiet—Vorläufige Mitteilung (On the Applicability of Hot Wires to Measurements in the Ultrasonic Region—Preliminary Communication).—H. Müller and T. Kraefft. (*Zeitschr. f. Phys.*, 1932, Vol. 75, No. 5/6, pp. 313–314.)

This note gives a preliminary account of tests of the suitability of Wollaston wires as receivers in sound fields produced by piezo-quartz crystals.

The Action of Oscillating Piezoelectric Quartz on Solutions and Suspensions of Colloids.—N. Marinesco. (*Comptes Rendus*, 23rd May, 1932, Vol. 194, pp. 1824–1827.)

Piezoelectric Properties of Rochelle Salt Crystals.—Schulwas-Sorokin. (*Zeitschr. f. Phys.*, No. 9/10, Vol. 73, 1932, pp. 700–706.)

The Transient Current in a Rejector Circuit [and Application of Results to Telephonic Filters].—Pomey. (*See* under "Properties of Circuits.")

Tone Correction and Distortion.—McLachlan. (*See* under "Reception.")

Sound Rays as Extremals.—Bateman. (*See* under "Propagation of Waves.")

PHOTOTELEGRAPHY AND TELEVISION.

Difficulties encountered in Transmitting Pictures over Telephone Circuits.—E. S. Ritter. (*Journ. Television Soc.*, March, 1932, Series 2, Vol. 1, Part 4, pp. 113–124.)

The preliminary part of this paper includes tables of data relating to the C.C.I.T. standard (66 mm) and alternative (88 mm) drums. Section 5 deals with the production of a current suitable for transmission over a telephone circuit, the rotating disc method of producing the carrier frequency being treated first and the various components of the resulting current being discussed; the system in which the oscillator-produced current is modulated by the amplified picture current, and a band-pass filter inserted to limit the frequencies passing to the line, is dealt with next. Figs. 3, 4 and 5 show the appearance of new frequencies and beat frequencies when the picture contains lines close together producing frequencies near the maximum modulation frequency. Figs. 6 and 7 show the effect of lines at a slight angle.

Section 6 deals with the transmission of the carrier current over the line: the use of equalising networks: the need for phase-correcting networks, and their effects, illustrated by a number of oscillograms: synchronisation and phasing of the sending and receiving apparatus: carrier current and radio circuits: photographic problems and the ways they are dealt with in the various systems: public picture services. In the subsequent discussion, the author outlines the Bart-Lane (punched tape) system for telegraph circuits and compares its capabilities with those of the other systems: other points dealt with include the comparative advantages of transmitting from film transparencies and prints, the transmission of positive to positive, and the effect of the shaped aperture in the Belin system.

The C.C.I.T. Standard and Alternative Drums.—Ritter. (*See* above abstract.)

Modern Phototelegraphy [Bartlane System]. R. C. Walker. (*Wireless World*, 1st June, 1932, Vol. 30, pp. 564–567.)

The author describes the system in considerable detail. It has "many unique features and advantages not possessed by other systems." The photograph is coded into a message on a punched tape. *See* also Ritter, above.

Two-Way Television [in Paris].—Baird Television Corporation. (*Electrician*, 27th May, 1932, Vol. 108, p. 740.)

A paragraph on recent two-way television and telephony transmissions using about 1 mile of telephone circuit. Scanning was with infra-red light. Reception on a screen 10″ by 5″ gave a fairly coarse image but with features and expressions clearly recognisable.

Inauguration of a "Visiotelephony" Service [between the Galéries Lafayette and the Offices of "Le Matin," Paris].—Lyon and Stoyanowsky: Baird Company. (*Rev. Gén. de l'Élec.*, 28th May 1923, Vol. 31, p. 730.)

Opened to the public from 20th May. "In a few days it will be working between Paris, Lyons and Nice."

The Derby by Television.—Baird Television Co. (*Electrician*, 10th June, 1932, Vol. 108, p. 786.)

Short note on the apparatus used and the quality of reception. Three land lines were used between Epsom Downs and the Metropole Cinema, London, and three mirror drums at the transmitting and receiving ends performed the scanning and recomposition.

Fernsehversuche mit Ultrakurzwellen (Television Tests [German P.O.] on Ultra-Short Waves).—G. Krawinkel and K. Ziebig. (*Fernsehen u. Tonfilm*, No. 2, Vol. 3, 1932, pp. 65–69.)

Auf dem Weg zum Projektionsfernsehen (On the Way to Projected Television).—F. Kirschstein: Sanabria. (*Fernsehen u. Tonfilm*, No. 2, Vol. 3, 1932, pp. 75–78.)

An examination of the advantages claimed for

Sanabria's three-spiral Nipkow disc principle, together with comments on the German P.O. double-disc principle and the results obtained with it.

RECENT ADVANCES IN TELEVISION.—H. J. Barton Chapple. (*Journ. Television Soc.*, March, 1932, Series 2, Vol. 1, Part 4, pp. 106–112.)

Section 3 deals with "zone" (multiple-channel) methods, section 4 with daylight television, and section 5 with large screen television, including comparisons between the Baird developments of the lamp screen, Kerr cell, and modulated arc.

ÜBER HELLIGKEITSSTEUERUNG BEI KATHODENSTRAHLRÖHREN UNTER BESONDERER BERÜCKSICHTIGUNG EINER NEUEN METHODE (Spot Brightness Control in Cathode Ray Tubes, with Special Reference to a New Method [Combination of Electrostatic Deflection on and off Anode Aperture, Deflection Compensation by a Second Deflecting Plate, and Post-Concentration by Cylinder]). —M. von Ardenne. (*Fernsehen u. Tonfilm*, No. 1, Vol. 3, 1932, pp. 18–29.)

MODEL FOR DEMONSTRATING TELEVISION AND FOR TESTING CHARACTERISTICS OF AMPLIFIERS, ETC.: MODEL FOR ILLUSTRATING THE FUNDAMENTAL PRINCIPLES OF TELEVISION. —R. Wilson and A. A. Waters: R. W. Corkling. (*Journ. Television Soc.*, March, 1932, Series 2, Vol. 1, Part 4, pp. 125 and 135.)

THE PRESENT STATE OF TELEVISION IN ENGLAND. —E. H. Traub: Haskell. (*Fernsehen u. Tonfilm*, No. 1, Vol. 3, 1932, pp. 50–51.)

Including an outline of the Gretton-Haskell "Televite" receiver using concentric slotted drums.

TELEVISION IN THE U.S.S.R.—P. Shmakov. (*Journ. Television Soc.*, March, 1932, Series 2, Vol. 1, Part 4, pp. 126–130.)

Including diagram (with values) of an amplifier for photoelectric currents, giving a voltage amplification up to 7×10^6 with a flat characteristic up to 50×10^3 c/s (Ash): receiving disc with positive synchronisation by poles on its periphery instead of by phonic wheel (Ryftin): and a tele-cinema transmitting apparatus for sound films.

TONFILM UND FERNSEHEN ([The Intimate Connection between] Sound Films and Television).—R. Thun. (*Fernsehen u. Tonfilm*, No. 1, Vol. 3, 1932, pp. 1–7.)

TELEVISION—SEVEN YEARS OF RESEARCH AND INVESTIGATION.—R. W. Corkling. (*Electrician*, 27th May, 1932, Vol. 108, p. 727.)

Summary of a paper read before the Television Society. The present position, according to the speaker, corresponds to the "coherer" days of wireless; some new development, equivalent to the discovery of the valve, is required before television can be said to have arrived. The author is investigating the possibility of electro-chemical application, whereby he hopes to eliminate a certain amount of the mechanical details accompanying most present systems.

DIE BRAUNSCHE RÖHRE FÜR FERNSEHZWECKE (The Cathode Ray Tube for Television).—E. Hudec and E. Perchermeier. (*Fernsehen u. Tonfilm*, No. 2, Vol. 3, 1932, pp. 87–94.)

A survey, finishing with a short description of the German P.O. high-vacuum installation.

LICHTSPEICHERUNG BEI FERNSEHGERÄTEN (The Storage of Light in Television Apparatus).—W. Friedel: Jenkins. (*Fernsehen u. Tonfilm*, No. 2, Vol. 3, 1932, pp. 104–106.)

After discussing the need for improved utilisation of the light source, the writer describes C. F. Jenkins' "storage" scheme using a number of photosensitive cells each feeding a condenser, these condensers being discharged by a commutator. In recommending amateurs to experiment along these lines, the writer particularly advocates the use of the "Schmierer" commutator which he says is too little known.

HELLIGKEITSFRAGEN BEI FERNSEHSENDERN (Problems of Brightness in Television Transmitters [Quantitative Treatment, including Comparison of Various Scanning Methods]). —R. Möller. (*Fernsehen u. Tonfilm*, Nos. 1 and 2, Vol. 3, 1932, pp. 29–41 and 95–104.)

DIE LINSENSCHEIBE (The Lens Disc).—E. Busse. (*Fernsehen u. Tonfilm*, No. 2, Vol. 3, 1932, pp. 78–87.)

A theoretical investigation. The quantitative results show that a lens disc transmitter requires a smaller expenditure of light energy than a perforated disc of equal size. This applies to light-ray scanning and film transmission, but not to daylight or stage transmission. In reception, the lens disc is superior both for projection and for virtual images.

NEW SCANNING METHOD [SUBDIVISION INTO SQUARES, CORRESPONDING ELEMENTS BEING SCANNED IN SUCCESSIVE SQUARES].—Toulon. (*Electronics*, June, 1932, p. 204.)

Modification of the method dealt with in June Abstracts, p. 352.

DIE LICHTTECHNISCHE GRUNDGLEICHUNG FÜR FERNSEHAPPARATE (The Fundamental Optical Equation for Television Apparatus).—R. Thun. (*Fernsehen u. Tonfilm*, No. 2, Vol. 3, 1932, pp. 106–108.)

DAS ELEKTRISCHE VERHALTEN VON GRENZSCHICHTEN (The Electrical Behaviour of Boundary Layers).—H. Teichmann. (*Ann. der Physik*, 1932, Series 5, Vol. 13, No. 6, pp. 649–680.)

Author's abstract:—"The possible electron transitions between metal, semi-conductor and insulator are reviewed. A short account is given of the results of experiments on attenuating layers and their theoretical explanation; this summarises our present knowledge of the construction of attenuating boundary layers. A working hypothesis is then proposed which gives a close connection between the structure of attenuating layers and the crystalline structure of the materials composing them. The attenuating layer is compared to a system of craters. The concept of the electrical 'field crater' is introduced as an analogy.

"This new working hypothesis shows that the attenuating layer photoelectric effect may be expected to show selectivity as regards the polarisation of the light exciting it. The selective external photoelectric effect is explained by the assumption that an attenuating layer forms between a semi-conducting foundation and a thin superposed metallic layer.

"Experiments are described which confirm the expected relations and which show in particular, with a fresh selenium-potassium layer, a maximum gain from the external photoelectric effect at the place where the selenium attenuating layer photoelectric effect has a maximum. It is shown that Fowler's theory of the selective photoelectric effect contains an implicit explanation of the attenuating layer phenomena founded on wave-mechanics, which is in good agreement with the hypothesis of field 'craters' here developed." A comprehensive list of literature references is appended.

PHOTOZELLE UND LICHTELEMENT (Photoelectric Cell and Light Element [Attenuating Layer Photoelectric Cell]).—F. v. Körösy and P. Selényi. (*Ann. der Physik*, 1932, Series 5, Vol. 13, No. 6, pp. 703–724.)

The authors use the expression "light element" [Lichtelement] to denote "a photoelectric arrangement of the type of the known copper-cuprous oxide photoelectric cells which, under the influence of an incident radiation, gives rise to an e.m.f. or, in a closed external circuit, an electric current."

Authors' summary :—"The following phenomena are assumed to take place in attenuating layer photoelectric cells : (*a*) a primary photoelectric current I_0 arises in the direction semi-conductor → metal, which is proportional to the intensity of the incident light when there is no retarding voltage at the attenuating layer ; (*b*) the maximum voltage V_0 attainable at the attenuating layer is given by Einstein's relation ; (*c*) the photoelectric current is weakened by any retarding voltage V which may be present by an amount given by the function $I(V)$; if V_0 becomes equal to V, the current ceases to flow ; (*d*) the photoelectric current flows from the metal partly through the external resistance w and the path resistance r of the cell itself, partly through the attenuating layer in its pass direction back to the semi-conductor ; (*e*) the external current i and the back current I' through the attenuating layer are in the inverse ratio of the external and the pass resistance ; they give rise to the retarding voltage drop V.

The procedure may be expressed by the equation $I(V) = \dfrac{V}{r + w} + I'(V)$ where $I'(V)$ is the pass characteristic of the attenuating layer.

The equivalent circuit diagram of an attenuating layer photoelectric cell is given ; experiments on a model set up according to the diagram show the analogy between model and photocell to be complete.

An experimental method of determining the characteristic of the attenuating layer is given. It follows from the above equation and was proved by experiments on selenium attenuating layer cells (*a*) that the short circuit current of the cells does not increase linearly with the intensity of the light but tends to a limiting value as the illumination increases ; (*b*) that the open circuit voltage of the cells tends to the value V_0 as the illumination increases, so that the intensity of illumination/open circuit voltage curves for a series of decreasing wavelengths lie above one another ; (*c*) that the external resistance with which the cells give the maximum external efficiency decreases continually as the illumination increases.

It is found that the conductivity of the attenuating layer increases during illumination and that discrepancies between calculation and experiment may possibly be traced to this cause. The energy balance of the selenium cell is discussed.

STRUKTURUNTERSUCHUNG DES KUPFEROXYDUL-GLEICHRICHTERS : EIN BEITRAG ZUM KRISTALL- UND SPERRSCHICHT-PHOTOEFFEKT (Structural Investigation of the Copper Oxide Rectifier : Contribution to the Crystal and Attenuating Layer Photoelectric Effect).—K. Scharf and O. Weinbaum. (*Physik. Zeitschr.*, 15th April, 1932, Vol. 33, No. 8, pp. 336–341.)

This paper describes a metallographic investigation of a Cu_2O rectifier plate. Starting from the copper surface of the plate, the various layers were removed by etching and the cross-section examined microscopically. Photographs are given of the surface at various stages of the etching. An X-ray examination was also made. The different direction of the photoelectric current in the posterior and anterior wall cells is shown to be due to their different crystalline structure.

SPERRSCHICHT BEIM BLEISULFID (The Attenuating Layer in Lead Sulphide).—F. Heineck. (*Naturwiss.*, 20th May, 1932, Vol. 20, No. 21, p. 365.)

This preliminary note describes experiments on the action of lead sulphide as a detector under various conditions ; the conclusion is reached that the attenuating layer acts as an insulator.

THE CONSTANCY OF ACTION OF THE COMMERCIAL STOP-LAYER PHOTOELECTRIC CELL.—Schwarz. (*See* Section IIg of abstract under "Measurements and Standards.")

LICHTELEKTRISCHE ZELLEN MIT DÜNNSCHICHTIGEN ALKALIKATHODEN (Photoelectric Cells with Cathodes of Thin Layers of Alkali Metals).—R. Sewig. (*Zeitschr. f. Phys.*, 1932, Vol. 76, No. 1/2, pp. 91–105.)

Author's abstract :—The paper describes technical improvements in the manufacture of photoelectric cells with monatomic layers of alkali metals. The method given by Asao and Suzuki (1931 Abstracts, pp. 390–391 : "diffusion cathodes," with intermediate layers of silver and gold) for increasing the sensitivity of photoelectric cells is studied, using a large number of heavy metals. Discussion of results leads to the conclusion that the effective action of the diffusion cathodes is based on an increase of optical absorption rather than in a decrease of the work function.

MODERNE ALKALIFOTOZELLEN (Modern Alkali Photoelectric Cells).—W. Kluge: AEG. (*Fernsehen u. Tonfilm*, No. 1, Vol. 3, 1932, pp. 41–49.)

THE "PATINA" PHOTOELECTRIC CELL.—F. Noack: Lorenz Company. (*Fernsehen u. Tonfilm*, No. 2, Vol. 3, 1932, pp. 118–119.)

On the new cell referred to by Hatschek under "Acoustics and Audio-frequencies": the method of connection is shown. The alkali metal film is similar to that in other cells: its surface is about 15 cm^2. Internal resistance is about 0.5–1 megohm; polarising voltage about 190 v.

CHARACTERISTICS OF THE WESTON PHOTRONIC CELL.—(*Electronics*, May, 1932, p. 168.)

LICHTELEKTRISCHE ZELLEN UND IHRE ANWENDUNG (Photoelectric Cells and Their Use).—H. Simon and R. Suhrmann. (Notice of a book, *Physik. Ber.*, 1st May, 1932, Vol. 13, No. 9, p. 911.)

AN AMPLIFIER (LOFTIN-WHITE CIRCUIT) FOR USE WITH PHOTOELECTRIC CELLS.—Bressi. (*See* abstract under "Subsidiary Apparatus and Materials.")

AUTOMATIC MEAN AMPLITUDE CONTROL IN L.F. AMPLIFIERS: CORRECTION.—Krawinkel and Perchermeier. (*Fernsehen u. Tonfilm*, No. 1, Vol. 3, 1932, p. 53.)

Correction to an equation in the paper referred to in Jan. Abstracts, p. 47.

PIEZOELECTRIC-PHOTOELECTRIC AMPLIFIER FOR ELECTRIC CURRENT VARIATIONS.—A. Thomas. (American Pat. 1 760 383, pub. May, 1930: summary in *Fernsehen u. Tonbild*, No. 2, Vol. 3, 1932, p. 122.)

Designed primarily for the amplification of microphonic currents, for sound-film purposes, this device is applicable also to photoelectric currents. The piezoelectric crystal (preferably Rochelle salt) carries a small mirror reflecting a light ray on to and off a photo-sensitive cell.

NEW METHOD FOR THE STUDY OF THE PHOTOELECTRIC EFFECT OF ALKALI VAPOURS.—J. Kunz. (*Phys. Review*, 1st March, 1932, Series 2, Vol. 39, No. 5, pp. 866–867.) Abstract only.

THE PHOTOELECTRIC AND THERMIONIC PROPERTIES OF PALLADIUM.—W. W. Roehr and L. A. Du Bridge. (*Phys. Review*, 1st March. 1932, Series 2, Vol. 39, No. 5, p. 866.) Abstract only.

THE PHOTOELECTRIC PROPERTIES OF FILMS OF BERYLLIUM, ALUMINIUM, MAGNESIUM AND THALLIUM.—H. de Laszlo. (*Phil. Mag.*, June, 1932, Series 7, Vol. 13, No. 88, pp. 1171–1178.)

Author's abstract:—Opaque films formed by the evaporation of the above metals in high vacuum on to a previously degassed surface were examined with respect to their photoelectric properties in monochromatic light. Measurements were made between λ 5 000 and 2 400 Å, and the photoelectric response in coulombs per erg as well as in electrons per quantum was plotted against the wavelength. Magnesium was found to be a suitable surface to use in the construction of photoelectric cells for measurement in the ultra-violet.

PHOTOELECTRIC EMISSION FROM CADMIUM AND MERCURY.—D. Roller and H. Zenov. (*Phys. Review*, 1st March, 1932, Series 2, Vol. 39, No. 5, p. 866.) Abstract only.

INFLUENCE DE LA LUMIÈRE DIFFUSÉ SUR LES MÉSURES PHOTO-ÉLECTRIQUES (The Effect of the Diffused Light on Photoelectric Measurements).—T. D. Gheorghiu. (*Comptes Rendus*, 23rd May, 1932, Vol. 194, pp. 1810–1813.)

A FURTHER EXPERIMENTAL TEST OF FOWLER'S THEORY OF PHOTOELECTRIC EMISSION.—L. A. Du Bridge. (*Phys. Review*, 1st March, 1932, Series 2, Vol. 39, No. 5, p. 866.) Abstract only.

ADDITIONAL EXPERIMENTAL VERIFICATION OF FOWLER'S PHOTOELECTRIC THEORY.—G. B. Welch. (*Phys. Review*, 1st May, 1932, Vol. 40, No. 3, pp. 470–471.)

New treatment of data previously published by the writer (1929 Abstracts, p. 159) gives excellent confirmation of Fowler's theory (*cf.* 1931 Abstracts, p. 622) and indicates a slight increase of the work function with time in the case of all metals except germanium.

ELECTRONS AND LIGHT QUANTA.—Fleming. (*See* under "General Physical Articles.")

LICHTABSORPTION UND SELEKTIVER PHOTOEFFEKT (Absorption of Light and the Selective Photoelectric Effect).—H. Fröhlich. (*Zeitschr. f. Phys.*, 1932, Vol. 75, No. 7/8, pp. 539–543.)

PHOTOELECTRIC ABSORPTION IN HYDROGEN-LIKE ATOMS.—P. A. M. Dirac and J. W. Harding. (*Proc. Camb. Phil. Soc.*, April, 1932, Vol. 28, No. 2, pp. 209–218.)

PHOTOVOLTAIC PROPERTIES OF CADMIUM SULPHIDE.—R. Audubert and C. Stora. (*Comptes Rendus*, 29th March, 1932, Vol. 194, pp. 1124–1126.)

"To sum up, the sulphide of cadmium . . . presents a photovoltaic effect due without doubt to the same photolytic process invoked for the photosensitive substances already studied (CuO, Cu_2O, CuI, Ag_2S, AgI and Hg_2I_2). If any photo-electronic phenomena—always possible—intervene, they can only play a secondary part."

A NEW METHOD OF MEASURING X-RAY INTENSITIES EMPLOYING AN ELECTRONIC PHOTOCELL.—P. R. Gleason. (*Phys. Review*, 1st April 1932, Series 2, Vol. 40, No. 1, p. 134.)

THE COMPOUND PHOTOELECTRIC EFFECT OF X-RAYS IN LIGHT ELEMENTS.—G. L. Locher. (*Phys. Review*, 15th May, 1932, Series 2, Vol. 40, No. 4, pp. 484–495.)

DER RÖNTGENSTRAHLEN-FERNSEHER (The X-Ray Televisor).—F. Levy-Michel. (Summary in *Fernsehen u. Tonfilm*, No. 1, Vol. 3, 1932, pp. 49–50.)

MEASUREMENTS [OF INFRA-RED RADIATION] WITH THE PHOTOELECTRIC RELAY.—Barnes and Matossi. (*See* under "Measurements and Standards.")

VARIATION AVEC L'ÉPAISSEUR DES EFFETS MAGNÉTO-OPTIQUES PAR TRANSMISSION DES COUCHES MINCES DE FER (The Variation with Thickness of the Magneto-Optical [Kerr] Transmission Effects of Thin Films of Iron).—M. Cau. (*Comptes Rendus*, 9th May, 1932, Vol. 194, pp. 1642–1644.) *See* also next reference.

THE RÔLE OF MULTIPLE REFLECTIONS IN THE MAGNETO-OPTICAL KERR EFFECTS OF THIN IRON FILMS.—M. Cau. (*Comptes Rendus*, 23rd May, 1932, Vol. 194, pp. 1807–1809.)

Further development of the work referred to in 1929 Abstracts, p. 395.

MÉTHODE STROBOSCOPIQUE POUR LA MÉSURE DES BIRÉFRINGENCES ÉLECTRIQUES (A Stroboscopic Method of Measuring Electrical Double Refraction).—R. Lucas and M. Schwob. (*Comptes Rendus*, 17th May, 1932, Vol. 194, pp. 1729–1731.)

Combining the advantages of various previous methods (including the use of a.c. potentials) without their defects.

SUR LE RÔLE JOUÉ PAR LA NATURE DES ÉLECTRODES DANS LA CONDUCTIBILITÉ DES LIQUIDES SEMI-CONDUCTEURS (The Rôle played by the Nature of the Electrodes in the Conductivity of Semi-Conducting Liquids [Nitrobenzene]).—J. Sambussy. (*Comptes Rendus*, 17th May, 1932, Vol. 194, pp. 1724–1725.)

BEITRÄGE ZUR PHYSIK DER NITROBENZOLKERRZELLE. V. BESTIMMUNG DER ELEKTROOPTISCHEN KERRKONSTANTE DES NITROBENZOLS: $\lambda = 5\,461$ ÅE (Contributions to the Physics of the Nitrobenzol Kerr Cell. V. Determination of the Electro-Optical Kerr Constant of Nitrobenzol: $\lambda = 5\,461$ Å).—F. Hehlgans. (*Physik. Zeitschr.*, 1st May, 1932, Vol. 33, No. 9, pp. 378–382.)

Continuation of the researches dealt with in January, February and April Abstracts, pp. 47, 103 and 234 (two). The value of the Kerr constant obtained was 3.86×10^{-6} electrostatic c.g.s. units; the probable error was $\pm$ 0.9 %.

EXPERIMENTAL INVESTIGATIONS OF THE CURRENT CONDUCTION IN DIELECTRIC FLUIDS AT HIGH FIELDS.—Nikuradse. (*See* under "General Physical Articles.")

MEASUREMENTS AND STANDARDS.

STROMMESSUNG BEI SEHR HOHEN FREQUENZEN (The Measurement of Ultra-High-Frequency Currents).—H. Schwarz. (*Hochf:tech. u. Elek:akus.*, May, 1932, Vol. 39, pp. 160–171.)

A survey and criticism of numerous existing methods and a description of several new methods developed by the writer. Section I.1 deals with the difficulties in comparing two ammeters at these frequencies: bridge methods (Fortescue and Moxon—Abstracts, 1931, p. 334—and the Wien baretter-bridge, 1931, p. 48) are not satisfactory beyond a certain frequency, since the dimensions of the bridge circuit cannot be reduced indefinitely. The writer therefore employs in his tests a series connection of the meters to be compared, in a resonance circuit (Fig. 2) of very rigid special design. The meters are all un-cased, one important source of error—eddy current losses and parasitic capacities—being thus avoided. Section I.2 shows the generator and test circuits: for frequencies of 7×10^7 c/s the available energy is 1.2 kw, but the range extends to 2×10^8 c/s.

Section I.3 discusses the skin effect in thin resistance wires. The two Rayleigh formulae (I and II) and the two Stefan formulae (III and IV) are given. "It is sometimes stated that I and III should be used for low frequencies, II and IV for high: this is not the whole truth, it is better to say that I and III apply to *small* skin effects $\left(\frac{R'}{R} \leqq 1.35\right)$ and II and IV to *large* skin effects $\left(\frac{R'}{R} \geqq 1.35\right)$, since these effects depend not only on the frequency but also on the conductivity of the material." For practical purposes, Zenneck's curves are recommended (*Ann. der Physik*, 1903). The constantan wires included in the writer's resonance circuit (serving as heaters for two thermo-elements) were tested as to resistance variation with frequency by a relative and by an absolute method. *Fig. 4 shows how satisfactorily the combination of formulae I and IV (used as specified above) represent the measured results at these ultra-high frequencies.*

Section II deals successively with the various methods of current measurement, beginning with thermal methods; (a) hot-wire instruments: that of Fortescue and Moxon (Abstracts, 1930, p. 461: also 1931, p. 47) is referred to as accurate up to 10^8 c/s provided the frequency is known, but as having the disadvantage of large size—"such an instrument [data of a specimen quoted by the inventors] is bigger than a whole resonance circuit for 10^8 c/s." Another objection to hot-wire instruments, for frequencies over 3×10^7 c/s, is that the total resistance cannot help being so large as to cause an inconveniently high loss in an r.f. circuit: for the wire is bound to have considerable resistance per unit length owing to skin effect, and yet cannot, for mechanical reasons, be made too short.

(b) The vibrating thread ammeter (Schlesinger, 1931, p. 47) is claimed by the inventor to have the advantage of high sensitivity for small power consumption—10^{-5} w for a wire resistance of 1.35 ohm. The present writer detracts from this claim by saying that the simple hot-wire air thermometer can give an equal sensitivity: "moreover, Schlesinger's instrument is very dependent on frequency owing to its low resistance; although this effect can be calculated, it is a complex business since the resistance variation with temperature has also to be taken into account." Large size is also cited as an objection. (c) The bolometer bridge as described by Hund. The present writer, using a tungsten wire free from skin effect, carried out measurements up to 10^8 c/s with a maximum error (compared with a thermo-element method) of 1.5 %: "but very great care is necessary in the construction" and the method is dismissed as unsuitable for practical purposes on account of bulk and the complex adjustment of the very essentially efficient r.f. choking coils protecting the bolometer.

(d) Thermo-junctions. The work of Schäfer and of Brandes and others was chiefly directed towards developing sensitivity. The writer describes researches of his own to determine the suitability of the thermo-junction method for ultra-high-frequency measurement. A comparison between Figs. 6 and 7 shows how he prevents the entrance of r.f. into the junction–galvanometer circuit: the junction wires are arranged close together, almost parallel, and chokes are introduced. By this means he has successfully measured up to frequencies of 2×10^8 c/s. Up to 1.2×10^8 c/s, comparative measurements using Rohde's peak-voltmeter (1931, p. 393: *see* also Section 4, below) showed agreement throughout within 1.5%. A special advantage of thermo-junction devices is their small size: the heater wire need not exceed 6—8 mm in length; resistance (in spite of the necessity for freedom from skin effect) need not be more than 3—4 ohms. The maximum current for the thermo-element described is 300 mA.; for larger currents, 20 constantan wires were arranged round a cylinder (Fig. 8), one only being used as the heater.

(e) Duddell galvanometer: this is considered to be limited to frequencies below 3×10^7 c/s, owing to induced eddy currents causing errors. In any case it is only suitable for laboratory measurements of small currents.

(f) Hot-wire air thermometer, as improved by de los Monteros in 1908: sensitivity 10^{-5} w, but affected by external influences: this defect is largely overcome in Scheibe's design, with a sensitivity of 4×10^{-5} w. In spite of some inconveniences, this is probably the best existing method for small r.f. currents in the laboratory. Scheibe measured small currents up to 5×10^8 c/s within 2%. (g) The Photoammeter: the writer combines in one evacuated container a tungsten heater, free from skin effect, and a modern stop-layer photoelectric cell connected direct (without polarising voltage) to a galvanometer. Investigations showed that the photocell was subject to no variation with time for loads up to 3×10^{-5} A; the slight temperature variations in the room and the increase in temperature due to the source of light also were without effect; only an artificial rise of 40° produced an error of 1%. Comparative measurements show that the photoammeter will measure up to frequencies of 1.2×10^8 c/s within 0.8% (the limit of readability of the thermoammeter used for the comparison). "The only disadvantage of the method is the comparatively large energy consumption in the heater wire—about 0.1 w for a current of 150 mA. For this reason the method is only suitable for currents under 1 A."

Section II.2 deals with the writer's work on the use of a current transformer for ultra-high frequencies, to allow currents over 1 A to be measured by (*e.g.*) a thermo-element as described earlier. The objections to the "straight wire and concentric ring" type of current transformer are discussed: the form used by the writer is that of a square secondary with the primary (*e.g.* part of a dipole aerial) parallel with one of its sides, and the thermo-junction heater inserted in the middle of the opposite side. This arrangement is examined at length on pp. 166–167. A special advantage is its small energy consumption—for the arrangement described it is only 0.1 w. The writer considers this to be the best solution of the problem of measuring ultra-high-frequency currents up to high values of current.

Section 3 deals with dynamometer instruments: the Moullin ammeter (1930, p. 461) is stated to give errors of 4% and 16% for 10- and 5-metre waves respectively, owing to capacity and dielectric loss effects; moreover, although its size can be reduced so as to be more suitable for ultra-high-frequency circuits, such reduction would diminish the sensitivity. The type described in the paper quoted can be used for strong currents up to 2×10^7 c/s in frequency. The writer then describes his short-circuited ring ammeter on the repulsion principle (Fig. 15) which, though possessing its own advantages, is only suitable for laboratory purposes and has a useful scale of only 70°. Section 4 deals with the indirect measurement of current by potential measurement across a condenser: the Pungs and Vogler Kerr-cell method (1931, p. 567) can hardly be serviceable beyond 10^7 c/s because of the large capacity of the Kerr cell, while Kirchner's cathode-ray method—for the same kind of reason—is reliable only up to 3×10^7 c/s. Rohde's peak voltmeter, already referred to, is available up to 1.5×10^8 c/s with a 1% error, but such indirect methods of current measurement are only suited to the laboratory.

Part III describes the writer's researches on the permeability of iron for frequencies between 2.5×10^7 and 2×10^8 c/s, in which he used the iron as a heater for a thermo-junction. His results agree with those of Strutt and of Michels, and with the view of Wien as to the course of the permeability at ultra-high frequencies. A variation of permeability with frequency, in the range considered, could not be found: increase of current load produced an increase of permeability.

A METHOD FOR MEASURING SMALL CAPACITIES [VIBRATING CONTACTS DEVICE, SECOND METHOD].—J. A. Van den Akker. (*Review Scient. Instr.*, May, 1932, Vol. 3, pp. 224–229.)

A new version of the method dealt with in 1931 Abstracts, p. 448, more convenient for capacity measurement than the earlier method.

A NEW THERMIONIC VOLTMETER [FOR PEAK POTENTIALS 200–2 000 VOLTS UP TO VERY HIGH FREQUENCIES].—J. Thomson. (*Journ. Scient. Instr.*, June, 1932, Vol. 9, pp. 186–191.)

Author's abstract:—"The paper describes a thermionic voltmeter the action of which depends upon the emission of secondary electrons from the anode of a new type of valve [cylindrical tube 14 cm × 3 cm diam., with fine-wire platinum filaments at each end, and mid-way disc anode and pierced-disc grids 1 cm from each filament]. The capacity of the instrument and its power factor are exceedingly small [$C < 0.07\,\mu\mu F$], so that it is very suitable for the measurement of high potentials at high frequencies. The voltmeter has a straight line calibration within the limits investigated by the writer, the gradient of the line being independent of the frequency of the alternating potential. The intercepts of the line on the axes are, however, linear functions of the frequency. The readings of the instrument depend upon the wave-form of the potential. It may thus be used to compare the 'peak factors' in an oscillatory circuit at different times." The highest frequency mentioned in the writer's tests was 4.13 megacycles/sec. "It should be possible to construct a similar tube to perform any desired measurement at any frequency."

COMPARING OSCILLATORY PEAK FACTORS BY A SPECIAL THERMIONIC VOLTMETER.—Thomson. (*See* above abstract.)

A VALVE VOLTMETER METHOD OF HARMONIC ANALYSIS.—Greenwood. (*See* under "Acoustics and Audio-frequencies.")

IMPROVED RADIO-FREQUENCY MEASUREMENTS [INCLUDING OSCILLATOR WITH OUTPUT TRANSFORMER HAVING SPECIAL MATERIAL FOR CORE, GIVING CONSTANT OUTPUT FROM 100 TO 1 500 KC/SEC.].—Wigand: Siemens Company. (*Funk, Berlin*, 8th April, 1932: summary in *Electronics*, June, 1932, p. 205.)

AN INSTRUMENT FOR MEASURING THE RESISTANCES OF EARTHS.—L. Triau: Siemens & Halske. (*Génie Civil*, 14th May, 1932, Vol. 100, p. 504.)

The telephone bridge method fails when (as often happens) the auxiliary earths are of much higher resistance than the earth under test. The special circuit (with magneto generator) here described avoids this difficulty.

MISURA DELLE TENSIONI ELETTRICHE ALTERNATIVE MEDIANTE RADDRIZZATORI A SECCO (The Measurement of A.C. Potentials by means of Dry-Plate Rectifiers).—B. Focaccia. (*L'Elettrotec.*, 15th May, 1932, Vol. 19, No. 14, pp. 361–370.)

Part I deals with the measurement of small potentials of industrial or low acoustic frequencies, the author's method being independent of wave-form and of frequency. A bridge circuit is used, containing a rectifier in each arm and a galvanometer and adjustable series resistance in the diagonal. Part II discusses a similar method for high potentials.

ÜBER DIE FREQUENZENTZERRUNG VON MESSGERÄTEN MIT TROCKENGLEICHRICHTERN (Frequency Correction in Meters with Dry-Plate Rectifiers).—H. Kaden. (*E.N.T.*, May, 1932, Vol. 9, pp. 175–181.)

For the writer's previous work on these meters, *see* Jan. and July Abstracts, pp. 41 and 416. It is here shown that by correct proportioning of the input transformer and auxiliary components, the instruments can be made practically independent of frequency. Special treatment is necessary for instruments with preliminary amplification.

PRINCIPLES OF A NEW PORTABLE ELECTROMETER.—R. Gunn. (*Phys. Review*, 15th April, 1932, Series 2, Vol. 40, No. 2, pp. 307–312.)

INTERNATIONALE FREQUENZMESSUNGEN. ERZEUGUNG VON NORMALFREQUENZEN MITTELS PIEZOELEKTRISCHEN OSZILLATORS (International Frequency Measurements. The Production of Standard Frequencies by means of Piezoelectric Oscillators).—A. Scheibe and U. Adelsberger. (Summary in *Hochf:tech. u. Elek:akus.*, April, 1932, Vol. 39, pp. 145–146.)

WIDE WAVE BAND PRECISION WAVEMETER (10–300 Metres, with Neon Tube Oscillator for Reception Measurements).—Soc. Franç. Rad. élec. (*Bull. S.F.R.*, Dec., 1931, Vol. 5, pp. 192–197.)

ÜBER EINE FEHLERQUELLE BEI DER KAPILLARWELLENMETHODE DER FREQUENZMESSUNG (A Source of Error in the Capillary-Wave Method of Measuring Frequency).—M. Katalinić: Schultze. (*Zeitschr. f. tech. Phys.*, No. 5, 1932, Vol. 13, pp. 239–241.)

Further development of the work referred to in 1931 Abstracts, p. 570.

EXAMINATION, BY IMMERSION, OF LARGE QUARTZ CRYSTALS [DETECTION OF FAULTS, DETERMINATION OF ROTATORY POWER, ETC.].—A. Arnulf. (*Rev. d'Optique*, Nov., 1931, Vol. 10, pp. 453–473.)

A PRELIMINARY REPORT ON THE ANOMALOUS VARIATION OF THE ELECTRICAL CONDUCTIVITY OF QUARTZ WITH TEMPERATURE.—S. Shimizu. (*Phil. Mag.*, May, 1932, Series 7, Vol. 13, No. 87, pp. 907–934.)

ELEKTRISCHE LEITFÄHIGKEIT VON BELASTETEN PIEZOQUARZEN (Electrical Conductivity of Loaded Piezo-Quartz Crystals).—F. Seidl. (*Zeitschr. f. Phys.*, 1932, Vol. 75, No. 7/8, pp. 488–503.)

LA TEMPÉRATURE D'UN CRISTAL PIÉZO-ÉLECTRIQUE FONCTION DE SON RÉGIME VIBRATOIRE (The Temperature of a Piezoelectric Crystal as a Function of Its Oscillatory Régime).—A. de Gramont and D. Beretzki. (*Comptes Rendus*, 23rd May, 1932, Vol. 194, pp. 1777–1778.)

The temperature of one electrode is measured by a thermo-couple. The temperature rise depends on the h.f. potential, which determines the amplitude of vibration: it sometimes exceeds 140°. The variation in temperature naturally affects the frequency. If a crystal is liable to vibrate at two different frequencies, these can be distinguished by the temperatures which are characteristic of the two régimes. The writers stress the inadequacy of keeping the oscillator in a thermostatically controlled chamber: temperature variations of the surrounding air are very small compared with those due to the different modes of vibration. Thus the indications of the microammeter connected to the thermo-couple are invaluable for the regulation of the amplitude and frequency. They also point out the advantages of surrounding the crystal by a vacuum.

LOW FREQUENCY VIBRATIONS IN ROCHELLE SALT AND QUARTZ PLATES.—W. G. Cady. (*Phys. Review*, 1st March, 1932, Series 2, Vol. 39, No. 5, p. 862.)

Abstract only of a paper on observations of frequency of Rochelle salt and quartz resonators with flexural vibrations in planes perpendicular to all three axes and with torsional vibrations about the X-axis. "A quartz flexural vibrator 9.3 cm long has been made to serve as a master oscillator at only 3 000 c/s."

MULTIPLES AND SUB-MULTIPLES OF TEN [GERMAN PROPOSALS].—(*Wireless Engineer*, May, 1932, Vol. 9, No. 104, p. 252.)

COMMUNICATION OF STANDARD TIME SIGNALS [U.S.A. NAVAL OBSERVATORY].—M. M. Dupré. (*Commercial Stds. Mthly.*, May, 1932, Vol. 8, No. 11, pp. 326–328.)

PHOTOELECTRICALLY-CONTROLLED TIME SIGNALS AT BANDOENG.—W. F. Einthoven: Vening Meinesz. (*Tijdschr. Nederland. Radiogenoot.*, March, 1932, Vol. 5, No. 4, pp. 127–129.)

A NEW TILTED ELECTROMETER [QUARTZ FIBRE "LEAF" IN HYDROGEN].—H. Carmichael. (*Proc. Physical Soc.*, 1st May, 1932, Vol. 44, Part 3, No. 243, pp. 400–407.)

THE NATURAL FREQUENCIES OF SINGLE-LAYER SOLENOIDS: DETERMINATION BY TAKING ELEMENTARY SECTIONS AND APPLYING A SYSTEM OF ELLIPTICAL CO-ORDINATES.—H. Zuhrt. (*V.D.E. Fachber.*, 1931, pp. 36–39.)

THE INDUCTANCE OF LINEAR CONDUCTORS OF RECTANGULAR SECTION.—A. H. M. Arnold. (*Journ. I.E.E.*, May, 1932, Vol. 70, No. 425, pp. 579–586.)

CALCULATION OF REACTANCE COILS WITH OPEN IRON CORES.—Buchholz. (*See* under "Subsidiary Apparatus and Materials.")

MESSUNGEN MIT DEM PHOTOELEKTRISCHEN RELAIS (Measurements [of Infra-Red Radiation] with the Photoelectric Relay).—R. B. Barnes and F. Matossi. (*Zeitschr. f. Phys.*, 1932, Vol. 76, No. 1/2, pp. 24–37.)

A NEW WATTMETER [FOR A.C. AND D.C.] BASED ON THE PRINCIPLE OF THE HALL EFFECT.—S. Fukuda. (*Journ. I.E.E. Japan*, April, 1932, Vol. 52 [No. 4], No. 525. English summary pp. 60–61.)

THE EFFECT OF PRESSURE UPON THE E.M.F. OF THE WESTON STANDARD CELL.—T. C. Poulter and C. Ritchey. (*Phys. Review*, 1st March, 1932, Series 2, Vol. 39, No. 5, pp. 816–820.)

Authors' abstract:—Several specially designed Weston Standard Cells have been constructed and subjected to large hydrostatic pressures. The cell cases were made of glass, beeswax, or rubber, and the e.m.f. measured at pressures from 1 to 12 000 atmospheres. Such pressures have the effect of increasing the e.m.f. only by a small per cent.

ÜBER ABSORPTIONSMESSUNGEN IN REINEN FLÜSSIGKEITEN UND ELEKTROLYTLÖSUNGEN IN GEBIET KURZER ELEKTRISCHER WELLEN NACH EINER NEUEN METHODE (On Absorption Measurements in Pure Liquids and Electrolyte Solutions in the Region of Short Electric Waves, by a New Method).—J. Malsch. (*Ann. der Physik*, 1932, Series 5, Vol. 12, No. 7, pp. 865–888.)

The method used in the measurements described in this paper was the direct, absolute thermometric measurement of the quantity of heat absorbed by the fluid from short electric waves of length 76, 48, and 28 metres. The results showed good agreement both with Debye's dipole theory and with the theory of electrolytic solutions.

DIE DIELEKTRIZITÄTSKONSTANTEN EINER ANZAHL OXYDE (The Dielectric Constants of a Number of Oxides [in particular Al_2O_3]).—A. Güntherschulze and F. Keller. (*Zeitschr. f. Phys.*, 1932, Vol. 75, No. 1/2, pp. 78–83.)

MESSUNG DER DIELEKTRIZITÄTSKONSTANTEN VON SALZEN (Measurement of the Dielectric Constants of Salts).—P. Schupp. (*Zeitschr. f. Phys.*, 1932, Vol. 75, No. 1/2, pp. 84–104.)

REPORT OF THE WORK AND RESEARCHES OF THE FRENCH NATIONAL LABORATORY OF RADIO-ELECTRICITY DURING 1931.—C. Gutton. (*Ann. des P.T.T.*, Jan., 1932, Vol. 11, pp. 78–80: summary in *Rev. Gén. de l'Élec.*, 30th April, 1932, Vol. 31, pp. 594–596.)

DEVELOPMENTS IN THE TESTING OF RADIO RECEIVERS.—Thomas. (*See* under "Reception.")

SUBSIDIARY APPARATUS AND MATERIALS.

SUR UN RADIOMÈTRE SENSIBLE AUX ONDES DE HERTZ (A Radiometer Sensitive to Hertzian Waves [and Useful in Exploring Electromagnetic Fields]).—G. A. Beauvais. (*Comptes Rendus*, 30th May, 1932, Vol. 194, pp. 1904–1906.)

In setting out to repeat Mlle. Husson's pressure of radiation experiments on 18-cm waves (1930 Abstracts, p. 502) the writer encountered difficulties due to the heating of the conductors, which gave rise to radiometric forces capable of masking completely the electromagnetic action sought. This has led him to construct a radiometer in which the conducting part consists simply of a strip of aluminium foil 8.5 cm long and a few mm wide, forming a half-wave resonator for the 18-cm waves. This strip is stretched by a quartz fibre bent into an arc of which the strip forms the chord: a very thin screen of mica, of the same size as the aluminium strip, is attached to the arc. The system is suspended *in vacuo* by a fine quartz fibre so that it can turn round a vertical axis not passing through the resonator; a small mirror is provided.

Used for exploring the electromagnetic field and determining the direction of the electric force, this device has the advantage, over a thermo-couple–galvanometer combination, that it does not modify the state of polarisation of the field or introduce (by the galvanometer leads) disturbances in its intensity. At a distance of 1 metre from a Pierret oscillator the spot deflection on a scale 1 metre away was 8 cm —corresponding to a sensitivity 50 to 100 times as great as that due to the electromagnetic effect. On the same principle a radiometer can be designed for waves of several metres' length.

DETERMINING FIELD DISTRIBUTION BY ELECTRONIC METHODS [RECORDING FIELD DIAGRAMS BY EXPLORING IN DISTILLED WATER AND TRANSFERRING POSITION BY PANTOGRAPH].—E. D. McArthur. (*Electronics*, June, 1932, pp. 192–194.)

A 500-cycle supply is used, to reduce the migration of ions in the fluid between the electrodes. The potential of the exploring electrode is measured by a thermionic voltmeter. Equipotentials of about 0.1 v can be located when the total voltage is 30. The equipotential lines in a RCA-57 valve are given as an example of the work of the apparatus.

STUDIO DI UN AMPLIFICATORE PER TENSIONE CONTINUA (Study of an Amplifier for Continuous Potentials).—A. Bressi. (*Alta Frequenza*, March, 1932, Vol. 1, No. 1, pp. 52–67.)

Examination of a two-stage amplifier (Loftin-White circuit) in which the grid and plate tensions of the triodes are supplied by tappings on a common battery. The equivalent parameters are calculated, and the relations between the battery tensions and the working tensions of the triodes are given on the basis of certain definite values of the other elements of the circuit. Some applications of the device for photoelectric cell measurements are described, and other possible applications are discussed.

L'AMPLIFICATEUR À LAMPES D'UNE GRANDE SENSIBILITÉ PERMET D'ÉCLAIRER LES PROBLÈMES DE PHYSIQUE NUCLÉAIRE : TRANSMUTATION, RAYONNEMENTS ULTRAPÉNÉTRANTS ET COSMIQUES (The Very Sensitive Valve Amplifier throws light on the Problems of Nuclear Physics: Transmutation, and the Penetrating and Cosmic Radiations).—L. Leprince Ringuet. (*L'Onde Élec.*, April, 1932, Vol. 11, No. 124, pp. 157–181.)

A NEW CATHODE-RAY OSCILLOGRAPH TUBE [TYPE FP-53, GIVING VISUAL OBSERVATION BY A LARGE GROUP IN FULL DAYLIGHT].—G. F. Metcalf: G. E. C. (*Electronics*, May, 1932, pp. 158–159.)

A hot-cathode high-vacuum tube with electrostatic focusing, giving visual observation of steady state phenomena up to 300 mc/sec. and photographic recording of single transients as high as 500 kc/sec. With an anode voltage of 1 000, a sensitivity of 23 volts per inch may be obtained: with 5 000 volts, about 115 (back pair of plates) and 200 (front pair) per inch.

A CHEAP CATHODE-RAY TUBE FOR 800 VOLTS POTENTIAL, OR 2 000 VOLTS FOR PHOTOGRAPHIC RECORDING.—R. Wigand: G. Budich Company. (*Rad., B., F. f. Alle*, June, 1932, pp. 251–254.)

Selling at 45 Reichsmarks. Deflection about 1 mm/volt, anode current about 50 μA. Fitted with a five-pin valve base.

BILDSPIEGEL UND STRICHBREITE BEIM KATHODENOSZILLOGRAPHEN (Screen Size and Width of Trace in the Cathode Ray Oscillograph).—K. Buss. (*Archiv f. Elektrot.*, 18th May, 1932, Vol. 26, No. 5, pp. 379–380.)

Author's summary:—It is shown that the cathode ray oscillograph fitted with a preconcentrating device can be made to produce a very fine trace even at very high recording velocities; when the height of the record is 4 cm this fine trace permits evaluation with an exactitude of 0.25%.

NEW METHOD FOR THE SIMULTANEOUS RECORDING OF PHENOMENA BY CATHODE RAY OSCILLOGRAPH AND THE DETERMINATION OF THE SCALE OF THE MAGNITUDES RECORDED.—K. Kasai, H. Takagishi and B. Tadano. (Summary in *Rev. Gén. de l'Élec.*, 21st May, 1932, Vol. 31, p. 167 D.)

The movement of the spot on the recording plate depends on (i) the speed of the electrons, (ii) the value of the field traversed, (iii) the constants of the oscillograph and the distance of the plate from the deflecting mechanism. For exact measurements it is necessary that the scale should be determined under identical conditions, which for each case depend on (i) and (ii). The writers therefore use the following procedure: they record on the same plate first a calibrating curve (occupying as small a space as possible) by applying a voltage of known frequency and then a known voltage corresponding to an axis of origin; finally the phenomenon itself is recorded. The original paper describes the arrangements for carrying out this procedure.

DIE SCHWÄRZUNG PHOTOGRAPHISCHER SCHICHTEN BEI NIEDRIGEN ERREGERSPANNUNGEN DES KATHODENOSZILLOGRAPHEN (The Blackening of Photographic Films at Low Excitation Voltages of the Cathode Ray Oscillograph).—H. Schäffer. (*Archiv f. Elektrot.*, 18th May, 1932, Vol. 26, No. 5, pp. 313–314.)

Frequencies of 10^6 to 10^7 c.p.s. may be photographically recorded with a cathode ray oscillograph excitation voltage of 20 kilovolts.

THYRATRON LINEAR TIME AXIS FOR CATHODE-RAY OSCILLOGRAPH.—H. Neustadt: Nottingham. (*Electronics*, June, 1932, pp. 198–199.)

Description of the thyratron-kenotron circuit used by Nottingham in the work dealt with in 1931

Abstracts, p. 500. " In actual practice, using an FG-17 thyratron, a tungsten-filament kenotron (a coated filament is not used because it does not saturate well) and a ½ microfarad condenser, it has been found easy to run the circuit at frequencies up to 1 500 c/s, and possible but difficult to run it up to 4 000."

The upper frequency limit is due to time lags in the thyratron: the effect is illustrated by an oscillogram of 10 000-cycle waves. It is seen that the middle portion gives a very fair picture of the wave; this indicates that by getting a few cycles on the screen and disregarding the end ones, it is possible to study frequencies much higher than 10 000 c/s.

ELEKTRONENOPTIK UND ELEKTRONENMIKROSKOP (Electron Optics and Electron Microscope).—E. Brüche and H. Johannson. (*Naturwiss.*, 20th May, 1932, Vol. 20, No. 21, pp. 353–358.)

This paper gives a general description of the analogies between the optics of electron beams and of light rays and discusses the possibilities of development of electron optical instruments on lines analogous to those of geometrical optics.

PHOSPHORESCENT SULPHIDES: THE INTERVENTION OF COLLISIONS OF THE SECOND TYPE.—M. Curie. (*Comptes Rendus*, 2nd May, 1932, Vol. 194, pp. 1566–1568.)

SHIELDING OF AN ELECTRODE FROM A HIGH POTENTIAL GRADIENT BY MEANS OF A CHARGED DIELECTRIC.—C. M. Slack. (*Phys. Review*, 1st April, 1932, Series 2, Vol. 40, No. 1, p. 132.)

ELECTROLYTIC RESISTORS OF HIGH RESISTANCE.—H. L. White and E. A. Van Atta. (*Review Scient. Instr.*, May, 1932, Vol. 3, 235–238.)

Resistances from 1×10^8 to 3×10^{10} ohms are made by sealing capillary bridges between calomel electrodes made up with dilute KCl-saturated calomel solution; they are constant with age and show no polarisation.

CONDUCTIBILITÉ ÉLECTRIQUE DU PAPIER NOIR. APPLICATIONS (The Electrical Conductivity of Black Paper. Applications [to the Making of High Resistances and the Tracing of Equipotential Lines]).—L. Grillet. (*Comptes Rendus*, 25th April, 1932, Vol. 194, pp. 1464–1465.)

The paper used by the writer is such that a strip 120 mm long by 50 mm wide and 1/10 mm thick gives a stable resistance (for a constant temperature—the resistance decreases as the temperature rises, showing that the conducting particles are most probably carbon) of the order of 100 000 ohms. Resistances, even variable resistances, can be made out of such a strip; or a pile of discs under pressure can be used as a variable resistance. Such a pile, at a voltage of 40 v, gave a current range from 0.1 mA to 0.3 A.

THE ELECTRICAL CONDUCTIVITY OF THE DIFFERENT VARIETIES OF CARBON.—R. Cordebas. (*Rev. Gén. de l'Élec.*, 23rd April, 1932, Vol. 31, pp. 547–556.)

ISOLANTITE CHARACTERISTICS [AT FREQUENCIES FROM 246 TO 1 375 KC/SEC.].—(*Electronics*, May, 1932, p. 168.)

PROPERTIES OF MOULDED PLASKON.—(*Ibid.*, p. 169.)

THE DIELECTRIC PROPERTIES OF VARNISHED CLOTH AT LOW VOLTAGE-GRADIENTS (E.R.A. REPORT).—L. Hartshorn. (*Journ. I.E.E.*, April, 1932, Vol. 70, No. 424, pp. 417–435.)

LOW-THERMAL-EXPANSION CERAMICS.—W. W. Winship. (*Electronics*, March, 1932, p. 94.)

THE DIELECTRIC CONSTANTS OF GLASSES AND THEIR DEPENDENCE ON THE COMPOSITION.—F. Keller. (*Zeitschr. f. tech. Phys.*, No. 5, 1932, Vol. 13, pp. 237–239.)

THE SURVEY OF PROGRESS IN INSULATING MATERIALS.—A. R. Dunton. (*Journ. Scient. Instr.*, June, 1932, Vol. 9, pp. 178–186.)

THE SHOT EFFECT AND ELECTRICAL BREAKDOWN IN INSULATORS.—R. M. Bozorth and F. E. Haworth. (*Phys. Review*, 1st March, 1932, Series 2, Vol. 39, No. 5, pp. 845–847.)

The authors have measured the fluctuations in currents through insulating materials subjected to high electric fields and have formed certain conclusions regarding the nature of electrical breakdown in solids. Most of the noise they have measured seems to be due to a succession of discharges which are very much larger than the average; the carriers in these groups seem to be electrons rather than ions.

DIE VERLUSTKURVE LUFTHALTIGER ISOLIERSTOFFE (The Loss Curve of Air-Containing Insulating Materials).—A. Gemant. (*Zeitschr. f. tech. Phys.*, No. 4, Vol. 13, 1932, pp. 184–189.)

ÜBER DIE DIELEKTRISCHE FESTIGKEIT EINIGER STOFFE (The Dielectric Strength of Certain Substances [CCl_4 and CS_2]).—H. Eisler. (*Ibid.*, pp. 189–191.)

DIELECTRIC LOSSES IN INSULATING MATERIALS.—H. H. Race. (*Phys. Review*, 1st April, 1932, Series 2, Vol. 40, No. 1, p. 124.)

THE DIELECTRIC CONSTANT AND POWER FACTOR OF SOME SOLID DIELECTRICS AT RADIO FREQUENCIES.—W. Anderson. (*Phil. Mag.*, May, 1932, Series 7, Vol. 13, No. 87, pp. 986–993.)

This paper describes an investigation of the variation of dielectric constant and power factor with frequency between 150 kc/s and 1 500 kc/s of mirror glass, unglazed porcelain, ebonite, keramot, paxolin, bakelite, millboard and indiarubber.

DIELECTRIC LOSSES IN ROCKSALT.—P. L. Bayley. (*Phys. Review*, 1st April, 1932, Series 2, Vol. 40, No. 1, p. 120.)

THE DISC LEADING-IN INSULATOR.—H. Brülle. (*E.T.Z.*, 25th Feb., 1932, Vol. 53, pp. 177–178.)

THE BEST SHAPES FOR CONDENSER LEADING-IN INSULATORS.—H. Einhorn. (*E.T.Z.*, 18th Feb., 1932, Vol. 53, pp. 153–155.)

HÖCHSTAUSNUTZUNG VON GLEICHSTROMBELASTETEN EISENKERNDROSSELN (Utilisation to the Fullest Extent of Iron-Cored Chokes carrying Direct Current.).—R. Gürtler. (*Hochf:tech. u. Elek:akus.*, May, 1932, Vol. 39, pp. 171–173.)

Further development of the work dealt with in April Abstracts, p. 236. In many cases, such as chokes used for filtering in rectifier circuits or for smoothing purposes, the most efficient (smallest and cheapest) choke is simply that which gives the required inductance and just enough loss to cause the maximum allowable heating, always assuming that the optimum air-gap and winding have been selected as indicated in the previous paper. The present paper shows that this condition for the best utilisation of a choke is given by a formula (66) representing the maximum permissible value of LI^2 : a table of type data can be constructed and used in conjunction with this formula. The latter part of the paper deals with the different case of iron-cored windings in which the winding resistance and time constant L/R play an important part—*e.g.*, transformers ; equations are derived for the greatest possible time constant (71) and for the least (70—under conditions of maximum permissible heating and optimum dimensioning), and these can be used to decide the choice of the best type.

THE DESIGN OF IRON CORE CHOKES.—M. G. Scroggie (*Wireless World*, 1st June, 1932, Vol. 30, pp. 558–561.)

Graphs and simplified method of calculating are given for the design and construction of iron core chokes.

BERECHNUNG DER REAKTANZSPULEN MIT OFFENEM EISENKERN (The Calculation of Reactance Coils with Open Iron Cores).—H. Buchholz. (*Archiv f. Elektrot.*, 21st April, 1932, Vol. 26, pp. 233–249.)

Author's summary :—" On the assumptions given in Sec. I, the expression 22, valid without restrictions, is derived for the complex magnetic potential of an open-iron-cored reactance coil. With its help are calculated the maximum magnetic flux of the coil (equation 26b) and the fictitious air gap (equation 28). The expression 30 for the self inductance of the coil is compared with that for a similar coil without an iron core, 31. The curves given in Figs. 5 and 6 allow the determination of the fictitious air gap and of the self inductance, for a given ratio of diameter of coil to its length. In relation to actual practical cases, the values thus obtained for the self inductance represent upper limits " [one of the assumptions in Sec. 1 being that the iron has an infinitely great permeability].

I LIMITI DI APPLICABILITA' DELLA FORMULA DI STEINMETZ (The Limits of Validity of the Steinmetz [Hysteresis Loss] Formula).—I. Lucchi (*L'Elettrotec.*, 5th June, 1932, Vol. 19, No. 16, pp. 418–421.)

ÜBER EINEN EFFEKT, DEN FERROMAGNETISCHE STOFFE IM ELEKTROMAGNETISCHEN WECHSELFELDE ZEIGEN (On an Effect shown by Ferromagnetic Materials in an Alternating Electromagnetic Field).—A. Esau and H. Kortum. (*Zeitschr. f. Phys.*, 1932, Vol. 73, No. 9/10, pp. 602–619.)

The effect referred to is that mechanical structures which can oscillate, and whose elastic parts consist of certain ferromagnetic materials, can be excited by alternating longitudinal magnetisation to torsional oscillations of their own natural frequency.

MAGNETISATION OF MACROSCOPIC POWDERS IN WEAK FIELDS.—R. Chevallier. (*Comptes Rendus*, 25th April, 1932, Vol. 194, pp. 1468–1471.)

AIMANTATION DES POUDRES FERROMAGNÉTIQUES DANS LES CHAMPS FAIBLES (The Magnetisation of Ferromagnetic Powders in Weak Fields).—R. Chevallier. (*Comptes Rendus*, 18th April, 1932, Vol. 194, pp. 1327–1329.)

PERMEABILITY OF IRON AT ULTRA-HIGH FREQUENCIES.—Schwarz. (*See* end of abstract under " Measurements and Standards.")

SYMPOSIUM ON FERROMAGNETISM.—F. Bitter, S. L. Quimby, R. M. Bozorth, K. J. Sixtus, L. Tonks, T. D. Yensen, P. P. Cioffi, S. R. Williams and L. W. McKeehan. (*Phys. Review*, 15th Jan., 1932, Series 2, Vol. 39, No. 2, pp. 337–377.)

CHARACTERISTICS OF LEAD STORAGE BATTERIES UNDER REDUCED ATMOSPHERIC PRESSURE [Improved Capacities under 13 mm Pressure].—S. Makio. (*Journ. I.E.E. Japan*, April, 1932, Vol. 52 [No. 4], No. 525. English summary, p. 63, Japanese text, pp. 345–349.)

SOME FACTORS AFFECTING THE PERFORMANCE AND LIFE OF LEAD ACCUMULATORS : PART III.—J. T. Crennell and A. G. Milligan. (*World Power*, June, 1932, Vol. 17, No. 102, pp. 404–408.)

TRASFORMATORE STATICO AUTO-REGOLATORE A CORRENTE COSTANTE (The Self-Regulating Static Transformer giving a Constant Value of Current).—F. Correggiari. (*L'Elettrotec.*, 25th May, 1932, Vol. 19, No. 15, pp. 396–398.)

LAMP RESISTANCES FOR D.C. RECEIVERS.—F. E. Henderson. (*Wireless World*, 8th June, 1932, Vol. 30, pp. 594–596.)

Either carbon or metal filamented lamps may be used for the purpose of absorbing surplus voltage in d.c. mains receivers. The metal filament lamp is shown to be the most suitable, in that it minimises and also tends to compensate for fluctuations in the voltage of the supply mains. Life tests consisting of repeated switchings of modern indirectly heated valves connected in series with metal filament lamps failed to show that any detrimental effects resulted from the strong current-surge which naturally occurs when switching on a metal filament lamp.

AUTOMATIC VOLTAGE REGULATION [VOLTAGE REGULATOR TRANSFORMER].—K. Howe: Ward Leonard Company. (*Electronics*, May, 1932, pp. 164–165.)

CURRENT-VOLTAGE AND THERMAL CHARACTERISTICS OF THE COPPER OXIDE RECTIFIER.—W. B. Pietenpol and G. W. Presnell. (*Phys. Review*, 1st March, 1932, Series 2, Vol. 39, No. 5, pp. 862–863.)

Abstract only.

STRUCTURAL INVESTIGATION OF THE COPPER OXIDE RECTIFIER. CONTRIBUTION TO THE CRYSTAL AND ATTENUATING LAYER PHOTOELECTRIC EFFECT.—Scharf and Weinbaum. (*See* under "Phototelegraphy and Television.")

THE ELECTRICAL BEHAVIOUR OF BOUNDARY LAYERS.—Teichmann. (*See* under "Phototelegraphy and Television.")

THE ATTENUATING LAYER IN LEAD SULPHIDE.—Heineck. (*See* under "Phototelegraphy and Television.")

DER WELLENSTRAHL-GLEICHRICHTER (The Jet Wave Rectifier).—J. Hartmann. (*E.T.Z.*, 4th Feb. and 17th March, 1932, Vol. 53, pp. 98–105, 260–263: Discussion, p. 271.)

EIN NEUER GALVANOMETERSCHUTZ (A New Protection for Galvanometers [Use of Triode as Overload Bye-Pass]).—C. Moerder. (*Zeitschr. f. Instr:kde*, No. 12, Vol. 51, pp. 606–612.)

CONDENSERS MADE BY DEPOSITION OF METALLIC POWDER BY JET OF ACETYLENE GAS.—(French Pat. 719 755, Soc. Ducretet, pub. 10th Feb., 1932: summary in *Rev. Gén. de l'Élec.*, 30th April, 1932, Vol. 31, p. 147 D.)

CATHODE SPUTTERING—A COMMERCIAL APPLICATION [TO COVERING MICROPHONE DIAGRAMS WITH GOLD ELECTRODE SURFACES].—H. F. Fruth. (*Bell S. Tech. Journ.*, April, 1932, Vol. 11, No. 2, pp. 283–292.)

HILFSMITTEL FÜR DAS ARBEITEN MIT ORTSKURVEN—INVERSIONSZEICHENSTAB (An Auxiliary Appliance for Work with Locus Curves—The Inversion Ruler and Slide Rule [for Graphs of Electrical Networks]).—H. Reppisch. (*Hochf:tech. u. Elek:akus.*, April, 1932, Vol. 39, pp. 139–141.)

Consisting essentially of two scales, one linear throughout, the other linear from 0 to 1 and thereafter giving the lengths corresponding to the reciprocal values of the linear portion. Examples are given of its use.

STATIONS, DESIGN AND OPERATION.

BROADCASTING HOUSE, LONDON.—(*Engineering*, 13th May, 1932, Vol. 133, pp. 570–572.)

Details of studios, equipment and method of control. One interesting development in control room equipment is the programme meter, which gives a visible indication of the audible strength of the programme. It is calibrated in equally spaced divisions representing a change in sound intensity of 4 db. During a transmission, the reading is kept between divisions 1 and 7, representing a difference of 24 db. Below division 1 transmission would be lost below the noise level of the chain, and above division 7 the transmitter would be over-modulated. For further details of acoustic features of the studios, *see* Ashbridge, Jan. Abstracts, p. 40.

SCOTTISH REGIONAL STATION [AT WESTERGLEN].—(*Electrician*, 27th May, 1932, Vol. 108, p. 728.)

THE PRAGUE [CESKY-BROD] HIGH-POWER BROADCASTING STATION.—Strong, Mirk and Gallant. (*L'Onde Élec.*, April, 1932, Vol. 11, No. 124, pp. 182–208.)

THE CAPE AIR ROUTE: EXPERIMENTS WITH SHORT WAVE WIRELESS.—(*Electrician*, 13th May, 1932, Vol. 108, p. 682.)

THE COLTANO RADIO STATION.—(*Alta Frequenza*, March, 1932, Vol. 1, No. 1, pp. 149–154.)

EUROPÄISCHER PROGRAMMAUSTAUSCH (European Broadcast Programme Exchange [with Some Statistics]).—H. Antoine. (*Die Sendung*, 27th May, 1932, Vol. 9, No. 22, p. 464.)

GENERAL PHYSICAL ARTICLES.

UNIFIED THEORY OF GRAVITATION AND ELECTRICITY.—A. Einstein and W. Mayer. (Long summary in *Physik. Ber.*, 15th April, 1932, Vol. 13, pp. 771–772.)

SIR A. S. EDDINGTON'S RECENT THEORIES.—W. N. Bond. (*Proc. Physical Soc.*, 1st May, 1932, Vol. 44, Part 3, No. 243, pp. 374–382.)

THE DERIVATION OF MAXWELL'S EQUATIONS FROM THE EQUATIONS OF THE QUANTUM THEORY.—M. Fahmy. (*Ibid.*, pp. 368–373.)

DEDUCTION OF THE MAXWELL EQUATIONS WITH THE AID OF EDDINGTON'S UNDULATORY TENSOR.—J. J. Placinteanu. (*Comptes Rendus*, 21st March, 1932, Vol. 194, pp. 1054–1057.)

THE PROBABLE VALUES OF e, h, e/m AND α.—R. T. Birge. (*Phys. Review*, 15th April, 1932, Series 2, Vol. 40, No. 2, pp. 229–261 and 319–320.)

ELECTRONS AND LIGHT QUANTA [NEGATIVE EXPERIMENTAL TEST ON ACCELERATION OR RETARDATION OF THE FORMER BY THE MOMENTUM OF THE LATTER].—Ambrose Fleming. (*Proc. Physical Soc.*, 1st May, 1932, Vol. 44, Part 3, No. 243, pp. 281–294.)

EXPERIMENTAL INVESTIGATIONS OF THE CURRENT CONDUCTION IN DIELECTRIC FLUIDS AT HIGH FIELDS.—A. Nikuradse. (*Archiv f. Elektrot*, 21st April, 1932, Vol. 26, pp. 250–260.)

Continuation of the work referred to in 1931 Abstracts, p. 340.

QUANTUM THEORY OF RADIATION.—E. Fermi. (*Reviews of Mod. Physics*, Jan., 1932, Vol. 4, pp. 87–132.)

ELECTRIC AND MAGNETIC DOUBLE REFRACTION.—J. W. Beams. (*Ibid.*, pp. 133–172.)

THEORY OF THE DIFFUSION OF NEUTRONS, COEFFICIENT OF ABSORPTION AND IONISATION.—J. L. Destouches. (*Comptes Rendus*, 30th May, 1932, Vol. 194, pp. 1909–1911.)

NEUTRON, THE ZERO ELEMENT.—Swinne. (*See* abstract under "Atmospherics and Atmospheric Electricity.")

ZUM AUFTRETEN DES VEKTORPOTENTIALS IN DER RIEMANNSCHEN GEOMETRIE (On the Appearance of Vector Potential in Riemannian Geometry).—C. Lanczos. (*Zeitschr. f. Phys.*, 1932, Vol. 75, No. 1/2, pp. 63–77.)

THE CHARACTERISTIC VALUES OF THE DIRAC ELECTRON.—Al. Proca. (*Comptes Rendus*, 7th March 1932, Vol. 194, pp. 836–838.)

"Thus the magnetic charge of a Dirac electron is impossible to observe in all cases, on a free electron. Should one conclude therefore that its study is useless? By no means. Take the case where an external field exists. To write the Dirac equation in this case one allows oneself to be guided by analogies with the classical theory. But this part of the theory depends essentially on the hypothesis that the electron possesses absolutely no magnetic charge. The question is, has one the right to continue to apply an equation established for a particle *without* magnetic charge to the Dirac electron which actually has one?"

MISCELLANEOUS.

OPERATIONAL CALCULUS.—PART I. THE DEFINITION OF AN OPERATIONAL REPRESENTATION OF A FUNCTION AND SOME PROPERTIES OF THE OPERATOR DERIVED FROM THIS DEFINITION: PART II. THE VALUES OF CERTAIN INTEGRALS AND THE RELATIONSHIPS BETWEEN VARIOUS POLYNOMIALS AND SERIES OBTAINED BY OPERATIONAL METHODS.—H. V. Lowry. (*Phil. Mag.*, May and June, 1932, Series 7, Vol. 13, Nos. 87 and 88, pp. 1033–1048 and 1144–1163.)

A SIMPLE METHOD FOR THE NUMERICAL SOLUTION OF DIFFERENTIAL EQUATIONS.—W. G. Bickley. (*Phil. Mag.*, May, 1932, Series 7, Vol. 13, No. 87, pp. 1006–1014.)

THE KELVIN LECTURE: DR. SUMPNER ON THE WORK OF OLIVER HEAVISIDE.—W. E. Sumpner. (*Electrician*, 29th April, 1932, Vol. 108, p. 609.)

THE PRESENT STATUS OF COMPLEX ANGLES IN THEIR APPLICATIONS TO ELECTRICAL ENGINEERING.—A. E. Kennelly. (*Journ. I.E.E. Japan*, Feb., 1932, Vol. 52 [No. 2], No. 523, pp. 166–185.)

GRAPHICAL SYMBOLS FOR COMMUNICATION ENGINEERING (Commission Électrotechnique Internationale). (*Bull. Assoc. suisse d. Élec.*, 15th April, 1932, Vol. 23, No. 8, pp. 174–185.)

A SHORT MONOGRAPH ON NOMOGRAPHY.—F. M. Wood. (*Trans. Eng. Inst. Canada*, Vol. 36, 1926–1930, pub. 1932, pp. 207–231.)

THE CALCULATION OF ERRORS BY THE METHOD OF LEAST SQUARES.—R. T. Birge. (*Phys. Review*, 15th April, 1932, Series 2, Vol. 40, No. 2, pp. 207–227.)

NOUVELLE REPRÉSENTATION ALGÉBRIQUE DES COURANTS ALTERNATIFS ET DE TOUS AUTRES PHÉNOMÈNES OSCILLATOIRES (New Algebraic Representation of Alternating Currents and of all other Oscillatory Phenomena).—A. Blondel. (*Comptes Rendus*, 25th April, 1932, Vol. 194, No. 17, pp. 1413–1417.)

The method of representing oscillatory phenomena here described is based on the representation of $(\sqrt{-1})^\delta = e^{\delta\sqrt{-1}}$ as a vectorial operator of unit length, rotating round the origin when δ is varied; δ is measured in quadrants or fractions thereof.

A RELIABLE METHOD OF OBTAINING THE DERIVATIVE FUNCTION FROM SMOOTHED DATA OF OBSERVATION.—G. Rutledge. (*Phys. Review*, 15th April, 1932, Series 2, Vol. 40, No. 2, pp. 262–268.)

LE CONGRÈS DE L'UNION INTERNATIONALE DE RADIODIFFUSION À ROME DU 19 AU 24 OCTOBRE 1931 (The U.I.R. Congress at Rome). (Summary in *Rev. Gén. de l'Élec.*, 23rd April, 1932, Vol. 31, p. 136 D.)

ETHER SPECTRUM CHART SHOWING RECENT RADIO REALLOCATION [AND AUDIBLE AND PHOTOELECTRIC SPECTRA]. (Supplement to *Electronics*, April, 1932.)

REPORT OF THE WORK AND RESEARCHES OF THE FRENCH NATIONAL LABORATORY OF RADIOELECTRICITY DURING 1931.—Gutton. (*See* under "Measurements and Standards.")

ON THE PREPARATION OF ARTICLES FOR "THE WIRELESS ENGINEER." (*Wireless Engineer*, May, 1932, Vol. 9, No. 104, p. 247.)

LINOTYPE OPERATED DIRECT FROM TYPEWRITTEN "COPY": THE SEMAGRAPH.—B. L. Green. (*Electronics*, April, 1932, p. 125.)

Beneath the regular letters, a special typewriter prints corresponding control symbols made up of combinations of dots. These groupings of dots, scanned by a photocell, actuate the matrix-releasing mechanism.

THE RELIABILITY OF ELECTRON TUBES IN ELEVATOR SERVICE.—C. C. Clymer. (*Gen. Elec. Review*, April, 1932, Vol. 35, pp. 238–239.)

AN APPARATUS FOR THE GENERATION AND MEASUREMENT OF LOW-FREQUENCY ELECTROMAGNETIC ALTERNATING FIELDS [FOR GEOPHYSICAL EXPLORATION: 5–1 000 CYCLES/SEC.: FREQUENCY INDEPENDENT OF LOAD].—M. Müller. (Summary in *Physik. Ber.*, 1st April, 1932, Vol. 13, p. 751.)

SICHTBARMACHUNG HOCHFREQUENTER ELEKTRISCHER SCHWINGUNGEN DURCH ELEKTRODENLOSE GLIMMENTLADUNG (Making High-Frequency Electrical Oscillations Visible with the Electrodeless Glow Discharge).—F. Herold. (*Physik. Zeitschr.*, 15th May, 1932, Vol. 33, No. 10, pp. 418–419.)

UTILISATION OF THE E.M.FS OF INDUCTION FOR THE REGISTRATION OF VARIATIONS IN THE VELOCITY OF CONDUCTING LIQUIDS: A NEW HAEMODROMOGRAPH WITHOUT A BLADE IN THE BLOOD.—P. Fabre. (*Comptes Rendus*, 21st March, 1932, Vol. 194, pp. 1097–1098.)

AN ELECTRONIC HIGH-SPEED TIMING DEVICE.—W. M. Roberds. (*Electronics*, March, 1932, pp. 90–91.)

Further development of the device dealt with in February Abstracts, p. 109.

INFRA-RED SEXTANT USED ON MAURETANIA DURING DAYS OF CLOUDY WEATHER.—MacNeil. (*Electronics*, June, 1932, pp. 201 and 209.)

THE NATURE OF THE PHOTOELECTRIC CELL, AND ITS APPLICATION TO (CHEMICAL) MEASURING PROCESSES.—AUTOMATIC ELECTROPHOTOMETER FOR LIGHT-ABSORPTION MEASUREMENTS.—G. Gollnow: Geffcken and Richter. (*Chem. Fabrik*, 18th May, 1932, pp. 161–163.)

DAS LICHT-MEKAPION (The Mekapion Photometric Recorder).—S. Strauss. (*Elektrot. u. Masch:bau*, 8th May, 1932, Vol. 50, No. 19, Supp. pp. 17–19.)

PHOTOELECTRIC CELLS FOR ADJUSTING THE ILLUMINATION OF VEHICLE TUNNEL IN PARIS TO CORRESPOND WITH THE OUTSIDE LIGHTING.—(*Electronics*, June, 1932, pp. 200–201.)

THE ADDITION OF A "MEMORY" [GAS-FILLED TRIGGER RELAY TUBE] TO A PHOTOELECTRIC CELL DETECTING FLAWS.—(*Electronics*, June, 1932, p. 201.)

A PHOTOELECTRIC RAPID COUNTING EQUIPMENT FOR THE EXACT COUNTING OF UP TO 1 200 OBJECTS PER MINUTE.—E. Bornitz. (*AEG Mitteil.*, No. 2, 1932, pp. 60–61.)

RAPID COUNTING RELAYS FOR IMPULSES UP TO 20 PER SECOND.—O. Dworeck. (*Ibid.*, p. 62.)

PHOTOCELL CONTROL OF TEMPERATURE FOR FILAMENT-COATING [AND OTHER ELECTRIC] OVENS.—W. P. Koechel. (*Electronics*, May, 1932, pp. 170 and 182.)

MEASUREMENT OF ROTATIONAL VIBRATION WITH PIEZOELECTRIC CRYSTALS.—H. Lund. (Summary in *Sci. Abstracts, Sec. B*, May, 1932, Vol. 35, No. 413, p. 238.)

PIEZOELECTRIC MEASUREMENT OF ACCELERATION, ETC., IN MOTORS.—H. Lund. (*AEG Mitteil.*, No. 12, 1931, pp. 694–697.)

Cf. Kluge and Linckh, and *Physik. Tech. Reichsanstalt*, both January Abstracts, p. 54.

A NEW PORTABLE RECORDING ACCELERATION AND VIBRATION METER ON THE PIEZOELECTRIC PRINCIPLE, USING VALVE VOLTMETER AND STRING GALVANOMETER.—R. Ambronn. (*Feinmech. u. Präz.*, No. 9, Vol. 39, pp. 199–204.)

Cf. April Abstracts, p. 242.

PIEZOELECTRIC PROPERTIES OF ROCHELLE SALT CRYSTALS.—R. D. Schulwas-Sorokin. (*Zeitschr. f. Phys.*, No. 9/10, Vol. 73, 1932, pp. 700–706.)

A NEW FORM OF DILATOMETER [RECORDING ULTRA-MICROMETER CIRCUIT FOR DETERMINING THE TEMPERATURE AT WHICH ANY ABNORMAL CHANGE IN LENGTH OCCURS].—W. E. Prytherch. (*Journ. Scient. Instr.*, April, 1932, Vol. 9, pp. 128–131.)

A GRID-GLOW MICROMETER [FOR MEASURING DISPLACEMENTS OF LESS THAN ONE TEN-THOUSANDTH OF AN INCH].—R. W. Carson. (*Electronics*, June, 1932, pp. 191 and 204.)

METODI ELETTRICI PER LA MISURA DI PRESSIONI E DI SPOSTAMENTI (Electrical Methods of Measuring Pressures and Displacements [Comprehensive Survey of Ultra-Micrometer, Piezoelectric and Magnetostrictive Methods]).—G. Sacerdote. (*Alta Frequenza*, March, 1932, Vol. 1, No. 1, pp. 16–51.)

THE MEASUREMENT OF RAPIDLY CHANGING MECHANICAL FORCES BY ALTERATION OF CROSS SECTION OF LIQUID RESISTANCES: DISCUSSION.—Wallichs and Opitz: Schmaltz. (*Zeitschr. V.D.I.*, 16th April, 1932, Vol. 76, No. 16, p. 382.)

THE RAPID DETERMINATION OF MOISTURE IN SEEDS AND OTHER GRANULAR SUBSTANCES [INCLUDING A VALVE-OSCILLATOR METHOD].—R. M. Davies. (*Proc. Physical Soc.*, 1st May, 1932, Vol. 44, Part 3, No. 243, pp. 231–245.)

ZUSAMMENHÄNGE DER KENNLINIEN FÜR VERLUSTE UND WIRKUNGSGRAD (The Relations between the Characteristic Curves for Losses and Efficiency [of Machines in General]).—L. Binder. (*Zeitschr. V.D.I.*, 14th May, 1932, Vol. 76, No. 20, p. 494.)

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.

VALVE CONSTRUCTION.

Convention date (Germany), 21st January, 1930. No. 368005.

A close spacing between the grid and filament, to steepen the characteristic curve, is ensured by first threading small insulating beads over the grid-wire and then winding the latter closely on to the filament wire, contact between the two being prevented only by the thickness of the beads. Grids of from 1 to 0.5 mm. internal diameter can be constructed in this way.

Patent issued to Telefunken Ges. für Drahtlose Telegraphie m.b.h.

SIGNALLING SYSTEMS.

Application date, 8th January, 1931. No. 370449.

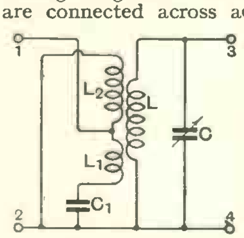
When signals are transmitted on the side-bands alone, the carrier wave being suppressed, it is necessary in reception to demodulate the signal by first combining it with a locally generated wave identical in frequency and phase with the suppressed carrier. According to the invention this demodulating wave is generated at the receiving station not from a separate oscillator, but by a process of frequency-division from the incoming side-bands. The latter are passed first through a full-wave rectifier, then through a filter which transmits a band in the neighbourhood of twice the carrier frequency, next through a current-limiter, and finally through a frequency-divider which reproduces the original carrier frequency.

Patent issued to Standard Telephones and Cables, Ltd., and V. J. Terry.

CONSTANT-COUPLING CIRCUITS.

Convention date (U.S.A.), 19th August, 1930. No. 370768.

Relates to couplings designed to ensure substantially constant amplification, or in other words uniform sensitivity throughout the whole tuning range of a receiver. The terminals 1, 2 are connected across aerial and earth, or across the output circuit of a previous amplifier, whilst the terminals 3, 4 (of which 4 is common to 2) feed the grid-filament circuit of the next valve-stage. It will be seen that the path from terminal 1 is divided into two branches, one consisting of the inductance L_2, and the other comprising the inductance L_1 and series condenser C_1. The current flow through L_1, C_1 is greater at the higher frequencies, whilst that through L_2 increases as the frequency diminishes. The two currents are substantially out-of-phase, since one branch is predominantly capacitative and the other predominantly inductive at the signal frequency. The secondary circuit L, C is tuned by the condenser C, which automatically varies the voltage-ratio between the input and output circuits as the wavelength changes.



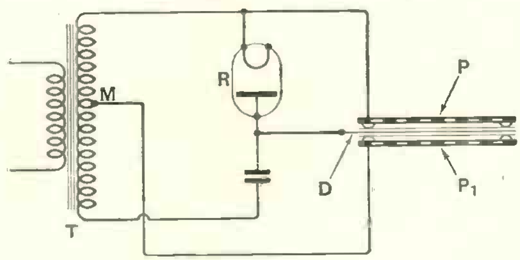
No. 370768.

Patent issued to Hazeltine Corporation.

ELECTROSTATIC SPEAKERS.

Application date, 1st June, 1931. No. 370248.

Relates to a low-voltage speaker of the electrostatic type biased by rectified voltage derived from the speech input. The diaphragm *D* is of semi-conducting material such as goldbeater's skin, preferably coated with rubber, and stretched between two layers of silk. A D.C. biasing potential is supplied by a rectifier *R* shunted across the input transformer *T*. The outer electrodes *P*, P_1 of perforated metal, are connected across a mid-point tapping *M* and one end of the transformer *T*, so that the applied speech voltages are always less than the rectified bias on the centre diaphragm.



No. 370248.

Patent issued to A. Rauser and W. Steuer.

REACTION-CONTROL.

Convention date (Holland), 15th February, 1930. No. 370569.

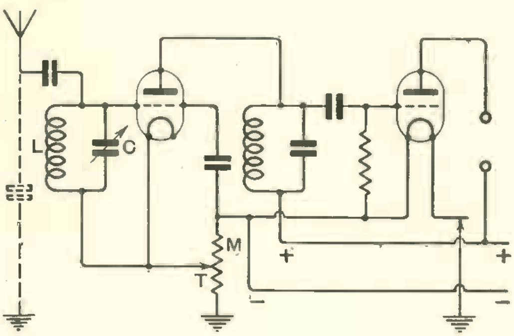
In order to prevent a falling-off in the efficiency of rectification as reaction is increased—due to the shift in the working point of the detector valve—the latter valve is excluded from the feed-back circuit. Instead a branch circuit is taken from one of the H.F. valves directly on to the grid of the first L.F. amplifier, and a feed-back connection is taken from the plate circuit of that valve to the grid of the H.F. stage. Since the L.F. amplifier operates solely on the straight-line part of its characteristic valve, the ratio of input to feed-back energy is kept constant, thus giving a more uniform control over reaction. At the same time the efficiency of the detector valve is maintained at a maximum.

Patent issued to H. H. S. À. S. Idzerda.

ELIMINATING MAINS HUM.

Convention date (Holland), 8th April, 1930. *No.* 368533.

The grid of the input valve is connected through a condenser *C* to one end of an impedance *M*, which may be a variable resistance, inserted in series with



No. 368533.

the normal impedance existing between cathode and ground. The cathode connection is then taken to an intermediate tapping *T*. For the proper values of *M* and *T* the tuned input circuit *L*, *C* forms one diagonal of a bridge, the other diagonal of which is formed by the impedance *M*, so that by correct balancing the transfer of pick-up voltages from the cathode connections to the input circuit is prevented.

Patent issued to N. V. Philips Gloeilampenfabrieken.

BAND-PASS COUPLINGS.

Application date, 26th January, 1931. *No.* 366273.

The inductances in a two-wave band-pass filter are arranged at right angles on a common support or former, so that they do not require complete screening. The values of inductance are such that when the coils form parts of separate tuned circuits the latter can be tuned independently, whilst at the same time the mutual inductance provides the requisite coupling to ensure that the combined circuits have the desired band-pass characteristic. The resonance band of the filter is preferably designed to be constant at approximately 8,000 cycles on each of the two wave-ranges.

Patent issued to L. E. T. Branch.

DISTRIBUTING BROADCAST PROGRAMMES.

Application date, 6th March, 1931. *No.* 366317.

Broadcast programmes are received at some point free from local disturbances, where they are amplified and then transmitted over line wires to an automatic telephone exchange, from which they are distributed to various subscribers. The selection of any desired programme is made by the usual dialling device. When the programme is being received the subscriber can, at choice, either receive incoming telephone calls, or be protected by the usual " busy " signal. In the former case, the broadcast programme is automatically restored directly the subscriber replaces his receiver.

Patent issued to The General Electric Co., Ltd., and J. E. Collyer.

GRAMOPHONE MOTORS.

Application date, 14th October, 1930. No. 367822.

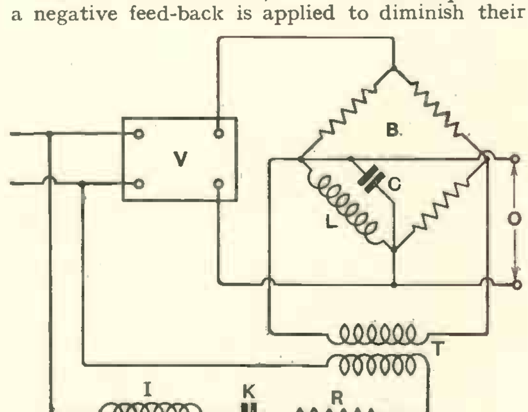
To ensure a compact assembly, the governor device of an induction motor is housed inside a central recess formed at one end of the rotor element. With a synchronous speed of 3,000 revs. per min. a large step-down ratio is employed in the gear between the rotor and the turntable, and a comparatively small torque, so that the magnetic core and energising coil can be reduced to small dimensions, in order to afford the necessary accommodation for the governor.

Patent issued to E. Paillard et Cie.

SELECTIVE RECEPTION.

Application date, 12th January, 1931. *No.* 367987.

Selectivity is enhanced by the provision of a Wheatstone bridge coupling between the input and the output circuits, so that at the resonance frequency there is no effective reaction whilst any other undesired frequencies are weakened by a negative reaction feed-back. As shown the output from the amplifier *V* is applied across the vertical diagonal of the bridge *B*, one arm *L*, *C* being tuned to the desired frequency and connected to the output terminals o. The horizontal diagonal is back-coupled to the input through a transformer *T* and a series of control impedances *I*, *K*, *R*. The arms of the bridge are adjusted to balance at the frequency of the resonant circuit *L*, *C*. For other frequencies a negative feed-back is applied to diminish their



No. 367987.

effect, the terminals of the transformer being reversed when necessary. Provision is made to apply positive reaction at the resonant frequency when desired.

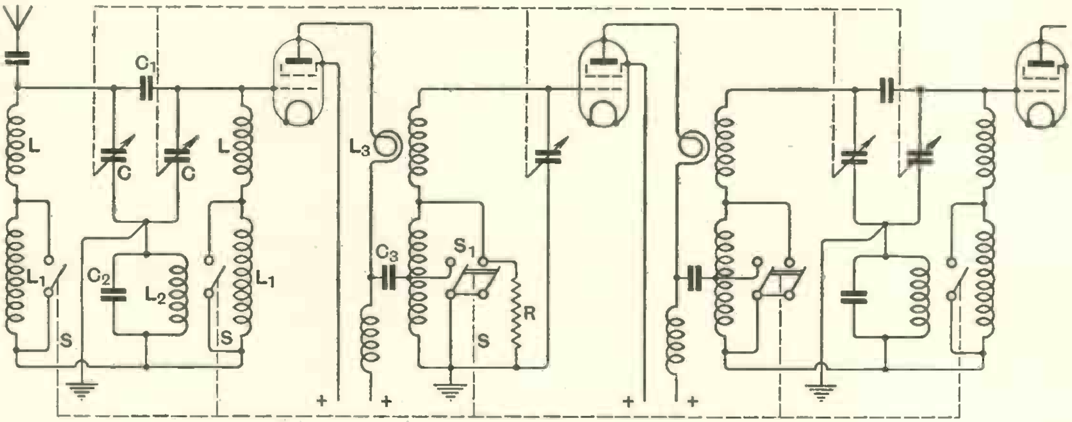
Patent issued to Kolster-Brandes, Ltd., and W. S. Percival.

BAND-PASS COUPLINGS.

Convention date (U.S.A.), 4th September, 1930.
No. 367409.

The input circuit to a screen-grid or pentode amplifier comprises two identically tuned circuits, each consisting of an inductance L, a loading inductance L_1 for the longer waves, a tuning-condenser C, and a coupling-condenser C_1 which may consist of the inherent capacities of the circuit components. The tuned circuits are also coupled through a shunt circuit C_2, L_2 made resonant to a frequency near the lower limit of the tuning range. In the intervalve stage a separate coupling L_3 is provided for the short-wave coil, whilst a coupling-condenser C_3 is also provided for the long-wave coil. When the wave-band switch S is open, on the long-wave setting, the auto-transformer action gives the desired degree of coupling in conjunction with the coil L_3; on the short-wave setting a contact S_1 on the switch S short-circuits the lower part of the loading coil. A resistance R serves to equalise the amplification gain on both wave-bands.

Patent issued to Radio Frequency Laboratories Inc.



No. 367409.

LOUD SPEAKER FILTERS.

Convention date (Holland), 24th April, 1930.
No. 369745.

The "rustling" noise common to certain loud speakers which have otherwise a high-grade musical response is eliminated by interposing between the valve output and the speaker a filter circuit having a characteristic curve which falls off towards the high-frequency end more rapidly than the response curve of the speaker itself. This suppresses the ultra-high non-musical notes which are the cause of the trouble.

Patent issued to N. V. Philips Gloeilampenfabrieken.

TUNING SYSTEMS.

Convention date (U.S.A.), 26th August, 1929.
No. 366475.

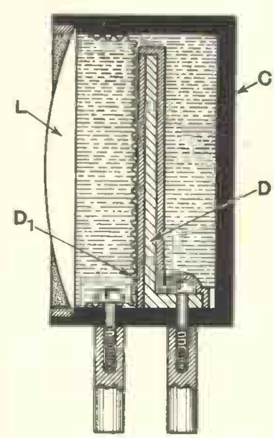
The high-frequency stages of a wireless receiver are tuned by varying the permeability of iron-cored coupling-transformers. The cores consist of compressed finely-divided iron, prepared chemically by reducing iron sulphate by a stream of hydrogen. The particles should be small enough to pass through a screen of 250–300 mesh to the sq. inch. To further reduce eddy currents the particles are also insulated from each other by being mixed with paraffin wax, mineral oil, gum, varnish, etc. The cores are movable in and out of binocular transformer windings by a tuning-control, which may also be ganged to a variable condenser to ensure a straight-line amplification characteristic over the whole tuning range.

Patent issued to Johnson Laboratories Inc.

LIGHT-SENSITIVE CELLS.

Convention date (U.S.A.), 6th December, 1929.
No. 368388.

The cell comprises a Bakelite casing C containing a transparent liquid, such as glycerine, and closed at the front by a glass lens L. Mounted inside the casing is a copper disc D forming one electrode, and a wire-gauze of copper coated with sulphide, selenide, or telluride is inserted in close contact with the sensitive electrode D_1. The latter is of the cuprous-oxide type, etched with a solution of hydrofluoric acid. The cell is particularly suitable for reproducing audible frequencies from the sound-trace on a talking film, though it is also applicable to television and still-picture transmission.



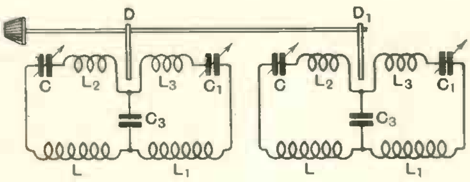
No. 368388.

Patent issued to Arcturus Radio Tube Co.

BAND-PASS COUPLINGS.

Convention date (Germany), 6th February, 1930. *No.* 368479.

A band-pass coupling is designed to have a normally constant band-width for "searching" which can be decreased if necessary to narrower limits, for instance when interference is present. As shown in the Figure, the normal tuning-elements L, C and L_1, C_1 are augmented by additional coils L_2, L_3. By varying the coupling between



No. 368479.

the coils L_2, L_3, for instance by interposing copper discs D, D_1 mounted on a common shaft, the overall inductive coupling may be made to cancel out the capacitive coupling through the condensers C_3. Or the effective coupling between the band-pass elements may be brought to any intermediate value according to the band-width desired.

Patent issued to Telefunken Ges für Drahtlose Telegraphie m.b.h.

TELEVISION SYSTEMS.

Application date, 27th August, 1930. No. 368721.

The picture to be transmitted is first focused upon a flat, fine-mesh screen covered with light-sensitive material and forming the cathode of a photo-sensitive cell. The resulting electron stream is subjected to a sufficiently high voltage to preserve the characteristics of the original image at every cross-section of its path. An apertured plate is interposed between the cathode and anode, and a transverse voltage of substantially straight-line wave-form is applied to the discharge stream, so as to sweep it to-and-fro across the aperture, where it is focused upon the anode of the tube, and serves to modulate an outgoing carrier-wave. In reception the incoming picture elements are reassembled on the fluorescent screen of a cathode-ray tube.

Patent issued to W. W. Triggs.

Application date, 11th February, 1931. *No.* 369335.

The picture or object to be transmitted is focused on to a photo-sensitive surface through an optical system which permits the scene to be amplified or reduced in size unequally in the horizontal and vertical directions, so as to produce an image of uniform area from originals of different sizes. This facilitates subsequent handling in apparatus of standard type.

Patent issued to R. G. Wilson.

Convention date (U.S.A.), 17th July, 1930. *No.* 369832.

The picture is projected on to the photo-electric cathode of a cathode-ray tube, which has an anode-structure consisting of a series of conductive plugs or elements mounted on and insulated from a pair of supporting plates. The resulting electron emission from the cathode charges up the assembly of plug-elements, so as to form an equivalent "electric image," which is then scanned by a beam or ray from an electron "gun." The current flow occasioned by the incidence of the scanning-ray is then proportional to the "charge" on each plug, *i.e.*, to the light-and-shade values of the original picture. For a picture 5 inches square, 6,400 plug elements are arranged in 80 parallel rows, each row also comprising 80 units.

Patent issued to Marconi's Wireless Telegraph Co., Ltd.

BROADCAST RELAY SYSTEMS.

Application date, 26th January, 1931. *No.* 368923.

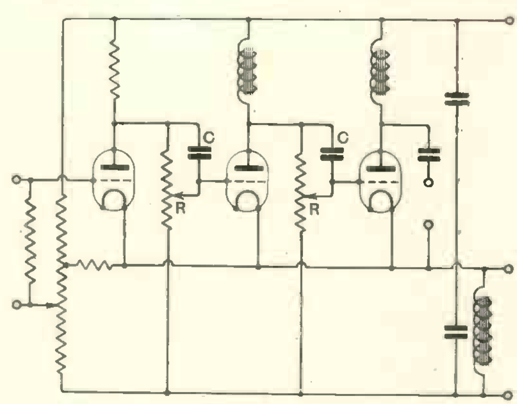
Two alternative programmes are relayed from a central station to a number of subscribers, one in high-frequency form, the other as a rectified current. The receiving set consists of a single valve connected to operate either as a low-frequency amplifier or as an anode-bend rectifier for the incoming H.F. signals, according to the position of a switch in the input circuit. This gives the listener at any time a choice of two programmes.

Patent issued to H. C. Holmes and Community Radio (1928), Ltd.

DIRECT-COUPLED AMPLIFIERS.

Application date, 11th December, 1930. *No.* 368788.

Amplifiers of the direct-coupled type, though free from distortion, give a relatively poor amplification owing to heavy attenuation in the inter-stage



No. 368788.

couplings. As shown in the Figure this drawback is minimised by providing shunt condensers C tapped across part of the coupling-resistances R. The effect is to transfer the higher audible frequencies with small attenuation, thereby increasing the gain per stage.

Patent issued to A. H. Midgeley.

MISCELLANEOUS.

Measurements.—Resistances, inductances, condensers, wave-meters, undertaken by retired engineer. Loans of instruments and books to responsible experimenters considered.—Enquiries BM/ZLME, W.C.1. [0226

PATENTS, ETC.

The Proprietors of British Patents Nos. 246,036, 269,705 and 271,419, relating to "Electric Discharge Devices," are desirous of entering into negotiations with interested parties with a view to the exploitation of the inventions either by sale of the Patent Rights or by the granting of Licences on reasonable terms. All enquiries should be addressed to Wm. Brookes & Son, No. 1, Quality Court, Chancery Lane, London, W.C.2 [0224

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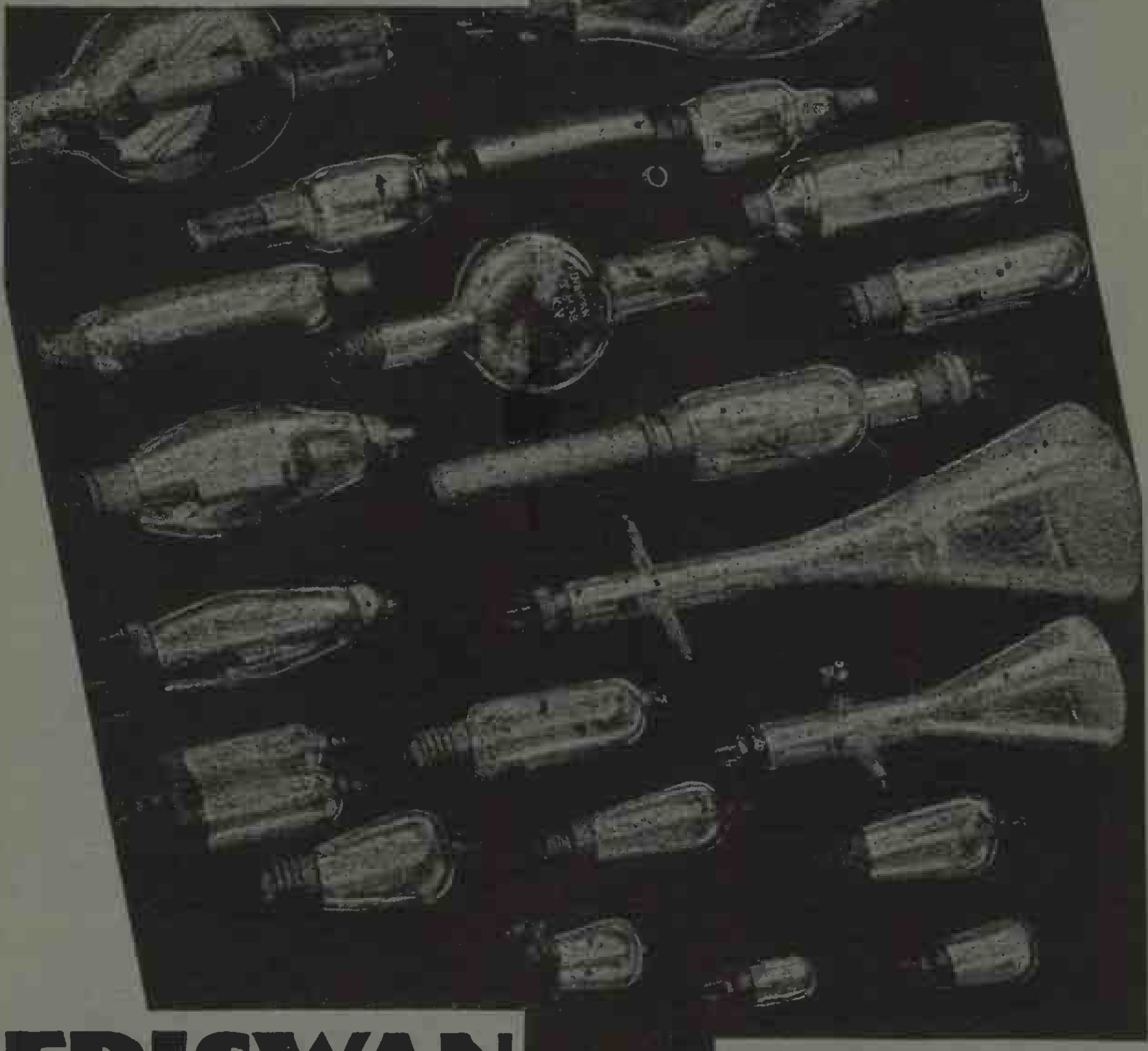

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