Brayshaw

THE

WIRELESS ENGINEER

AND

EXPERIMENTAL WIRELESS

NUMBER 109 VOLUME IX OCTOBER 1932

A JOURNAL OF

RADIO RESEARCH

AND

PROGRESS

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PUBLISHED BY

ILIFFE & SONS LTD.

DORSET HOUSE TUDOR STREET LONDON E.C.4

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The
WIRELESS ENGINEER
and EXPERIMENTAL WIRELESS
A Journal of Radio Research & Progress

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VOL. IX No. 109

OCTOBER 1932

C O N T E N T S

Published Monthly on the first of each month
SUBSCRIPTIONS Home and Abroad: One Year, 32/-, 6 Months, 16/-. Single Copies, 2/8 post free

Editorial Offices
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THE

WIRELESS ENGINEER

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Editorial.

The Two-circuit Tuner.

IN the early days of wireless telegraphy, long before the advent of broadcasting, or even of the thermionic valve, selectivity was obtained by the use of two loosely-coupled tuned circuits. The coupling was usually varied by moving one coil relatively to the other and was adjusted to give the loudest signal consistent with selectivity. And now, after thirty years of development, exactly the same method is employed for sifting out the desired signal from the multiplicity of waves which act upon the receiving aerial. With the advent of broadcasting, however, a new condition was imposed on the tuning device. To give good reproduction it was desirable that the response should be uniform over a range of several thousand cycles, and to obtain freedom from interference it was essential that the response should fall practically to zero everywhere outside this range. Many articles have been written on the subject of the details of design necessary to obtain the closest possible approximation to these requirements, and formulae have been established for the degree of coupling necessary to give this. Special methods of coupling have been devised in order to keep the coupling automatically at the correct amount for all positions of the tuning condensers. It would be interesting, however, to know how many commercial sets have the tuner designed and adjusted to give the optimum amount of double-humped response so that there is no loss of the high notes. With the increasing difficulty of avoiding interference and the natural desire to increase sensitivity, the designer is tempted—or forced—to adjust the coupling to give the maximum transfer of energy at the resonant frequency, that is to say, to loosen the coupling until the two humps disappear and with them the brilliancy of the high notes. There was a time when absence of bass was the outstanding characteristic of wireless reproduction, but one is now more often conscious of an excess of bass as compared with the upper registers. This suggests the advisability of incorporating some adjustment so that when interference permits one could extend the range of high note reception. This adjustment might be incorporated in the tuner, but a simpler solution would appear to be the addition of a small amount of adjustable tone correction in the audio-frequency stage. The tuner could then be adjusted to give sharp selectivity without any consideration of quality of reproduction. Another knob would be added to those already on the set, but it would not call for any accurate setting, and there can be little doubt that the possibility of exercising control over quality would appeal to most listeners.

Two-element Band-pass Filters.*

By R. T. Beatty, M.A., B.E., D.Sc.

1. Introduction.

THE purpose of this paper is to show how the design of band-pass filters can be greatly simplified by the use of charts from which the type of filter best suited to any particular problem can be immediately chosen ; the numerical values can then be easily calculated. A method is also given by which resonance curves may be drawn with a minimum of labour. The present treatment is limited to symmetrical filters, but it is hoped to consider in a future paper the effects of asymmetry and reaction.

2. A Single Tuned Circuit.

Let us first consider a single series tuned circuit. Since a filter consists of two such circuits coupled together, it is important to reduce the single circuit to its simplest mathematical terms before passing on to the more complicated filter system. Also the generalised filter curves which will be discussed in Section 4 are best regarded as

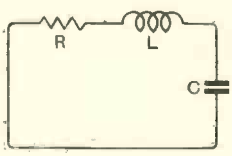


Fig. 1

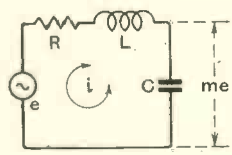


Fig. 2.

derived from the corresponding resonance curve for a single circuit.

2. 1.—*Impedance of a series circuit near resonance.*

In the circuit of Fig. 1 the impedance z is given by

$$z = R + j \,.\, L\omega - j/C\omega \quad .. \quad .. \quad (1)$$

at a frequency f given by $\omega = 2\pi f$.

Let ω_0 be the value of ω at resonance, that is, when $L\omega_0 \,.\, C\omega_0 = 1$, so that the j terms in (1) cancel out.

Near resonance put $\omega = \omega_0 + \Delta\omega$, so that

$$z = R + j \,.\, L\omega_0[1 + \Delta\omega/\omega_0] - j/C\omega_0[1 + \Delta\,\omega/\omega_0] \quad .. \quad (2)$$

$$= R + j \,.\, L\omega_0[(1 + \Delta\omega/\omega_0) - 1/(1 + \Delta\omega/\omega_0)] \quad .. \quad (3)$$

When $\Delta\omega/\omega_0$ is small compared with

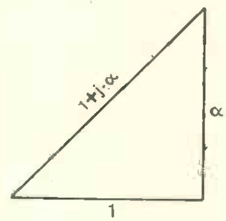


Fig. 3.

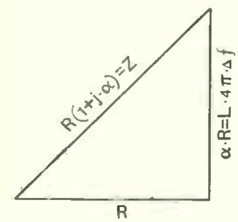


Fig. 4.

unity (3) may be replaced by the approximation

$$z = R + j \,.\, L\omega_0 \,.\, 2\,\Delta\,\omega/\omega_0 \quad .. \quad (4)$$

or

$$z = R\left[1 + j \,.\, \frac{L\omega_0}{R} \,.\, \frac{2\Delta\omega}{\omega_0}\right] \quad .. \quad (5)$$

$L\omega_0/R$, the ratio of the inductive reactance to the resistance, is termed the voltage magnification of the circuit and is usually denoted by m. It is easy to verify that when an e.m.f. e is injected in the series circuit of Fig. 2, the voltage which appears across C at resonance is m.e.

Hence (5) becomes

$$z = R[1 + j \,.\, m \,.\, 2\,\Delta\,\omega/\omega_0] \quad .. \quad (6)$$

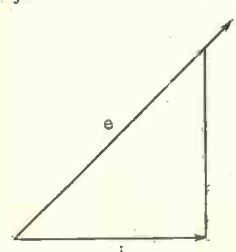


Fig. 5.

which may be contracted to

$$z = R[1 + j \,.\, a] \quad .. \quad (7)$$

where $a = 2m \,.\, \Delta\,\omega/\omega_0 = 2m \,.\, \Delta f/f_0$ (8)
which is equivalent to

$$a = L \,.\, 4\pi \,.\, \Delta f/R \quad .. \quad .. \quad .. \quad (9)$$

Equation (7), which is sufficiently accurate over the frequency range covered by the sidebands of a carrier wave, gives the series impedance of a circuit near resonance in terms of the resistance *R* at resonance and a variable *a*. *a* is proportional to the off-tune frequency Δf and is given in two equivalent forms by equations (8) and (9).

Fig. 3 shows the vector $1 + j \,.\, a$ which occurs in (7). By multiplying each side of

*MS. received by the Editor January, 1932.

this triangle by R we obtain the impedance diagram of Fig. 4. Since $e = i \cdot z$ the similar triangle of Fig. 5 shows that when i is multiplied by the operator z we obtain e, and the current lags behind the injected e.m.f. by an angle whose tangent is α. At resonance $\alpha = 0$, the impedance reduces to the resistance R, and current and e.m.f. are in phase.

2. 2.—*A Generalised Resonance Curve.*

From (7), or from Fig. 4, the absolute value of the impedance is $R\sqrt{1 + \alpha^2}$. Hence if the magnitude of e be kept constant while its frequency is varied, the current round the circuit of Fig. 1 varies as $1/\sqrt{1 + \alpha^2}$ and the voltage across the condenser varies as $1/C\omega \cdot \sqrt{1 + \alpha^2}$. If, over the resonance region, the variation in ω be neglected the final result is

$$(\text{voltage across } C)/(\text{resonance voltage across } C) = 1/\sqrt{1 + \alpha^2} \quad .. \quad (10)$$

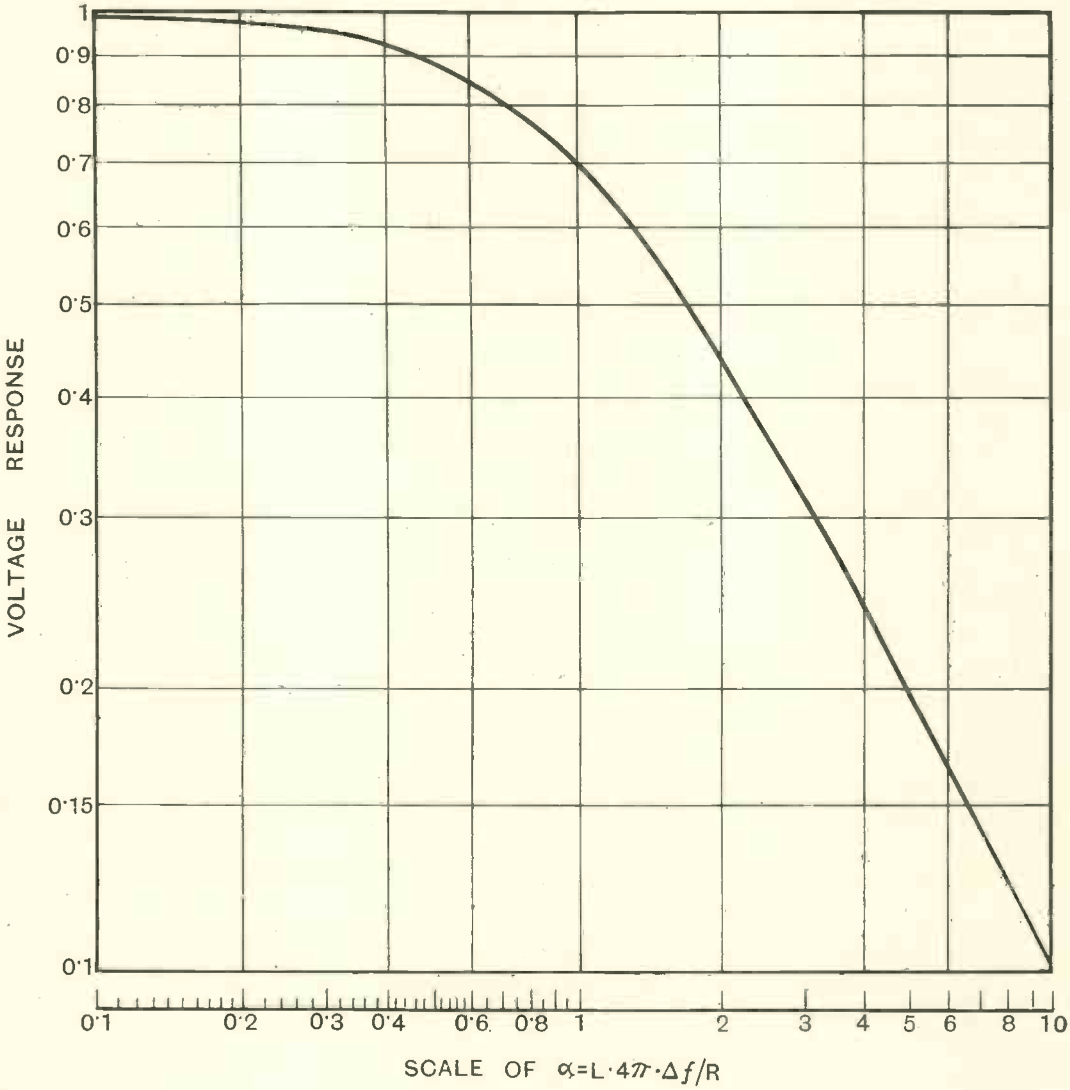


Fig. 6.

Now if we plot $1/\sqrt{1 + a^2}$ against a (Fig. 6) we get a resonance curve which holds for *any* series tuned circuit at *any* broadcast frequency and requires only a slight manipulation to give the horizontal scale of frequency appropriate to any particular case. Since the scale of a is logarithmic the operation of dividing the values of a by $L \cdot 4\pi/R$ in order to obtain the corresponding values of $\triangle f$ is performed by merely sliding the scale horizontally through the required distance and then regarding it as a scale of off-tune frequency.

As an example of the use of Fig. 6, let us take the case of a small coil described by Mr. Sowerby.*

The constants are given in the following table.

TABLE I

L = 230 microhenrys.

Carrier frequency on kilocycles.	Coil resistance in ohms.
600	5.45
1,000	10.7
1,500	24.8

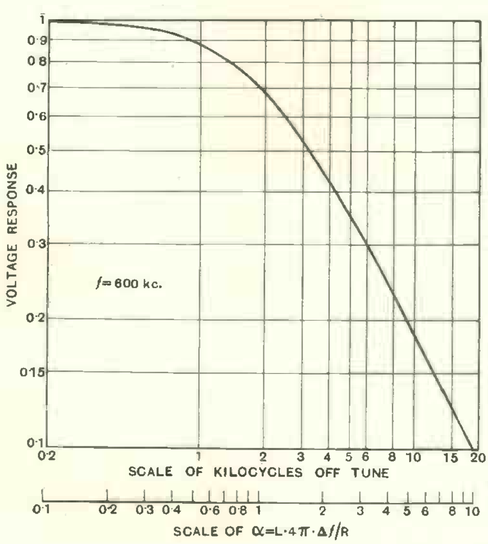


Fig. 7.

*The Wireless World, Jan. 29th, 1930, p. 108.

At 600 k.c.

$a = 4\pi L \cdot \triangle f/R = 4\pi \times 230$
$\times 10^{-6} \times \triangle f/5.45 = 0.53 \times 10^{-3}$
$\times \triangle f$ (cycles) $= 0.53 \times \triangle f$ (kilocycles).

Therefore, when $\triangle f = 1$ k.c. $a = 0.53$, so that a scale of kilocycles off tune is

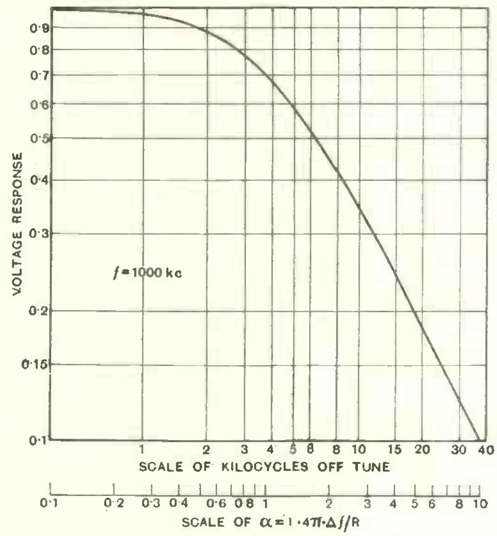


Fig. 8.

obtained by shifting the scale of a sideways till the point marked 1 occupies the position formerly marked 0.53. This is readily done by marking off the points 1, 2, 3, etc., on tracing paper which is then displaced to the left to the new position. Fig. 7 is obtained in this way and shows that at 5 k.c. off tune the sidebands are seriously cut down, the voltage across C being only 0.35 of that at resonance.

Figs. 8 and 9 show the resonance curve at 1,000 and 1,500 k.c. respectively, the calculations being carried out as before. At 1,000 k.c. the curve is flatter than at 600 k.c., the signal only falling to 0.59 at 5 k.c. off tune. At 1,500 k.c. it is flatter still owing to the big increase in R at this frequency. It may seem odd to speak of a curve of invariable shape becoming sharp or flat, but we must think of the reference frame into which it is fitted. This frame closes up as we pass from Fig. 7 to Fig. 9 and the curve becomes flatter relative to its environment.

This method of deriving the resonance curve for any single tuned circuit from a master resonance curve can be extended to cover the performance of any type of symmetrical band-pass filter, as will be explained in Section 4.

2. 3.—*The Degree of Accuracy of the Method.*

The effect of the approximations made in the above work may be briefly stated as follows: (1) The assumption in equation (10) that ω is constant over the resonance region makes the curve too high by $100 \times \triangle f/f$ per cent. (2) The approximation introduced in passing from equation (3) to equation (4) makes the curve too high by $50 \times \triangle f(1-y^2)/f$ per cent., where y is the height of the curve. (3) The assumption that R remains constant over the resonance region introduces no appreciable error since the variation in R is swamped at low values of y by the large value of the circuit reactance $4\pi L \,.\, \triangle f$. Hence at low values of y the curve reads $150 \times \triangle f/f$ per cent. too high for frequencies above resonance, and the same amount too low for frequencies below resonance. Thus at

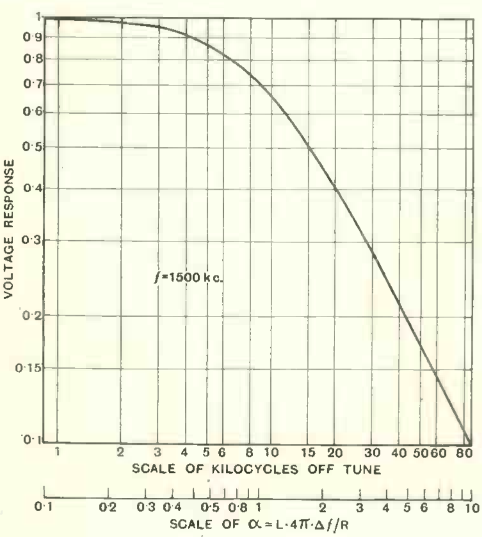


Fig. 9.

$y = 0.1$ the curves of Figs. 7, 8, 9 are respectively 5, 6, 8 per cent. too high. These errors are not large enough to vitiate the value of the method for rapid investigation of resonance curves, and if greater accuracy is required the corrections can easily be made.

3. A Symmetrical Filter Circuit.

Fig. 10 shows the representative form to which all two-element filters can be reduced. Two identical tuned circuits are coupled by a pure reactance X which is positive or

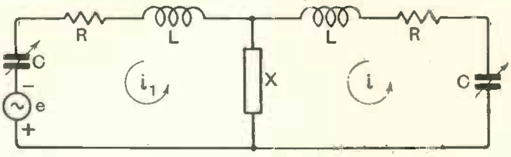


Fig. 10.

negative according as the reactance is inductive or capacitative. The two circuit equations are:

$$e = i_1[R + jL\omega - j/C\omega + jX] - i \,.\, jX \quad (11)$$

$$0 = i[R + jL\omega - j/C\omega + jX] - i_1 \,.\, jX \quad (12)$$

Let $f_0 = \omega_0/2\pi$ be the frequency at which the left mesh alone would resonate. Then

$$L\omega_0 + X_0 - 1/C\omega_0 = 0 \quad \ldots \quad (13)$$

and, as in Section 2. 1, we can put

$$R + jL\omega + jX - j/C\omega = R(1 + ja) \quad (14)$$

where $a = 4\pi(L + X_0/\omega_0) \,.\, \triangle f/R \quad \ldots \quad (15)$

It will appear that in all practical filters $X_0/L\omega_0$ is so small that we may with sufficient accuracy write

$$LC \,.\, \omega_0^2 = 1 \quad \ldots \quad (16)$$

and $\quad a = L \,.\, 4\pi \,.\, \triangle f/R \quad \ldots \quad (17)$

(11) and (12) now become

$$e = i_1 \,.\, R(1 + ja) - i \,.\, jX \quad \ldots \quad (18)$$

$$0 = i \,.\, R(1 + ja) - i_1 \,.\, jX$$

and on eliminating i_1

$$e/i = R^2(1 + ja)^2/jX - jX \quad \ldots \quad (19)$$

It will be shown presently that filter resonance curves can be drawn in such a way that each curve is completely determined when the ratio of coupling reactance to coil resistance is known.

Let us designate this ratio by the symbol β, so that

$$\beta = X/R \quad \ldots \quad (20)$$

Eliminating X from (19) by means of (20) we have

$$e/i = [2a - j(1 - a^2 + \beta^2)] \,.\, R/\beta \quad (21)$$

or $\quad e/i = \rho \,.\, R/\beta \quad \ldots \quad (22)$

where $\quad \rho = 2a - j(1 - a^2 + \beta^2] \quad \ldots \quad (23)$

Hence, as far as the relation between e and i is concerned, the filter of Fig. 10 may be replaced by the equivalent circuit of Fig. 11.

Equation (21), or its equivalent form (22), gives the output current i of the filter shown in Fig. 10. $\alpha = L \cdot 4\pi \cdot \triangle f/R$, and is a generalised off-tune frequency ratio. β, the ratio of coupling reactance to coil resistance, is substantially constant over the resonance region. ρ is given by equation (23): it varies rapidly over the resonance region. α, β, ρ are non-dimensional quantities.

3. 1.—*Geometrical Representation of* ρ.

Equation (23) shows that ρ can be represented by the vector shown in Fig. 12. We have now to find the path traced by the extremity of this vector as α varies.

Put $x = 2\alpha$, $-y = 1 - \alpha^2 + \beta^2$, then elimination of α gives

$$y + 1 + \beta^2 = x^2/4 \quad \ldots \quad (24)$$

Draw the parabola $y = x^2/4$ (Fig. 13) and displace the origin a distance $1 + \beta^2$ upwards along the vertical axis. Then any point on the parabola satisfies the relation (24) and accordingly ρ is represented vectorially by a line drawn from o to some point on the parobola.

As ρ sweeps downward from an initially horizontal position it passes through a minimum at M_1, where it is a normal to the parabola, increases to a maximum at the apex, and reaches another minimum at M_2. These three points correspond to the two peaks and the central depression of the usual resonance curve.

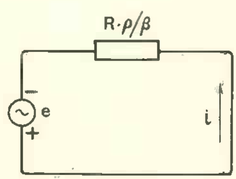


Fig. 11.

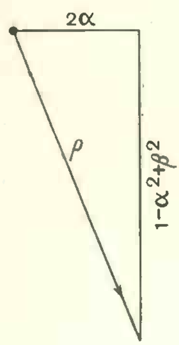


Fig. 12.

From (23) the absolute value of ρ is given by

$$\rho^2 = 4\alpha^2 + (1 - \alpha^2 + \beta^2)^2 \quad \ldots \quad (25)$$

On differentiating * with respect to α and equating to zero, we find that the minimum values of ρ occur when

$$\alpha = \pm\sqrt{\beta^2 - 1} \quad \ldots \quad \ldots \quad (26)$$

Since $\alpha = L \cdot 4\pi \cdot \triangle f/R$ and β = coupling reactance/R this expression can be put in the usual form.

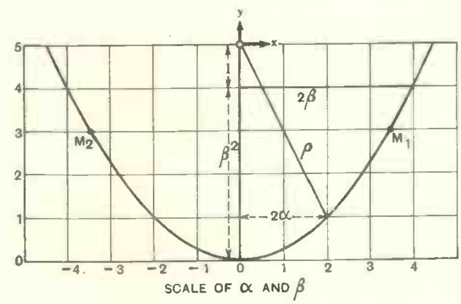


Fig. 13.

Peak separation $= 2 \cdot \triangle f$

$$= \frac{1}{2\pi L} \cdot \sqrt{[(\text{coupling reactance})^2 - R^2]} \quad \ldots \quad (27)$$

When $\beta < 1$ the value given in (26) becomes imaginary and ρ has only a single minimum, which occurs when $\alpha = 0$. Fig. 13 illustrates these results, for as β decreases the origin moves down the axis and M_1 and M_2 approach each other, finally coalescing at the apex when $\beta = 1$.

When $\beta > 1$, the minimum value of ρ is found by eliminating α between (25) and (26), and the result is that ρ (minimum) $= 2\beta$. If this value is inserted in equation (22) the right-hand side becomes $2R$, which is the impedance of the circuit of Fig. 10 at resonance when X is removed. Hence the introduction of the coupling reactance causes no loss of output signal strength provided that $\beta > 1$.

When $\beta < 1$, the minimum ρ occurs when $\alpha = 0$. In this case (25) reduces to

$$\rho = 1 + \beta^2$$

as is also evident from Fig. 13. The right-hand side of (22) now becomes $2R(1 + \beta^2)/2\beta$ and accordingly is greater than $2R$, so that the output signal falls off when the coupling reactance is smaller than the coil resistance.

4. Generalised Filter Resonance Curves.

From Figs. 10 and 11 we see that when X is in position $i = e \cdot \beta/R \cdot \rho$, while when X is removed and the circuit tuned to resonance

*Over the resonance range β is regarded as a constant.

$i = e/2R$. The ratio of the first current to the second is $2\beta/\rho$, and this is also the ratio of the corresponding output voltage signals. We will call this ratio the relative output voltage of the filter. Substituting the value curve is obtained, and Fig. 14 shows a set of curves for various values of β. The peak value of V is unity provided that $\beta >$ or $= 1$. The broken curve is repeated from Fig. 6 and refers to a single tuned circuit LCR, such

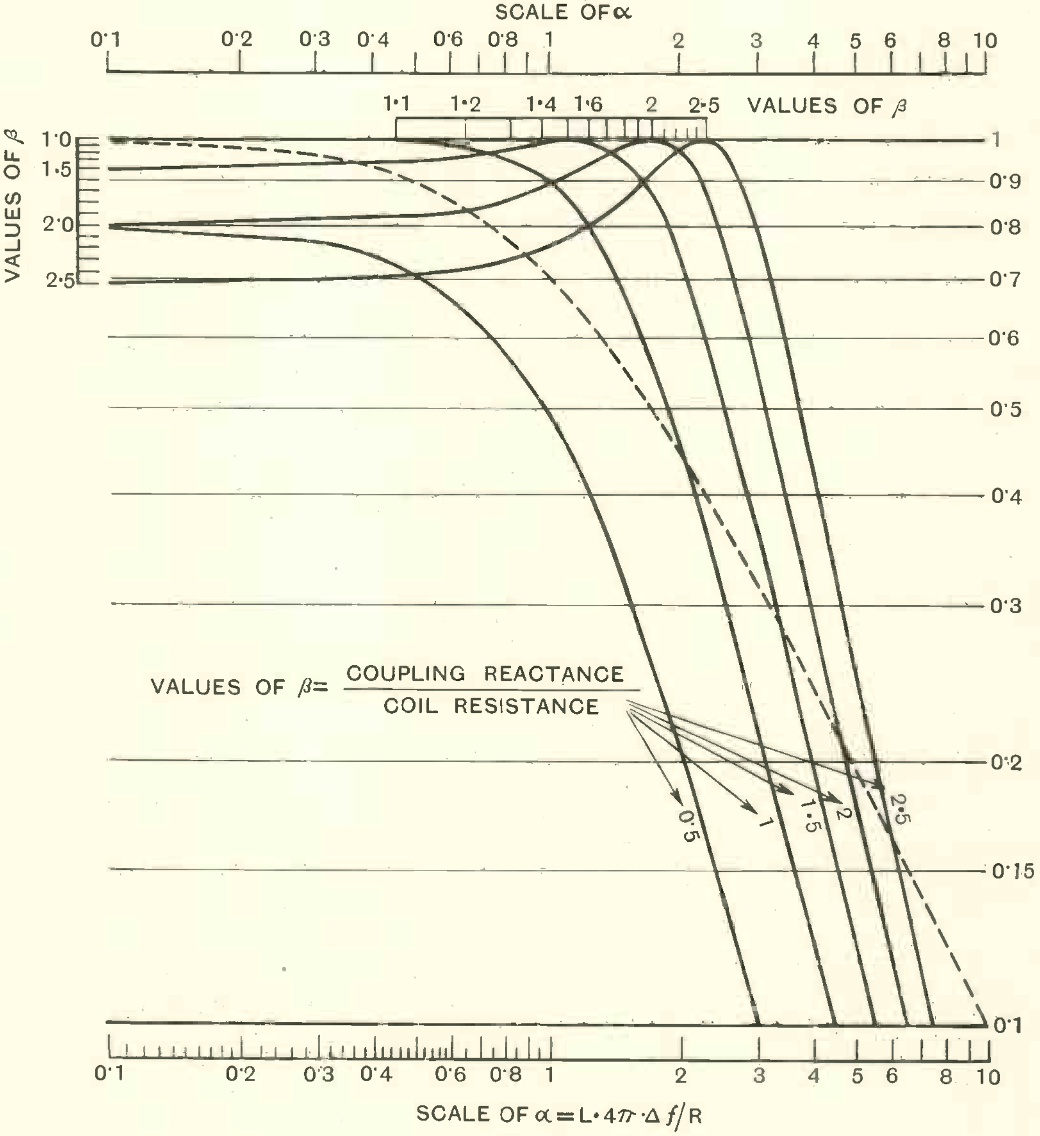


Fig. 14.

of ρ given by (25) we have

V = relative output voltage of filter

$$= 2\beta/\sqrt{[4\alpha^2 + (1 - \alpha^2 + \beta^2)^2]} \quad .. \quad (28)$$

When V is plotted against α a resonance as that shown in Fig. 1. Curves for values of β other than those shown can be roughly drawn by help of the two auxiliary scales on the upper part of the diagram; these indicate the initial point of the curve and the position of the peak.

This generalised chart can be adapted to any particular case as soon as L and R are known, since the scale of α can then be transformed into a scale of frequency off tune.

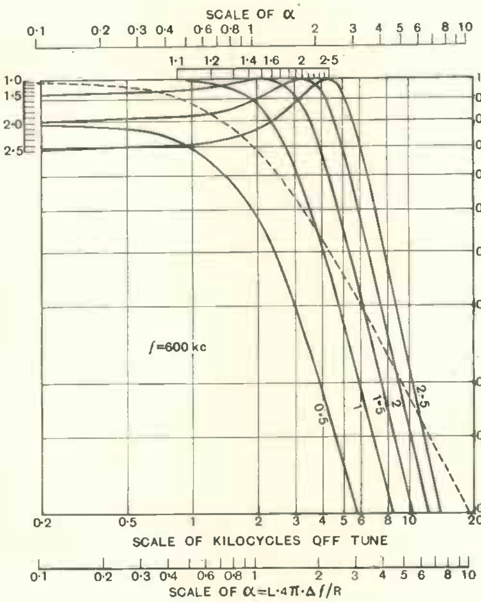


Fig. 15.

4. 1.—*An Example.*

Assume that in Fig. 10 the coils LL are made to the specification given in Table 1, Section 2, 2. For each coil $L = 230$ μ.H, $R = 5.45$ ohms at 600 k.c., 10.7 ohms at 1,000 k.c., and 24.8 ohms at 1,500 k.c. At each carrier frequency the scale of α can be transformed into a scale of k.c. off tune, and the results are shown in Figs. 15, 16, 17.

Inspection of these figures now enables us to assign the most suitable value of coupling reactance at each frequency. Suppose that the requirements are that up to 6 k.c. on each side of resonance V should not fall below 0.7, and that the cut-off should occur at about 20 k.c., the cut-off being taken as the point on any curve where $V = 0.1$. Then at 600 k.c. the curve for which $\beta = 2.5$ fulfils the first requirement and cuts off at 14 k.c. At 1,000 k.c. we choose $\beta = 1.1$ and the cut-off occurs at 17 k.c. At 1,500 k.c. the curves are all too flat: even with $\beta = 1$ the cut-off is at 39 k.c., and smaller values of β lead to loss of signal strength. If we can afford to let the peak signal drop to 0.8 we may choose $\beta = 0.5$, the cut-off now occurring* at 29 k.c.

These results are collected in Table 2, in which the 2nd and 3rd columns are multiplied

TABLE 2.

f	R	β	X
Carrier frequency. k.c.	Coil resistance. ohms.	From Figs. 15–17.	Coupling reactance required. ohms.
600	5.45	2.5	13.6
1,000	10.7	1.1	11.8
1,500	24.8	0.5	12.4

together to give the coupling reactance required at each carrier frequency. The problem now is to design the coupling so that these figures may be obtained, and a method for rapid design will be given in Sections 5 and 6.

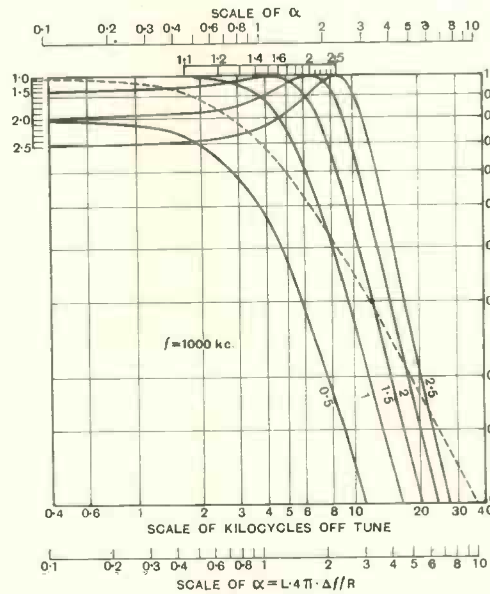


Fig. 16.

It may be remarked in passing that the usual method of designing filters on a basis

*On the diagram $V = 0.1$ at 26 k.c., but in order to get the cut-off point the whole curve must be displaced upwards till the peak value of V is unity. On producing the lower part of the curve the cut-off now occurs at 29 k.c.

of constant peak separation may involve undesirable results. It is evident from Figs. 15–17 that if a peak separation of 8.6 k.c. is prescribed at all carrier frequencies,

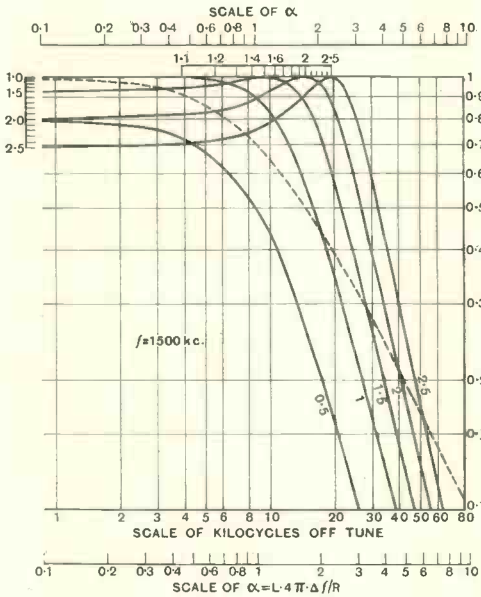


Fig. 17.

the curve, while correct at 600 k.c., is too flat at 1,000 k.c. and 1,500 k.c., for the side-bands are maintained to an unnecessary extent and the cut-off is insufficiently sharp.

The generalised filter resonance curves of Fig. 14 can be applied as in Figs. 15–17 as soon as L and R are known. The most suitable curve is then chosen at each broadcast frequency and the required coupling reactance $X(=\beta \, . \, R)$ is calculated. The design data for coupling are then obtained from Figs. 19 and 22.

5. Inductance-capacity Mixed Coupling.

Fig. 18 shows three well-known types of filter. Since the third includes the other two as particular cases, it is sufficient to consider the coupling reactance

$$X = - M\omega - 1/C\omega.$$

The curve obtained by plotting

$$M\omega + 1/C\omega$$

against ω on logarithmic paper, taking fixed values for M and C, remains of the same shape when M, C, are replaced by kM, C/k, k being any arbitrary number. Hence the shape is determined only by the product $M \, . \, C$ while the position depends on the ratio M/C.

This gives a hint as to the construction of a generalised design chart. Take a fixed frequency $f_0 = \omega_0/2\pi$, where the value of f_0 is left unspecified for the moment, and plot

$$y = (M\omega + 1/C\omega)/(M\omega_0 + 1/C\omega_0)$$

against f/f_0. This curve may be specified by a quantity A, where

$$M\omega_0 = A(M\omega_0 + 1/C\omega_0) \quad .. \quad (29)$$

and therefore

$$1/C\omega_0 = (1 - A)(M\omega_0 + 1/C\omega_0) \quad (30)$$

so that

$$y = A \, . \, \omega/\omega_0 + (1 - A)\omega_0/\omega \quad .. \quad (31)$$

Fig. 19 gives a set of these curves for different values of A. Since $y = 1$, when $f/f_0 = 1$, the curves pass through a common point (1, 1). If any curve is displaced parallel to itself on the chart so that the common point (1, 1) takes up the position f_0, $(M\omega_0 + 1/C\omega_0)$, then the curve gives the actual reactance plotted against f.

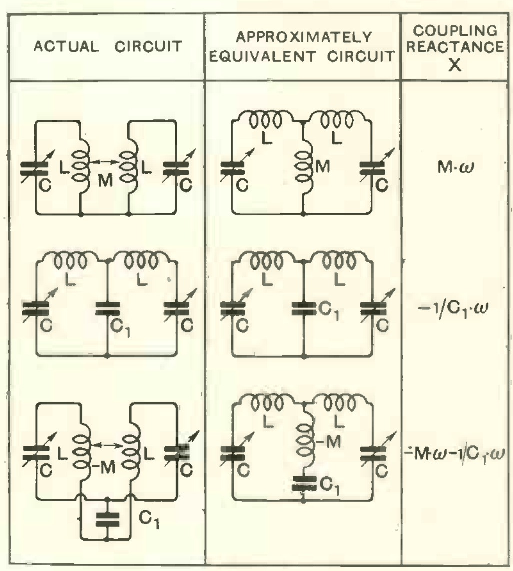


Fig. 18.

For the abscissae are now multiplied by f_0, while the ordinates are multiplied by $M\omega_0 + 1/C\omega_0$. Hence the abscissae now indicate f, while the ordinates indicate $M\omega + 1/C\omega$.

Since limitations of space prohibit such a large displacement it is better to adopt the converse process, namely, to draw the required curve of coupling reactance on tracing paper and fit it on to one of the curves of Fig. 19, as is illustrated in the following example.

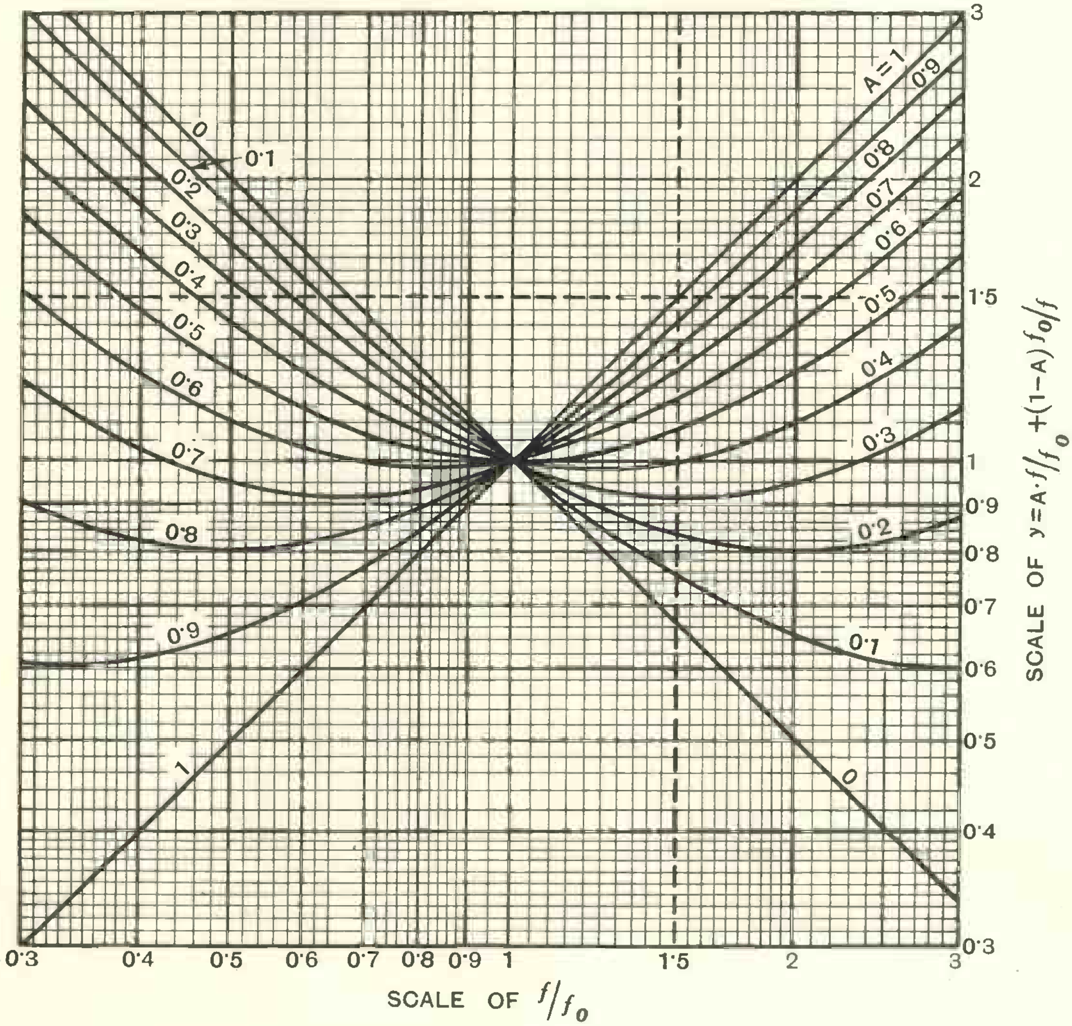


Fig. 19.

5. 1.—*An Example.*

From the data in Table 2 mark the values of R and X on tracing paper superposed on Fig. 19. The horizontal scale is to be regarded as a scale of kilocycles extending from 300 k.c. to 3,000 k.c., and the vertical scale as a scale of ohms extending from 3 to 30 ohms. Move the paper parallel to itself till the X-curve makes the best fit obtainable with one of the A-curves. As shown in Fig. 20, the curve $A = 0.5$ gives a close fit. Hence this curve when referred to the new scale gives the actual reactance $M\omega + 1/C\omega$. From the position of the common point we have

$$f_0 = 1{,}020 \text{ k.c.} \quad \ldots \quad \ldots \quad \ldots \quad (32)$$

$$M\omega_0 + 1/C\omega_0 = 11.75 \text{ ohms} \quad \ldots \quad (33)$$

Hence from (29) and (30)

$$M\omega_0 = 0.5 \times 11.75 = 5.87 \text{ ohms}$$

$$1/C\omega_0 = (1 - 0.5)11.75 = 5.87 \text{ ohms}$$

and substituting for $\omega_0 = 2\pi f_0$ from (32)

$$M = 5.87/2\pi \times 1.02 \times 10^6 = 0.92 \times 10^{-6} = 0.92\ \mu\text{H}.$$

$$C = 1/5.87 \times 2\pi \times 1.02 \times 10^6 = 0.027 \times 10^{-6} = 0.027\ \mu\text{F}.$$

The reader will find that the X-curve of Fig. 20 gives an equally good fit with other A-curves, for example $A = 0.4$ or $A = 0.6$. The values of f_0 and $M\omega_0 + 1/C\omega_0$ so obtained lead to the same numerical results for M and C.

When $A = 1$, equation (29) shows that $C = \infty$, and when $A = 0$, $M = 0$. Hence $A = 1$ corresponds to pure inductive coupling, and $A = 0$ to pure capacity coupling, while the intermediate curves represent mixed coupling.

6. Capacity—Capacity Combined Coupling.

Fig. 21 shows a filter in which the high potential ends of LL are connected by a capacity, and also the more general case in which two capacities C_1 C_2 are used to form a combined coupling. The equivalent circuits shown are correct to a high degree of approximation when C_2 is small compared with C. In the case of combined coupling, which includes the simpler circuit as a particular case, the coupling reactance is

$$C_2/C^2 . \omega + 1/C_1 . \omega$$

the minus sign being omitted. This may be written

$$C_2 . L^2 . \omega^3 + 1/C_1\omega$$

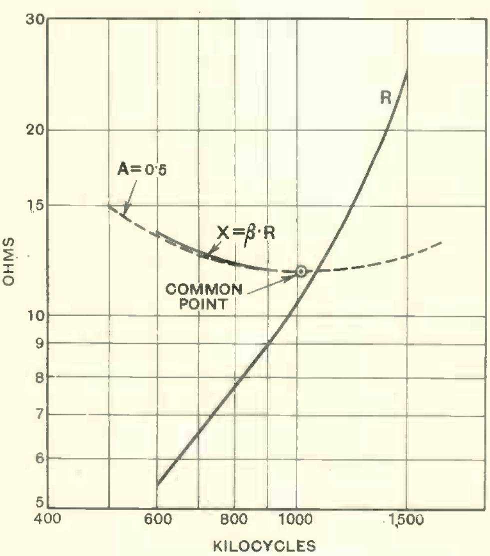


Fig. 20.

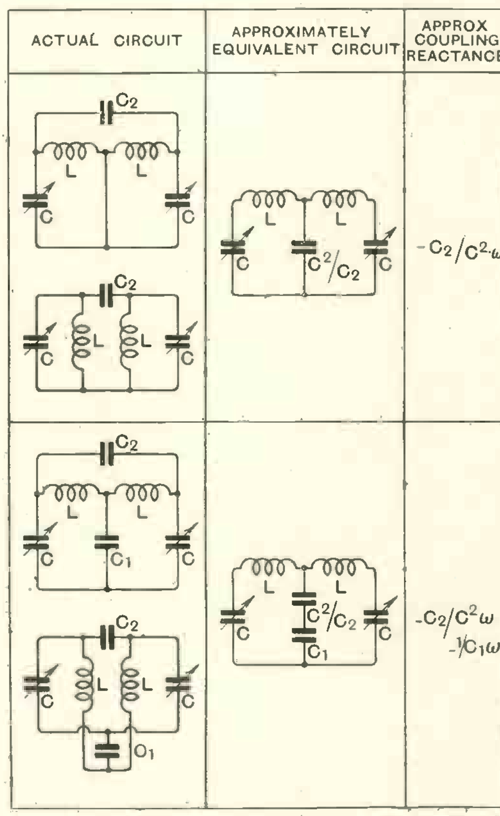


Fig. 21.

Hence as in equations (29)–(31) we can form a generalised chart by plotting

$$y = [C_2 . L^2 . \omega^3 + 1/C_1\omega]/[C_2 . L^2 . \omega_0^3 + 1/C_1\omega_0]$$

against f/f_0. Each curve is specified by a quantity A, where

$$C_2 . L^2 . \omega_0^3 = A[C_2 . L^2 . \omega_0^3 + 1/C_1\omega_0] \quad (34)$$

and therefore

$$1/C_1\omega_0 = [1 - A][C_2 . L^2 . \omega_0^3 + 1/C_1\omega_0] \quad .. \quad (35)$$

so that

$$y = A . \omega^3/\omega_0^3 + (1 - A)\omega_0/\omega \quad .. \quad (36)$$

A set of curves is given in Fig. 22 and may be used for filter design by the method described in Section 5.

6. 1.—*An Example.*

Draw on tracing paper the R-curve (Fig. 23) obtained from the data in Table 2. In finding the coupling reactance X which is required at various frequencies, let us assume X-curve turns upwards beyond $f = 1{,}000$ k.c. and joins the R-curve. When the tracing paper is moved over Fig. 22 the closest fit with the X-curve is given by $A = 0.1$, and the co-ordinates of the common point become

$$f_0 = 630 \text{ k.c.} \quad \ldots \quad (37)$$

$$C_2 \,.\, L^2 \,.\, \omega_0^3 + 1/C_1\omega_0 = 13 \text{ ohms} \quad (38)$$

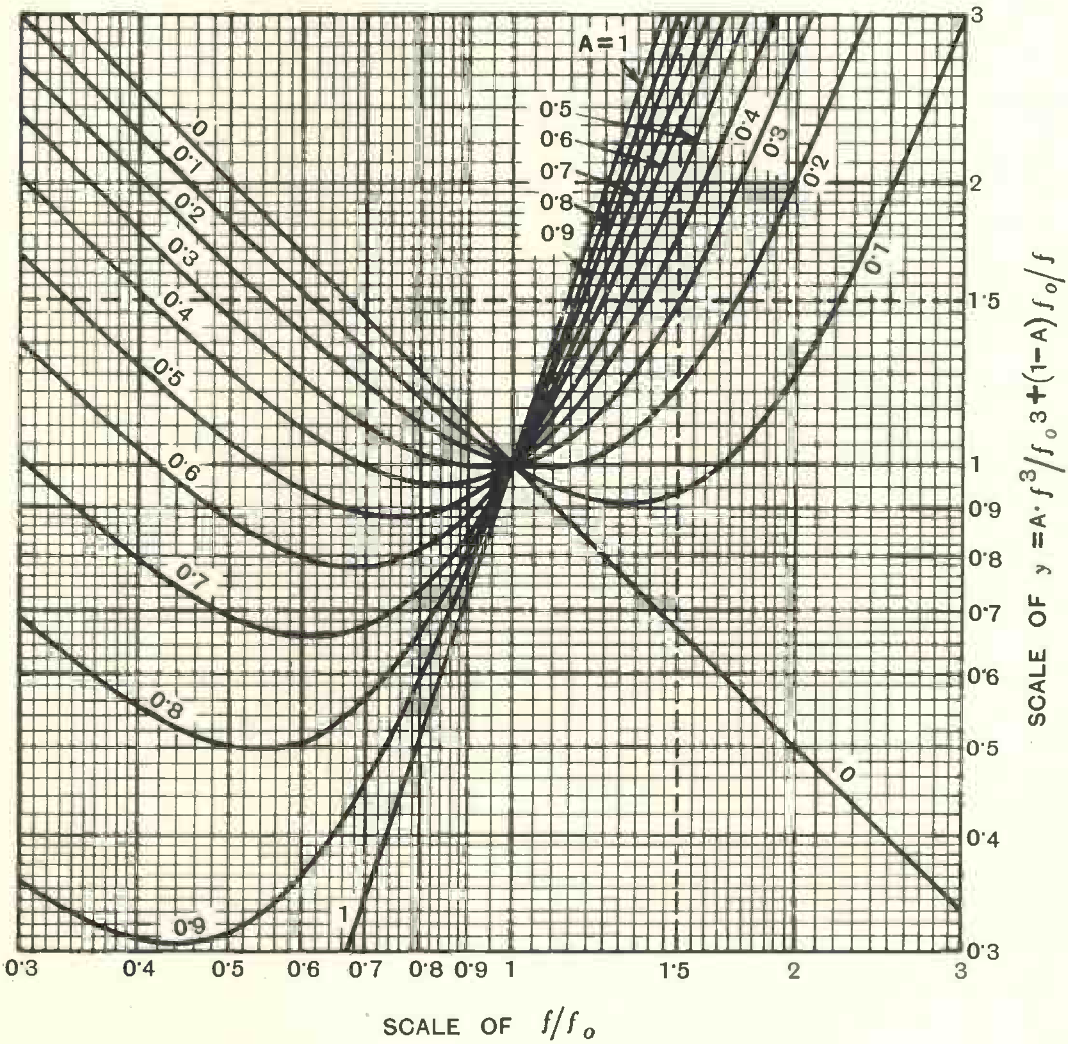


Fig. 22.

in this example that we cannot afford the loss of sensitivity involved in making β smaller than unity at the high frequencies. If at these frequencies we make $\beta = 1$, the

Hence from (34) and (35)

$$C_2 \,.\, L^2 \,.\, \omega_0^3 = 0.1 \times 13 = 1.3 \text{ ohms},$$

$$1/C_1\omega_0 = [1 - 0.1] \times 13 = 11.7 \text{ ohms},$$

and since

$$\omega_0 = 2\pi f_0 = 2\pi \times 0.63 \times 10^6 = 3.96 \times 10^6$$
$$L = 2.3 \times 10^{-4} \text{ henry.}$$
$$\therefore \quad C_2 = 0.4 \times 10^{-6} \mu\text{F.}$$
$$C_1 = .0215 \mu\text{F.}$$

7. Summary.

Figs. 14, 19, 22 contain all the data required for the design of symmetrical two-element band-pass filters.

The procedure is as follows :—

(1) Choose the value of inductance required for the coils *LL* (Fig. 10).

(2) Obtain the curve of coil resistance over the required range of high frequency *f*.

(3) At three or more frequencies within this range transform the horizontal scale of Fig. 14 into a scale of kilocycles off tune, using for this purpose the values of *L* and *R* already determined. Select in each case the most suitable value of β, the ratio of coupling reactance to coil resistance.

(4) From the values of β and *R* calculate the value of coupling reactance $X(=\beta . R)$ which is desired at each carrier frequency.

(5) Plot *X* against *f* on tracing paper placed on Fig. 19 or Fig. 22.

(6) Displace the tracing paper parallel to itself till the *X*-curve makes a close fit with an *A* — curve. Note the co-ordinates of the common point of intersection of the *A*-curves as read on the *X*-scale, *i.e.*, f_0 cycles/sec. and *h* ohms.

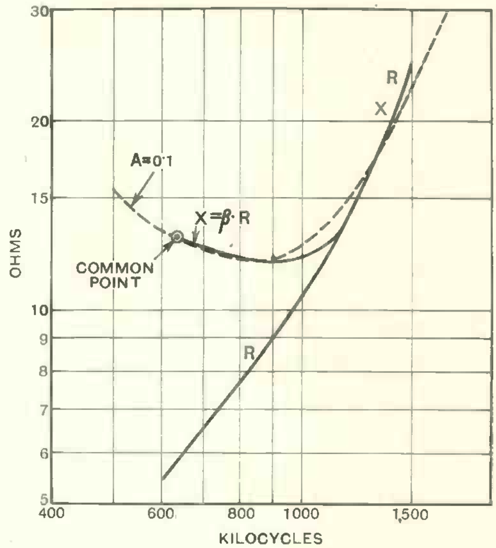


Fig. 23.

(7) Then in the case of inductance — capacity mixed filters (Fig. 19)

$$M . \omega_0 = A . h.$$
$$C_1 . \omega_0 = 1/(1 - A)h$$

while for capacity — capacity combined filters (Fig. 22)

$$C_2 . L^2 . \omega_0^3 = A . h.$$
$$C_1 . \omega_0 = 1/(1 - A)h.$$

Changes in Patent Procedure.

By Our Legal Correspondent.

IMPORTANT developments relating to the grant of patents for invention are foreshadowed in the provisions of the new Patents and Designs Act, 1932, which is scheduled to come into force on the 1st November next. The measure is designed to carry into effect, as far as possible, the recommendations made in the recent report of the Government Committee which sat under the Chairmanship of Sir Charles Sargant to consider what reforms could be made in the present system.

Perhaps the most significant change introduced by the new Act is an enlargement of the Official search normally made by the staff of the Patent Office into the novelty of each application.

It must be borne in mind that novelty is one of the major considerations on which the patent grant is founded. If it is absent the grant is void in law, even if Letters Patent have formally been issued to an inventor.

Up to the present the Official scrutiny in this direction has been limited to a search covering the files of prior British patents for a period of fifty years back. If the invention succeeds in passing safely through this test it is assumed to be novel so far as the Patent Office is concerned. But if the inventor, having secured his patent, takes it into Court to sue for infringement, he is open to attack on all sides, and may find that he has been " anticipated " by a previous patent filed in some other country or by a disclosure in some technical paper or publication, in which event the Court may declare his patent void.

Extended Search.

To minimise this risk, the 1932 Act extends the area of the Official search so as to embrace foreign as well as British patents, and other relevant technical or scientific textbooks and publications. In short, it aims at instituting a " universal " search instead of the present restricted one, thus bringing the British Patent Office into line with certain foreign countries, notably the U.S.A. and Germany, where the Official search has been conducted on a similarly wide basis for several years past.

As can well be imagined, the task is one of enormous magnitude, and there must inevitably be some delay before all the necessary data can be collected and arranged in such order as to make the search fully effective. But it is intended to make a start on the 1st November next with the material already in hand, and to extend the scope gradually and systematically as time goes on.

To meet the extra cost involved, the Act provides that the stamp fee payable on filing a Complete Specification shall be increased from three pounds to four pounds. The cost of filing a Provisional Application remains at one pound as before, and the fee of one pound payable on sealing is left unaltered, so that the total cost of a sealed patent, in official fees, under the new procedure will be six pounds instead of five pounds.

In view of the additional work entailed by the extended examination the time allowed between filing a Provisional and its corresponding Complete Specification is increased from nine months to a year. Acceptance must take place within eighteen months of the date of the application, instead of fifteen months as at present, and sealing within twenty-one months instead of eighteen, though further extensions of these periods may be granted on the payment of prescribed fees. An inventor may also, by paying a fee, voluntarily postdate his application, at any time prior to acceptance, by a period not exceeding six months. These increased margins of time will in general have the effect of postponing the publication of the completed patent by a corresponding period—a delay which may have certain disadvantages so far as the public is concerned, but which appears to be unavoidable.

As a corollary, applications made from abroad for British patents under the International Convention will not become available for public inspection until eighteen months after the priority date claimed in the country of origin—as compared with the existing interval of one year.

Additional Regulations.

It is interesting to note that amongst the several grounds on which action can now be taken to revoke an existing patent, the following are specifically mentioned in the new Act :—

That the invention is obvious and does not involve any inventive step having regard to what was known or used prior to the date of the patent

That the invention is not useful

That the Complete Specification does not sufficiently and clearly ascertain the scope of the monopoly claimed

That the Complete Specification does not disclose the best methods of performance of the invention known to the inventor at the time when he filed his application at the Patent Office.

The Act also gives specific power to the Comptroller to refuse a patent for any invention which has been wholly described in a prior publication, or for any invention which is so obviously contrary to well-established natural laws as to be frivolous. Further, the present law is strengthened against persons who make groundless threats of legal proceedings for alleged infringement of a patent.

Finally, provision is made for the setting-up of a special Appeal Tribunal for the purpose of hearing Appeals from decisions of the Comptroller of the Patent Office. The Tribunal is to consist of a Judge of the High Court, nominated by the Lord Chancellor, and has power to examine witnesses on oath, to make rules regulating practice and proceedings, and to award costs.

Damping of Low-frequency Oscillations in a M.C. Loud Speaker.*

By N. W. McLachlan, D.Sc.

It is known that the lower register in a moving-coil loud speaker is due to either or both (*a*) the surround acting as an auxiliary resonant diaphragm; (*b*) the diaphragm resonating as a rigid structure on the surround after the manner of a mass on a simple coil spring.† The object of the

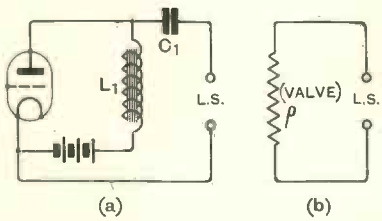


Fig. 1 (*a*). *Power valve circuit for L.S. with high resistance winding.* (*b*).—*Representative of* 1 (*a*) *when L and C are both very large.*

present article is to examine the conditions associated with (*b*), and to deduce an analytical relationship for aperiodicity.

A well-known power valve circuit used for operating speakers with high-resistance coils is shown in Fig. 1 (*a*). For simplicity the inductance L_1 and the condenser C_1 are assumed to be very large, *e.g.*, 100 H. and 50 μF. giving a natural frequency of about 2 ~. The circuit can therefore be redrawn as indicated in Fig. 1 (*b*), and into this we have to introduce something equivalent to the loud speaker when it is in operation. The speaker cannot be represented by an inductance in series with a resistance where a portion of the latter is attributed to radiation. Owing to the interaction of the mechanical resonance system with the coil and its associated magnetic field, it is necessary to introduce something in the nature of an oscillatory circuit. The arrangement portrayed in Fig. 2 (*a*) represents the valve and the equivalent electrical circuit of the moving-coil loud speaker.‡ It is very important to realise that *this is not the electrical analogue of the mechanical system.* If the equivalent electrical circuit were used in place of the loud speaker, the current, voltage, phase and power would be identical in the two cases. In the electrical analogue of the mechanical system, as shown in Fig. 2 (*b*), inductance ≡ mass and capacity ≡ compliance, whereas in Fig. 2 (*a*), L' ≡ compliance and C' ≡ mass, which is the other way round. Below 100 ~ the reactance of L_0 and the damping of R' are negligible. Thus the circuit ultimately reduces to the simple parallel $L'C'r$ combination of Fig. 2 (*c*). From the well-known differential equation to this circuit the condition for aperiodicity is

$$\frac{1}{4C'^2r^2} > \frac{1}{L'C'}$$

or

$$L' > 4C'r^2 \quad \ldots \quad (1)$$

where $r = R_0 + \rho$.

But from Fig. 2 (*a*) (see caption) we have

$$L' = C^2/k_0 \text{ and } C' = m/C^2$$

where $C = Hl$ = field strength × length of wire on coil.

k_0 = coefficient of restitution of diaphragm surround.

and m = equivalent mass of diaphragm.

Substituting these values for L' and C' in expression (1) we obtain the condition for aperiodicity. Thus

$$C^2 > 2\sqrt{k_0 m r^2} \quad \ldots \quad (2)$$

Referring to the electrical analogue of the diaphragm and the surround at low frequencies as illustrated in Fig. 2 (*b*), we see that the natural frequency in the absence of the magnetic field or with the coil open, is given in the electrical case by $\omega^2 LC = 1$ and in the mechanical case by $\omega^2 m = k_0$. Inserting this value of k_0 in formula (2) we find that the criterion for aperiodicity becomes

$$C^2 > 2\omega m r \quad \ldots \quad (3)$$

Since $C = Hl$, where H is the field strength, it follows that for given mechanical con-

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

† *Wireless World*, May 13th, 1931, and *Phil. Mag.*, 11, 1, (1931), 12, 771, (1931).

‡ *Wireless World*, Oct. 17th, 1928, and *Phil. Mag.*, 7, 1011, (1929).

ditions, aperiodicity is achieved only when the magnetic field strength exceeds a certain value determined by expression (3). The latter can obviously be rewritten in other ways, for example

$$r < C^2/2\omega m \quad .. \quad .. \quad (4)$$

which means that for any given type of loud speaker aperiodicity is obtained when the total resistance r is less than a certain value, namely, $C^2/2\omega m$. It may happen, however, that such a condition cannot be fulfilled. For example, it is clear from Fig. 2 (*a*) that the smallest possible value of r occurs when the coil is short-circuited on itself, *i.e.*, $\rho = 0$. If now r exceeds $C^2/2\omega m$, the motion cannot be aperiodic.

It should be clear that the aperiodic state is more likely to be secured with a small than a large value of k_0 the surround constraint, *i.e.*, the diaphragm should be readily moved to and fro by hand. Also from (4)

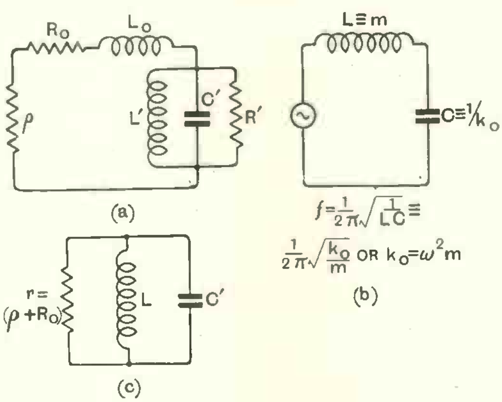


Fig. 2 (*a*).—*Equivalent circuit of power valve and loud speaker with elastic constraint. The L.S. portion applies equally to M.C. ammeters, oscillographs, galvanometers, etc.* k_0 *is the coefficient of restitution of the surround :* $L' = C^2/k_0$, $C' = m/C^2$, $R' = C^2/B$, *where* $C^2 = (Hl)^2$, m = *diaph. mass,* B = *mechl. resistance of diaph. due to sound and losses,* H = *field strength,* l = *length of wire on coil.* (*b*).—*Representative of* 2 (*a*) *under practical conditions at L.F.* (*c*).—*Electrical analogue of M.C. speaker with elastic constraint. Resistance has been omitted. For the decay state, the alternator is short-circuited and a resistance inserted.*

we see that the power valve should have a low resistance.

In calculating the value of C' the equivalent capacity, we use the formula m/C^2. The value of m to be inserted in this formula is termed the *equivalent* mass. If the kinetic energy of the diaphragm is $\frac{1}{2}mV_0^2$, then m is the equivalent mass and V_0 is the velocity of the coil. At low frequencies where the diaphragm moves as a whole, m = natural mass + accession to inertia. When, however, the diaphragm does not

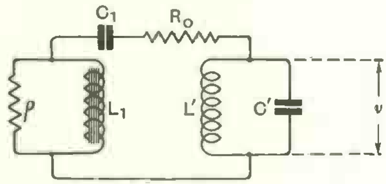


Fig. 3.—*Equivalent circuit of Fig.* 1 (*a*) *when L and C cannot be neglected.*

move as a whole, the velocity at the centre is different from that at various radii and m is reduced in value. It is always positive and must not be confused with the *effective* mass* defined by the impedance relationship $z = B + j\omega M_e$ where B is the mechanical resistance and M_e the effective mass both being referred to the driving point. M_e can be positive, negative or zero, and it arises from the interaction of the inertia and elastic forces together with the influence of transmission and radiation loss.

At frequencies contemplated in this article, the diaphragm can be considered to behave as a rigid structure, so that no difficulty arises concerning m.

The following example will introduce the atmosphere of practical values :

Let $C^2 = 1.2 \times 10^7$, $R_0 = 1{,}400$ ohms, $\rho = 2{,}600$ ohms,† mechanical resonance frequency $f = 50 \sim$ with coil circuit open, $m = M + M_1 = 30$ grams.

Then from (3) $2\omega mr = 7.5 \times 10^7$, which exceeds C^2. Thus the motion of the diaphragm would be oscillatory. Aperiodicity could be obtained by reducing the radial tension of the surround to a value where the natural frequency on open circuit was about $8 \sim$.

The foregoing is quite a typical case, and in general the motion of the diaphragm is oscillatory when the natural frequency occurs in the region of audibility. It is easy to show that the natural frequency *on open*

* *Proc. Phys. Soc.*, 44, 88, (1932).

† This is not the best value of ρ. It has been chosen for the purposes of illustration.

circuti is given by the formula

$$f = \frac{1}{2\pi}\sqrt{\frac{T_1}{ml}} \quad \ldots \quad \ldots \quad (5)$$

Where T_1 = radial tension of surround.

l = radial width of surround.

m = equivalent mass of diaphragm.

We are now in a position to examine the problem from a broader viewpoint. The circuit of Fig. 1 (*a*) is redrawn in Fig. 3 and it includes the equivalent circuit of the loud speaker excepting the static inductance of the coil L_0. Since the reactance of L_0 at low frequencies is small compared with $R_0 + \rho$, it can be omitted without serious error. There are now two possible periods of oscillation and the corresponding differential equation is :—

$$(aD^4 + \beta D^3 + \gamma D^2 + \delta D + \theta)v = 0 \quad (6)$$

where $D = d/dt$

v = voltage across C'

$r = R_0 + \rho$

$a = C'L'C_1L_1r$

$\beta = C'L'C_1R_0\rho + L'L_1(C' + C_1)$

$\gamma = C_1L_1r + L_1\rho(C' + C_1)$

$\delta = C_1R_0\rho + L_1$

$\theta = \rho.$

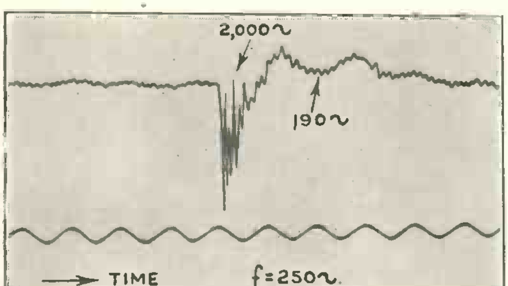


Fig. 4 (*a*).—*Impulse record of M.C. loud speaker with annular rubber surround. The coil of* 40 *turns was transformer coupled to the valve.* H = 7,000 *lines* cm^{-2}, *i.e., about* 0.6 *full strength.*

To solve this equation we consider the roots of the auxiliary equation

$$\lambda^4 + a\lambda^3 + b\lambda^2 + c\lambda + d = 0 \quad \ldots \quad \ldots \quad (7)$$

where $a = \beta/a$

$b = \gamma/a$, etc.

Since all the terms are positive there are —apart from equal roots—three possibilities :—

(1) Four imaginary roots, each pair corresponding to a different oscillation.

(2) Two imaginary and two real roots, corresponding to an oscillation superposed on an aperiodic decay curve.

(3) Four real roots corresponding to aperiodicity of the whole circuit.

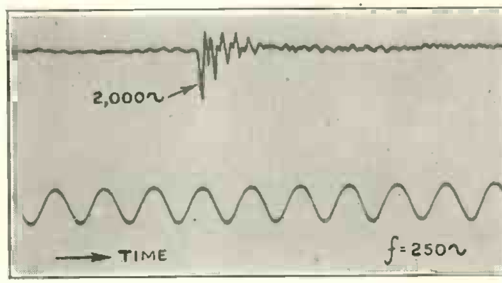


Fig. 4 (*b*).—*As at* (*a*) *but surround removed.*

The use of equation (7) can be illustrated by means of a practical example.

Let $C_1 = 2\mu$F, $L_1 = 30$ H, $\rho = 2{,}600$ ohms, $R_0 = 1{,}400$ ohms, $m = 24$ gm., $C^2 = 1.2 \times 10^7$, resonance $f = 50\sim$ when coil circuit is open.

At resonance we have from above

$k_0 = \omega^2 m \doteq 40f^2m = 2.4 \times 10^6$ dyne cm^{-1}. Also we have $L' = C^2/k_0 = 5$ H (caption to Fig. 2 (*a*)

and $C' = m/C^2 = .2\ \mu$F.

Computing the coefficients *a*, *b*, *c*, *d* in equation (7) we obtain

$$\lambda^4 + 2.8 \times 10^2\lambda^3 + 1.22 \times 10^5\lambda^2 + 1.55 \times 10^7\lambda + 1.083 \times 10^9 = 0 \quad \ldots \quad (8)$$

This biquadratic equation is solved in the customary manner, as shown in books on the theory of equations. Performing the necessary algebraic operations, we find that (8) can be written in the form of two factors thus :—

$$(\lambda^2 + 154\lambda + 1.18 \times 10^4)(\lambda^2 + 126\lambda + 9.08 \times 10^4) = 0 \quad \ldots \quad (9)$$

We now have two ordinary quadratic equations to solve. From (9) we can write

$$\lambda^2 + 154\lambda + 1.18 \times 10^4 = 0 \quad \ldots \quad (10)$$

and $$\lambda^2 + 126\lambda + 9.08 \times 10^4 = 0 \quad \ldots \quad (11)$$

The roots of both of these equations are imaginary, so that according to condition

(1) above there are two different oscillations. One oscillation is due to L_1C_1 and the other to $L'C'$, *i.e.*, the loud speaker diaphragm and its surround. Under these circumstances the solution of equation (9) and therefore of (10) and (11) is of the form

$$v = e^{a_1 t} (A_1 \sin \omega_1 t + B_1 \cos \omega_1 t)$$
$$+ e^{a_2 t} (A_2 \sin \omega_2 t + B_2 \sin \omega_2 t = P_1 + Q_1 \qquad \ldots \quad \ldots \quad (12)$$

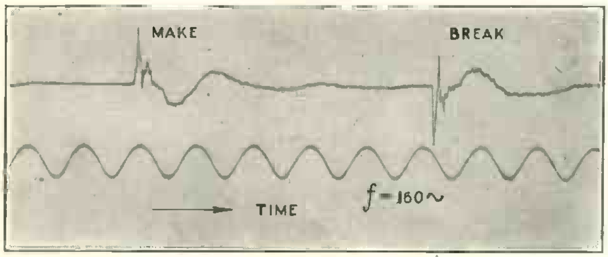


Fig. 4 (c).—*Impulse record of permanent magnet L.S. with leather surround. Moving-coil transformer coupled to valve.*

Both P_1 and Q_1 represent damped sine wave oscillations. The sum of the two gives v the L.F. voltage in the circuit after cessation of the driving voltage applied to the grid of the power valve.

From equation (10) we obtain

$$\omega_1 = \sqrt{1.18 \times 10^4 - \frac{154^2}{4}}$$

or $f_1 = \frac{\omega_1}{2\pi} = 12.2$ ~ this being due to L_1C_1.

From equation (11), we obtain

$$\omega_2 = \sqrt{9.08 \times 10^4 - \frac{126^2}{4}}$$

or $f_2 = \omega_2/2\pi = 46.8$ ~, this being due to the diaphragm, *i.e.*, $L'C'$.

Also the damping factor for L_1C_1 is

$$a_1 = \frac{154}{2} = 77,$$

and that for $L'C'$ is

$$a_2 = \frac{126}{2} = 63.$$

Thus the diaphragm oscillation has the lesser damping, owing to the influence of C_1 in series with ρ. The frequencies of the two circuits when isolated are 20.6 ~ and 50 ~ respectively, so that interconnection has reduced both values. The diaphragm oscillation occurs at too high a frequency and in practice would be serious; the L_1C_1 oscillation being inaudible can be disregarded.

To illustrate the problem more thoroughly, a series of impulse records* is given in Fig. 4, the circuital conditions were such that the L_1C_1 combination was large enough to be neglected. Record (*a*) shows three different oscillations (1) 33 ~ due to the diaphragm vibrating as a whole on the surround, *i.e.*, the $L'C'$ oscillation; (2) 190 ~ due to the surround oscillating as an annular membrane; and (3) 2,000 ~ due to the main symmetrical mode of vibration of the paper cone itself.† When the surround is removed, only the 2,000 ~ oscillation due to the diaphragm remains as shown in record (*b*). As a matter of interest the electrical analogue pertaining to the 33 ~ and 190 ~ oscillations is given in Fig. 5, resistance having been omitted. Record (*c*) portrays a particularly bad case where the annular surround was leather. The natural frequency of the diaphragm on the surround was 80 ~. In each of these cases the loud speaker coil was transformer-coupled to the valve, the circuit being that of Fig. 6.

If in equation (6) we divide throughout by the capacity C_1 and then make it infinite, *i.e.*, a short circuit, we obtain a differential equation of the third order which applies to the circuit of Fig. 6.

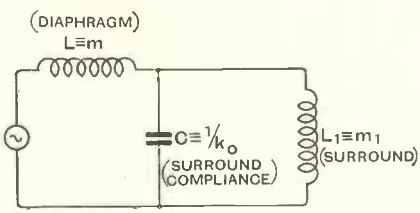


Fig. 5.—*Electrical analogue of M.C. loud speaker with elastic constraint. L and C correspond to the diaphragm oscillating as a whole on the surround: L_1 and C correspond to the surround vibrating as an annular membrane. For simplicity resistances representing losses have been omitted.*

* *Wireless World*, April 3rd, 1929, and *Phil. Mag.*, 12, 1, (1931), 12, 115, (1932).

† *Proc. Phys. Soc.*, 44, 408, (1932).

Thus for this case

$$a_1D^3 + \beta_1D^2 + \gamma_1D + \delta_1 = 0 \quad .. \quad (13)$$

where
$$a_1 = C'L'L_1r$$
$$\beta_1 = C'L'(R_0\rho + L_1)$$
$$\gamma_1 = L_1(r + C'\rho)$$
$$\delta_1 = R_0\rho.$$

Equation (13) can have (*a*) two imaginary and one real root (*b*) three real roots. Condition (*a*) is the one portrayed in the records of Fig. 4. The oscillation is superposed on a decay curve. To secure condition (*b*) the

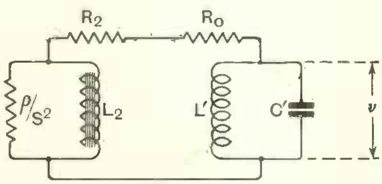


Fig. 6.—*Equivalent electrical circuit for records given in* Fig. 4 *where the valve is transformer coupled to a low resistance coil.* R_2 L_2 *are the resistance and inductance of the secondary winding, respectively, whilst* S *is the turns ratio.*

magnetic field would have to be very much more intense than that used during the experiments. In general, it is of interest to remark that the low-resistance secondary winding of a transformer provides greater damping than that obtained with a choke-condenser-coupled high-resistance coil.

There are other cases such as push-pull circuits where equation (6) can sometimes be reduced to the proper form by suitable substitution. The equation for Fig. 1 (*b*), this arrangement approximating to transformer coupling as shown in Fig. 6, is found by making both C_1 and L_1 infinite. Dividing each of the coefficients and the constant term of equation (6) by $C_1L_1(= \infty)$ we are left with

$$(L'C' + D^4 + L'D^3 + rD^2)v = 0,$$

or
$$\left(D^2 + \frac{D}{C'r} + \frac{1}{L'C'}\right)v = 0 \quad .. \quad (14)$$

where $r = R_0 + R_2 + \rho/s^2$.

This is the differential equation for the simple parallel $L'C'r$ circuit of Fig. 1 (*b*), and that from whose solution formula (1) above was derived.

Summary.

1. A fourth order differential equation is given which can be adapted to investigate the low-frequency growth or decay transients in a moving-coil loud-speaker.

2. When the natural frequency of the diaphragm on its surround occurs in the low-frequency audible region, *e.g.*, above 25 ~, the transient is usually oscillatory.

3. For good reproduction the natural frequency with the coil on open circuit should be below audibility. This does not apply to the case where the surround acts as an annular membrane. Here the natural frequency of the membrane should be in the neighbourhood of 100 ~.

4. The stronger the magnetic field and the lower the *closed* coil circuit resistance, the greater the damping.

There is little doubt that if the magnetic field strength in commercial loud speakers were increased appreciably, the quality of reproduction would be enhanced due to reduction in the natural oscillations which occur over the frequency range, and to the livelier response to transients (quicker growth and decay).

Sullivan Instruments.

We have recently received four new catalogues of Sullivan measuring instruments including the latest Sullivan-Griffiths screened generating sub-standard wavemeters, temperature-controlled valve-maintained tuning fork, Lucas-Sullivan quartz controlled multivibrator wavemeter, capacity matching set for comparing ganged condensers, etc. The catalogues are issued by H. M. Sullivan, Ltd., Leo Street, Peckham, London, S.E.15, and the subjects are classified as follows: (1) *Laboratory Condensers* (variable air condensers, fixed air condensers and mica condensers). (2) *Wavemeters* (including frequency standards, inductance standards and allied radio-frequency apparatus). (3) *Precision A.C. Measuring Apparatus* (non-reactance resistances, bridges and capacity test sets). (4) *Precision D.C. Measuring Apparatus* (galvanometers and shunts, high resistances, Wheatstone bridges, etc.).

Olympia, 1932.

Impressions of the Radio Exhibition.

SINCE the wireless industry has grown up round the desire of the ordinary man to have music in his home, it is naturally the receivers that first draw one's attention in a preliminary survey of the exhibits at Olympia. It was soon evident that the predominant type, at any rate in numbers and variety, was the general-purpose three-valve set, using a screen-grid high-frequency stage, a detector with reaction, and an output valve, this usually being a pentode for the sake of the slight extra gain it provides.

An approximate census of receiver-types is given in an accompanying table, reference to which will show that the three-valve set of this general type accounts for some 40 per cent. of all receivers exhibited. The popularity of this circuit is probably due to the fact that it is the simplest that will give reasonable satisfaction for general-purpose reception, reproducing the local stations and a few of the stronger foreigners at really acceptable quality. How many other stations such a set can be said to bring in depends chiefly on the musical standards set by the listener. It is self-evident that neither the range nor the selectivity of so simple a set can be adequate for more than eight or ten stations in any locality not favoured by better conditions of reception than those to which the Londoner is accustomed.

Two-valve Receiver Types.

Simple two-valve sets and superheterodynes run neck and neck for second place in the estimate of public favour that the exhibitors have set before us. The popularity of the two-valve receiver is probably due to a mixture of two causes, which have resulted in the production of two quite different types of set. In one of these price is frankly the predominating factor, the quality of reproduction usually being such that no discussion of it could be honest without also being libellous. Such receivers can often be recognised, even by the technically uninitiated, by the claims made for the reception of foreign stations. The suggestion that foreign stations can be received at loud-speaker strength on a two-valve set betrays all too clearly the vendor's standard of musical reproduction.

The second type of two-valve set makes no claim whatever to the reception of any but the local stations, but is designed with the idea of reproducing these in a manner that will give real pleasure to the musical listener. It is not restricted to two valves for reasons of price—it may even be relatively expensive—but because its purchaser is content to receive the local stations only. There is a limited but increasing number of listeners who demand the very highest standard of reproduction, and who have learnt that reception from foreign stations is usually sufficiently marred by background

Approximate Census of Receiver-types shown at Olympia.

Circuit.		Sets.	Total.	Percentage.
2-valve ...	Battery ..	18	51	16.7
	Mains ...	33		
3-valve ...	Battery ..	14	16	5.2
0-v-2	Mains ...	2		
3-valve ...	Battery ..	19	122	39.9
1-v-1	Mains ...	103		
4-valve ...	Battery ..	1	43	14.0
2-v-1	Mains ...	42		
4-valve ...	Battery ..	17	21	6.8
1-v-2	Mains ...	4		
5-valve ...	Battery ..	1	1	0.3
2-v-2	Portable .			
Superhetero-	Battery ..	8	53	17.3
dyne.	Mains ...	45		
Battery Sets (all types)		—	78	25.4
Mains Sets (all types) ..		—	229	74.6

This table, which has been compiled from catalogues, does not include kit sets.

noise and interference of all sorts to make pleasurable listening, for them, an impossibility. They therefore restrict themselves to the local stations, and require for their reception a set of the very highest attainable standard.

Were price not a factor in the choice of a set it would seem probable that the market would consist almost entirely of two types of receiver. Of these one would be a high-grade local-station set, designed to please the most exacting listeners of all, while the second class would consist of multi-valve receivers, probably of the superheterodyne type, designed to please those who are willing to make some slight sacrifice of musical quality for the sake of having a wide range of programmes at their disposal.

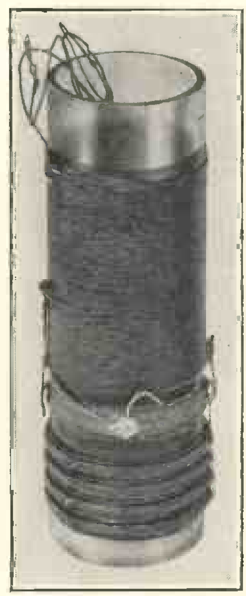
That price is a factor, and a very important one, is shown by the extreme popularity of the three-valve set, which in most cases cannot be regarded as perfect from either of the two points of view discussed, but is a price-controlled compromise between the two.

"Straight H.F." v. "Superhet."

The extension of the popularity of the superheterodyne has taken place very largely at the expense of the multi-valve receiver employing ordinary tuned high-frequency amplification. There can be no question that a "straight H.F." receiver, if it is to have selectivity fully adequate to present-day needs, must of necessity be rather complex in design, and will, in addition, tend to require more skill in handling than the modern ganged superheterodyne. On the other hand, there can be little doubt that where selectivity is not regarded as an urgent problem a receiver containing two variable-mu stages in conjunction with three or four tuned circuits of conventional type gives very satisfactory results indeed, and will probably always be cheaper than a superheterodyne of equal sensitivity. As long as price remains a factor in the choice of sets it would seem that there will always be a satisfactory market for the long-range straight set.

On the other hand, many manufacturers seem to have decided that a long-range set is an expensive luxury anyway, and that once embarked on the hunt for distant stations the purchaser will not begrudge the extra few pounds for which he can acquire the high selectivity of the superheterodyne; these makers offer no other type of long-range set.

It is interesting to notice that the intermediate low-frequency stage, which at one time was always interposed between detector and output stage, has practically vanished from mains receivers. Where it is retained it almost always implies the use of an output requiring so large a grid-swing that the unaided detector cannot supply the necessary signal voltage without itself suffering from overloading: in other words, the output stage approaches "public address" dimensions. In battery sets it is commoner, but even there is restricted largely to portable sets, where the design difficulties accompanying the use of two high-frequency stages are probably insuperable owing to the need for extreme compactness and a self-contained frame aerial. A few sets in which low price is the main attraction still retain the 0-v-2 circuit.



Litz-wound tuning coils on glass formers are a feature of this year's Philips' sets.

An unexpected feature of the Show was the inclusion of several battery-driven radio-gramophones, in one at least of which battery dimensions were strictly limited by its inclusion in the small containing case. It is difficult to see the market for such designs when it is remembered that a portable gramophone giving considerably better quality and higher volume can be purchased for little more than the cost of the motor.

Battery sets as a whole made up only one quarter of the total exhibits of receivers, the remaining three-quarters being designed for mains operation. Whether the sales of each type will be in proportion to the number of models exhibited it is impossible to guess, but from the fact that quite an appreciable number of makers do not think it worth while to offer any battery models at all one might perhaps assume it is expected that the mains receivers will sell much the more freely.

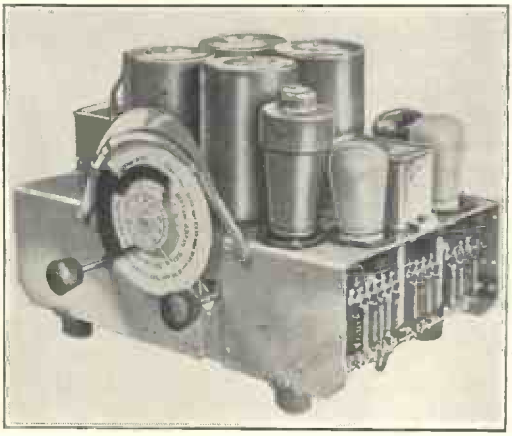
General tendencies in design are interesting, and though no statistics are available to prove the point, the impression was gained that the pentode is in a very large majority among output valves. The wider use of this type of valve is probable bound up with the habit, now almost universal, of including the loud speaker in the set, so that the necessary precaution of matching the load to the valve can be taken. Few manufacturers would care to take the risk of selling a set with a pentode in the output socket and leaving the choice of loud speaker entirely in the hands of the purchaser, though it is reasonably safe to do so when a triode output valve is used.

At the other end of the set it is very noticeable that the variable-mu valve has already nearly ousted the ordinary screen-grid valve both for high-frequency and intermediate-frequency amplification. The band-pass filter, primarily desirable for its ability to protect the grid of the first valve from the assaults of a powerful nearby station, is not nearly so essential when a variable-mu valve is used, and so has not extended its popularity appreciably beyond that which it had achieved a year ago. It is nevertheless a common feature, especially in three-valve sets, where a third tuned circuit confers a very acceptable increase in selectivity.

Screen-Grid Detectors.

In detector stages the ordinary triode remains the almost universal choice, but there are signs that its supremacy in this connection will be very seriously challenged next year by the screen-grid valve, which offers the advantages of greater available output combined with less input damping and slightly higher sensitivity.

The detector socket has for some time been the last secure stronghold of the triode; already some sets are offered in which no triode is used, and it is probable that receivers of this type will gain in popularity in the future. Even the oscillator socket of a superheterodyne is no safe place for the three-electrode valves; bigrids, screen-grid valves, and pentodes all lay claim to use as combined oscillator-detectors, while a dynatron oscillator is at least an alternative to a triode where the functions of oscillation and detection are awarded a valve apiece. Will the Show of 1935 contain no triodes at all?



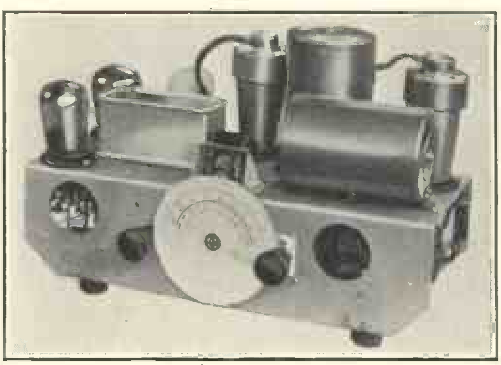
Philips' type 630A chassis incorporating two H.F. stages with Litz-wound high-efficiency tuning coils.

In details of design there was, as a whole, little of real novelty or of outstanding interest. In nearly every case the receivers offered represented the best of modern practice, but did not venture outside the limits of conventional design. The need for enhanced selectivity has resulted in a mild tendency to increase the efficiency of the tuning coils used, though the need for reasonable compactness and complete screening, combined with the demands of manufacturing convenience, have made any great movement in this direction very difficult.

The most ambitious attempt to attain selectivity by the use of highly efficient coils was that shown on the Philips' stand. The coils in question are wound with 15-strand Litzendraht on a former 1½in. in diameter, this former being made of glass to reduce dielectric losses. The screening-box surrounding the coil is made of copper instead of the more usual aluminium, and is not only considerably higher than most coil-screens, but has, in addition, the unusually large diameter of 3in. The coil itself has a winding length considerably in excess of its diameter, giving a long coil of the type that is known to offer the lowest high-frequency resistance when screened.

The gang-condenser used to tune these coils is a marvel of compactness; each section is hardly larger than a match-box, although its maximum capacity is 0.0006 mfd. This high capacity in a small space is attained by decreasing the spacing between the two sets of plates to about one-fifth of a millimetre. Dielectric losses have had careful attention here too—it was noticed that the insulation between stator-plates and frame consisted of porcelain, which is known to be an extremely good dielectric from the high-frequency point of view. As a result of these precautions the dynamic resistance of the tuned circuit reaches, we were told, the extraordinarily high figure of 600,000 ohms at 200 metres, which, since the coil has an inductance of 200 microhenrys, implies a magnification of about 320 at this wavelength, while one might perhaps hazard the guess that at about 450 metres the magnification would reach 400.

That a tuned circuit of such high magnification requires rather special accuracy in ganging and matching will be realised when it is pointed out that a tuning error of 5 kilocycles in 600 will reduce the signal voltage to less than one-fifth of that at resonance. We were, therefore, not at all surprised to hear that the matching, both of coils and condensers, has to be carried out with an accuracy very considerably higher than that usual in commercial receivers. An additional refinement is the use of two separate trimmers for the two wavebands, the trimmers being associated with the coils instead of with the tuning condensers.



Philips' three-valve A.C. chassis, type 830A.

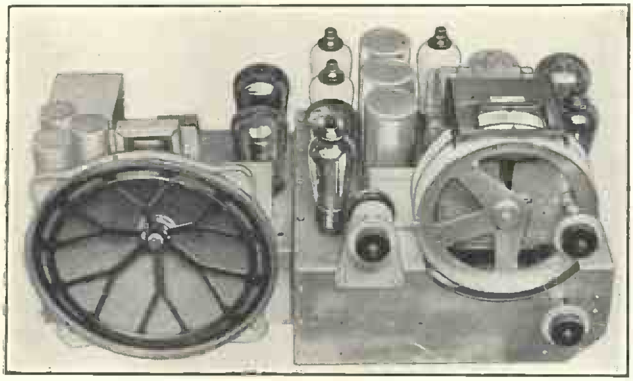
The reduction of dielectric losses in the tuned circuits just described necessarily implies that their dynamic resistance will fall off even more rapidly with increasing wavelength than would that of tuned circuits of more conventional design. Each of the two receivers using them is in consequence designed with one fully tuned stage of high-frequency amplification followed by a second stage in which the coupling to the detector valve consists of a high-frequency choke so designed that the amplification of the stage peaks at 600 metres on the medium-wave band and at 2,000 metres on the long-wave band. Substantially even amplification over each wave-range is thus attained.

Two sets are offered, in one of which a single tuned circuit precedes, and another follows, the first screen-grid valve, while in the more ambitious set each of these tuned circuits is replaced by a band-pass filter, the decreased gain thus brought about being compensated by an additional low-frequency stage. The writer had the privilege of an unofficial glance at a frequency-response curve of the receiver containing two band-pass filters; the selectivity fell very little below that of the average superheterodyne.

Superheterodyne Tendencies.

The superheterodyne receivers shown could broadly be divided into two general types. Some used a band-pass input filter followed immediately by the frequency-changer, but the general tendency was to add a stage of tuned high-frequency amplification when the limitations of price permitted. Using a variable-mu valve, the difficulties of overloading and cross-modulation that made the preliminary stage of amplification unsatisfactory for listeners living near a powerful station no longer exist, while the advantages of the stage in improving the signal-noise ratio, simplifying volume-control, and improving the stability of the I.F. amplifier without sacrifice of gain make its addition well worth while. It is interesting to notice that the superheterodyne, which began its existence as a receiver suitable for frame aerial use only, is now in every case designed for use with an open aerial.

Of the many models on view, one of the most interesting was the Murphy receiver, which possesses a number of unusual features. There are in all three pre-selector circuits connected with the preliminary high-frequency stage, but the conventional arrangement in which the band-pass filter precedes the valve has been abandoned. Instead, the single tuned circuit is connected to the aerial, while the band-pass filter is placed between the high-frequency valve and the first detector. This unusual arrangement has been adopted because it has been found that, by using the filter after the first valve instead of before it, valve noise is substantially reduced.



Murphy type A8 superheterodyne receiver with " double diode " detector and automatic gain control.

For the first detector another variable-mu valve is used, the coil used as coupling to the oscillator being in the cathode lead. The oscillator, a triode, has associated with its reaction coil a resistance-capacity network designed to keep the oscillation-voltage supplied to the first detector constant over the tuning-range. Two intermediate-frequency stages are used, the three band-pass filters associated with them allowing full scope for obtaining an exceptionally flat-topped resonance curve without sacrifice of adjacent-channel selectivity. The secondary of the first intermediate transformer is tapped at the centre for connection to the grid of the succeeding valve, thereby allowing the overall amplification to be lowered a little without sacrifice of the tuning characteristics.

The second I.F. transformer also has a centre-tapped secondary, but in this case the two ends are taken to the two anodes of a Mazda " Duo-diode " indirectly heated rectifier. Besides acting as second detector, this valve also provides automatic volume control, the rectified voltage being fed back through a system of potentiometers and decoupling resistances to vary the bias on both I.F. stages, the first detector, and the fundamental H.F. stage, all of which are of variable-mu type. To provide the voltage necessary to give the range of 1,000 to 1 over which the automatic volume control operates, it has been found necessary to apply a signal of 20 volts R.M.S. to the second detector; this accounts for the large amount of amplification preceding it, and makes it necessary, to avoid overloading the second I.F. valve, to feed back to it only a portion of the available signal-controlled bias.

Post-detector amplification has been cut down to a minimum; the diode, which, of course, provides no amplification at all, is coupled by its resistance to a screen-grid valve which in turn is coupled to the output pentode by a resistance of low value. A potentiometer grid-leak preceding the L.F. valve provides a manually operated volume control of range 500 to 1.

One of the minor difficulties in designing a modern superheterodyne lies in the need for finding a non-microphonic tuning condenser for the oscillator. In the Murphy

Ekco type S.H.25 superheterodyne receiver.

receiver the condenser is mounted on a steel tongue fixed at one end only, the other being steadied by rubber buffers.

The Ekco superheterodyne, which dispenses with the preliminary high-frequency stage, has an ingenious scheme for avoiding second-channel interference from the local station. A condenser of very small capacity is connected between aerial and the grid of the first detector, and is adjusted so that the voltage arriving at this grid by way of the tuned circuits is exactly counterbalanced by the voltage fed through this condenser. In practice the receiver is tuned to the point at which the second-channel interference is heard, and the condenser is then adjusted until it vanishes.

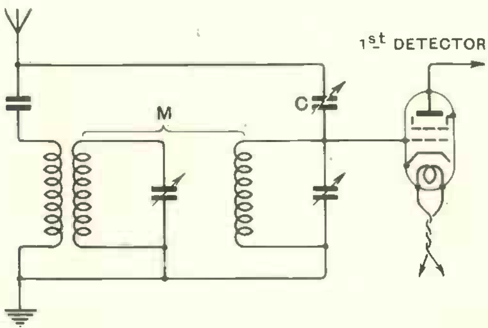


Fig. 1.—*Input circuit of Ekco S.H.25 superheterodyne. The adjustable condenser C, of capacity about 5μμF., can be set to remove second-channel interference from any one station.*

An Edison-Bell superheterodyne cuts the Gordian knot by using such an intermediate frequency that the tuning-points for second-channel interference fall outside the tuning range of the receiver ; the intermediate frequency is, therefore, much higher than usual.

Battery Sets.

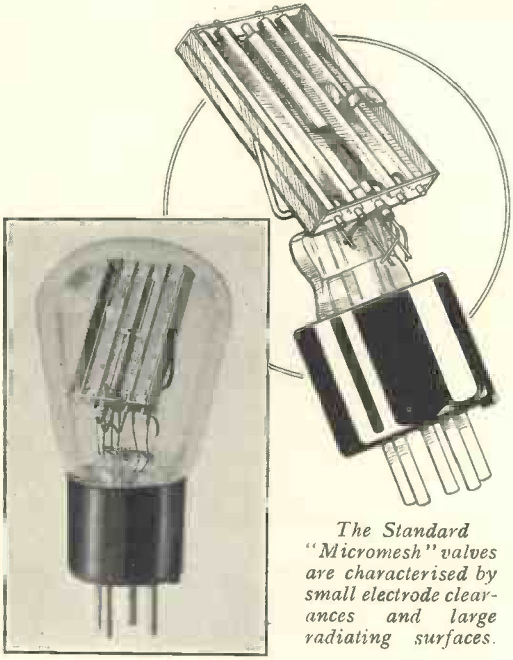
In battery sets, the chief novelty was to be found on the Philips stand, where there was shown a receiver in which the bias applied to the output valve—a pentode—is automatically regulated so that the anode current is never more than just enough to enable it to deal without distortion with the signal being handled at the moment. The method adopted is an ingenious adaptation of the automatic volume-control principle, and is carried out by connecting a valve, adjusted to operate as grid detector, in parallel with the loudspeaker, the rectified current being passed through a network of resistances in such a way as to control the grid-bias of the pentode in a suitable manner. As a result of this device, the receiver is able to deal with a loud signal when necessary, but the average anode current still remains within the capacity of a dry battery of moderate size. With no signal, the complete four-valve receiver only takes 5 milliamperes, this figure rising to 15 on a sustained laboratory signal calling for the full output of the last valve. When receiving music, the anode current would naturally fluctuate between these limits, rising to the full value only instantaneously on sudden peak notes. A fair average current for full-strength reproduction of a musical programme might be some 8 or 9 milliamperes.

Several receivers, among them being nearly all the larger sets of the Kolster-Brandes range, were equipped for the reception of short waves by plugging in a suitable coil. Though interesting, it would seem likely that this is only a passing phase so far as this country is concerned, for few would contend that any of the short-wave stations at present in operation possess


The Kolster-Brandes superheterodyne receiver, which is equipped for short-wave reception.

entertainment value on a par with that offered by transmitters on the medium-wave band.

In valves, the most noticeable general tendency is the replacement of the screen-grid valve by the more highly developed variable-mu type. Not only are there a number of these valves available for mains operation, but every maker now offers them in two-volt battery form. D.C. mains valves can now be had in a full range of types, and many of them draw no more than 100 milliamperes in the heater circuit. The high-efficiency pentode, which last year was a novelty, can now be obtained in a number of types from nearly all makers.



The Standard "Micromesh" valves are characterised by small electrode clearances and large radiating surfaces.

The only startling innovation is the Standard "Micromesh" series of A.C. mains valves. In these the clearance between the electrodes has been reduced to extraordinarily low limits, with the result that there is available a detector valve with an A.C. resistance of 10,000 ohms and a slope of 8 milliamps. per volt, and an output triode of resistance 1050 ohms having a slope of 12 and an undistorted output in excess of 1500 milliwatts. Although grid emission might be expected to result from the extreme closeness of the grid to the cathode, there is actually no trouble in this respect, the grid being kept cool in operation by a large metal fin. In spite of the large area of this fin, interelectrode capacities are, if anything, smaller than usual, the anode-grid capacity of the detector valve being only 5μμF. At the time of the Exhibition the manufacture of pentodes and screen-grid valves had not been embarked upon.

Two full-wave indirectly heated rectifiers

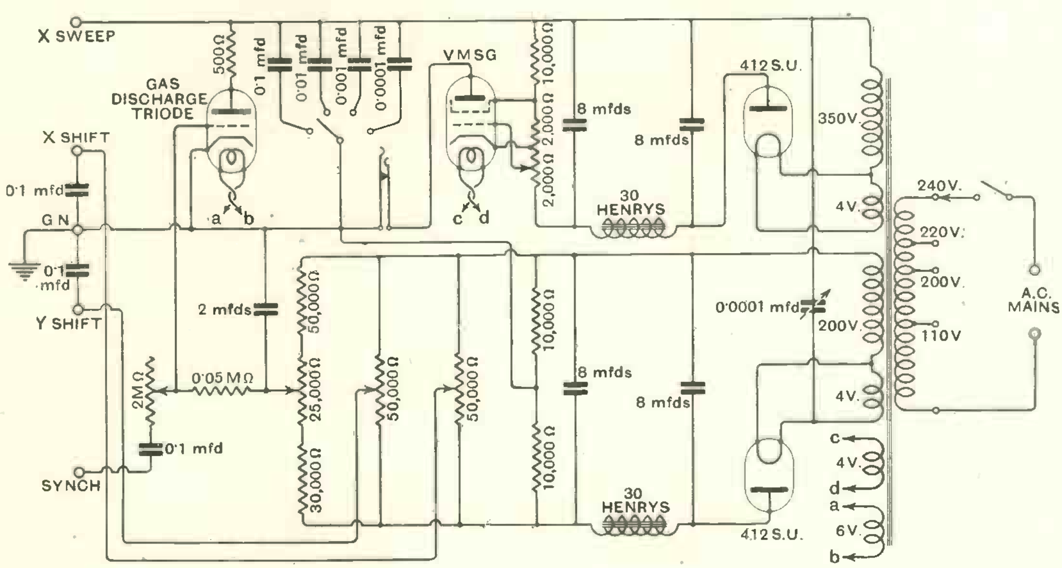
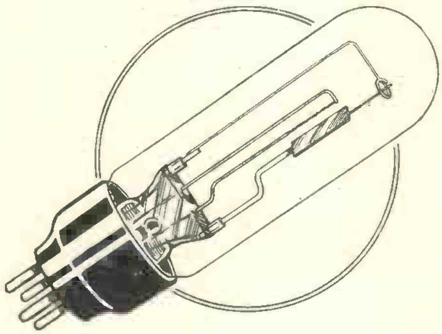


Fig. 2.—*Circuit of Cossor Time Base Unit.*

are also offered in the "Micromesh" series, one being rated for 250 v. 60 mA. and the other for 350 v. 120 mA. Owing to their exceptionally close clearances, the voltage drop across the valve itself is very small,



The Ediswan thermal-delay switch is mounted in vacuo and will break 200 mA at 1,000 volts.

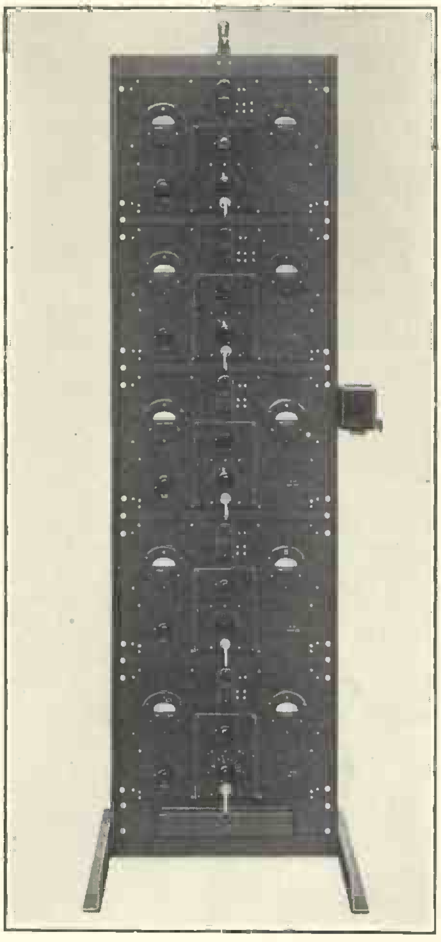
with the result that the valves actually deliver their maximum rectified current at 290 v. and 395 v. respectively if the R.M.S. voltage applied to their anodes is the maximum for which they are rated.

It is probably unnecessary to draw attention to the Standard cathode-ray oscillograph tube, which is a low-voltage hot-cathode tube of Braun type. It may be less well known that a linear time-base unit, self-contained with the exception of the power-supply, is also offered, and that there is available an A.C. power unit which will operate both the time-base and the tube itself, the supply for the tube being available at voltages of 300, 700, and 1,000 volts.

A more recent entrant to this field is the Cossor tube reviewed in the July issue of this journal. Subsidiary equipment is also offered for this tube, the time-base unit, of which the circuit is reproduced, being exceptionally complete. The adjustable synchronising device in this unit, which contains its own mains drive, enables the phenomenon under inspection to lock the time-base to its own frequency if desired. In addition to the time base, there is a complete power-unit for the tube itself, this giving a continuous range of voltages up to 3,000 volts.

Subsidiary Apparatus.

Thermal-delay switches of unusual type were seen on the Ediswan stand. These switches are totally enclosed in an evacuated bulb, and contain a bimetallic strip heated by radiation from a filament. The smaller switch will satisfactorily break up to 200 milliamperes at 1,000 volts, and owing to the indirect manner of heating the strip there may be a potential difference up to 1,000 volts between heater and contacts. The delay may be anything from 15 seconds to one minute according to the heater-voltage applied, and the switch is available in two patterns, one to make and one to



Ekco standard signal generator designed for use in works.

break the external circuit when the heater is energised. A larger switch will handle currents of 6 amperes at voltages not exceeding 250, and requires double the filament current of its smaller counterpart with which it is in other respects identical.

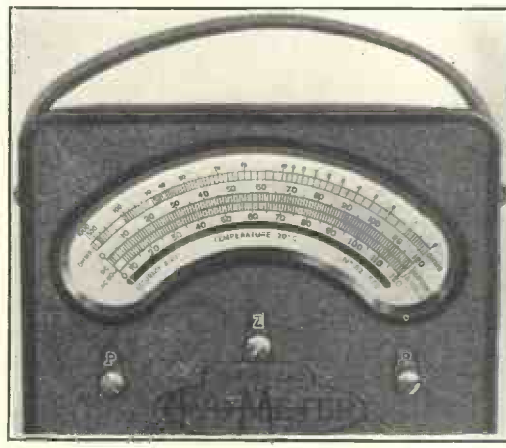
An exhibit which will be of considerable interest to the commercial set maker was shown by E. K. Cole. It consisted of a complete equipment for set-testing, its purpose being to check the overall sensitivity of a receiver at each of five wavelengths.

Westinghouse cuprous oxide photo-electric cell.

Five independent mains-operated oscillators, each with its own modulating equipment providing an individual audible note, are mounted up together on a large upright stand. The output from all five oscillators is mixed and fed through a screened transmission line to a number of test-positions, each with its own dummy aerial. Each oscillator is equipped with two meters, one monitoring the high-frequency output and the other enabling modulation to be held constant or varied at will from 30 to 50 per cent. Every contingency of the factory appears to have been taken into consideration, even to the necessity of testing sets of widely differing sensitivity with a common generator. The apparatus is designed for test work rather than for laboratory measurements, and though the output can be set by comparison with a standard signal-generator to any desired number of microvolts, it will in most factories be so adjusted that a receiver approved by the research department just passes the necessary tests. For this mode of use no auxiliary measuring apparatus whatever is required.

Metal rectifiers on the Westinghouse stand were present in profusion, and included among them were the small rectifier bridges used in A.C. meters of all types. A less-familiar exhibit was the copper-oxide photo-electric cell, which possesses the outstanding feature that the current generated is relatively large. With an external resistance equal to that of the cell (some 1800 ohms) a tungsten filament lamp evokes a current of about 5 microamperes per lumen. An interesting point is that the cell can also be used in much the same manner as a selenium cell. For some purposes this will give better results, since the current change on illuminating a cell which is already carrying a current is much greater even than the normal generated current. As much as 4 or 5 milliamperes can be passed through the cell from an external source.

In measuring instruments one novelty stood out; it was the new "Universal Avometer." The original Avometer is an instrument combining the function of a four-range milliammeter, a five-range voltmeter, and a four-range ohmmeter. To



The "Universal Avometer," which now incorporates seven 50-cycle A.C. ranges.

these D.C. ranges the new instrument adds three current ranges and four voltage ranges for 50-cycle alternating current, the usual copper-oxide rectifier being incorporated for this purpose. The instrument is no larger than the D.C. model, while the error on all ranges is within the limits laid down by the B.E.S.A. for first-grade instruments.

Besides their range of small instruments the Sifam company were showing an Aperiodic Impedance-measuring Test Set, as recently described by Mr. A. T. Starr in this journal. Readers who are interested are referred to page 325 of the issue for June, 1932.

A. L. M. S.

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.

Measurements of Impedances.

To the Editor, The Wireless Engineer.

SIR,—I would like to thank Professor Trewman for his letter in the August number of *The Wireless Engineer.* As regards his second point, I wish to state that I agree with Professor Trewman. The large condenser should be placed *in series with Z,* the word *across* being written in aberration; or, as Professor Trewman says, the *smallest* condenser should be placed *across Z.* In practice I have found it convenient to put 1 or 2 μF in series with the impedances I have measured. Whether a large condenser be placed in series or a small condenser in parallel is determined by the frequency of measurement and the magnitude of impedance to be measured. At higher frequencies in the audio-frequency range I have found a 2 μF placed in series to be most convenient; at radio frequencies an air condenser across the impedance would probably be most convenient.

With regard to his first point, I wish to point out that the method could be adapted to the range of frequencies when resistances are unreliable. In place of R_1 we could use a condenser C_1, when $Z = 1/\omega C_1$, and then C_2 is used in place of R_2, when $\phi = \sin^{-1}(1 - C_2^2/2C_1^2)$. Here it is necessary to know the frequency to the accuracy required in measurement, but it is not necessary to worry about the sign of ϕ as this is given.

Faraday House, W.C.1. A. T. STARR.

Mathieu's Equation and the M.C. Loud Speaker.

To the Editor, The Wireless Engineer.

SIR,—In your June issue I described a low-frequency phenomenon in M.C. speakers whereby the coil moved into the leakage field beyond the magnet, *i.e.*, a form of rectification. An outline of the analysis pertaining to this effect is given below.

Let m = total effective mass of diaphragm,

C = Force on coil per unit current (absolute), Length of wire × Radial Field Strength (H), $2\pi rnH = 2\pi rnkx$ (see Fig. 1a),

x = displacement,

$k = H/x$ = Slope of line in Fig. 1a,

I = Maximum a.c. in coil (sinusoidal),

and $\omega = 2\pi$frequency ($f = 50\sim$ in example below).

Neglecting mechanical and acoustic losses, the differential equation of the system in motion in a linear radial field (Fig. 1a) is

$$\frac{md^2x}{dt^2} + CI\cos\omega t = 0 \quad \ldots \quad (1)$$

Writing $\omega t = z$ and substituting in (1) we obtain

$$\frac{d^2x}{dz^2} + qx\cos z = 0 \quad \ldots \quad (2)$$

where $q = 2\pi rnkI/\omega^2 m$.

(2) is a particular case of a Mathieu equation whose canonical form is

$$\frac{d^2x}{dz^2} + (a + q\cos z)\,x = 0 \quad \ldots \quad (3)$$

In our case the parameter a is zero.

To solve (2) we assume

$$x = \sum_{n=-\infty}^{\infty} a_n e^{(n+\mu)iz},$$

where $i = \sqrt{-1}$, a_n = coefficient, and μ is a quantity to be determined determinantally. Proceeding on the customary analytical lines we obtain

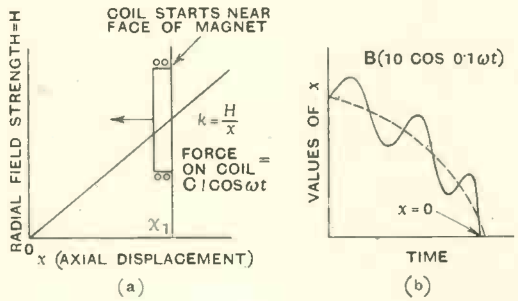


Fig. 1.

an infinite determinant from which μ can be evaluated. For the purpose of illustration we shall take, as a first approximation, the three central columns and rows of this determinant. Putting $q = 0.2$, which is a reasonable practical figure, we obtain a sextic equation for μ which yields ± 1.1, ± 0.89 and ± 0.16. In our third order determinant the values of n are $-1, 0, +1$ giving nine different values of $(n + \mu)$. These are 0.1, 0.11, 0.16, 0.84, 0.89, 1.1, 1.16, 1.89 and 2.1. The approximate solution of (2), therefore, contains nine components having different frequencies (and amplitudes). The frequencies are found on multiplying the preceding values of $(n + \mu)$ by $50\sim$. The relative importance of any component depends upon the magnitude of its coefficient a_n. Neglecting those with small coefficients we find approximately that the coil displacement

$$x = B\,(10\cos 0.1\,\omega t + \cos 0.89\,\omega t + \cos 1.1\,\omega t) \quad \ldots \quad (5)$$

where B is a constant depending upon the distance $0x_1$.

The chief feature of (5) is the reduction in the impressed frequency to 1/10th its original value. The amplitude, however, is *ten times* that of the other two frequencies. This is the key to the situation. A rough idea of the curve in (5) is given in Fig. 1b, which is not drawn to scale. The coil reaches the position $x = 0$ just before the quarter period of the $\frac{0.1\,\omega}{2\pi}$ component. Since the magnetic field is non-existent to the left of $x = 0$, the coil then experiences no force due to the a.c. in it. Once it reaches this position it cannot return, and moves into space with constant horizontal velocity. Thus we have accounted for the pseudo-rectification phenomenon. If x were negative to the left of the origin the motion of the coil would be periodic, *i.e.*, it would return. The rectification effect is, therefore, associated with the absence of field beyond $x = 0$.

The complete solution of (2) obviously contains an infinite number of alien frequencies which cannot be good for reproduction if the amplitude of motion is large.

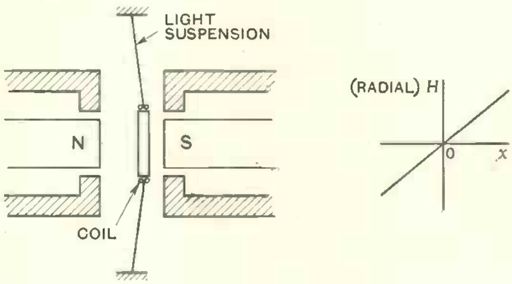


Fig. 2.

We now pass on to examine equation (3). When $q = 0$, the a.c. in the coil is also zero. If a is not zero, we have the case where a d.c. flows in the coil. According to the direction of the current (a + or −), the solution of (3) is stable (periodic) or unstable (contains Cosh and Sinh terms). When a is positive and the field negative to the left of $x = 0$, the coil oscillates to and fro like a pendulum. By altering the direction of the current the coil moves off into the denser portion of the field, there being no oscillation. An experimental arrangement is indicated in Fig. 2, where the coil is suspended between two L.S. magnets of opposite polarity.*

The superposition of an a.c. on the d.c. is represented analytically by equation (3), a and q both being different from zero. The solution of (3) is stable or unstable according to the values of a and q. When stable the coil executes an oscillation whose component frequencies depend upon a and q.

For a discussion of the various solutions of (3) reference can be made to Whittaker and Watson's book *Modern Analysis*; also to a paper by Van der Pol and Strutt in *Phil. Mag.*, 5, 18 (1928). The latter deals with the stability of the solutions and gives a comprehensive list of applications in the realm of physics. Some of these are of immediate interest to radio engineers, *e.g.*, frequency modulation and super-regeneration (see Carson and Armstrong, *P.I.R.E.*, 1922). To this list the above example on the M.C. speaker must be added. I should like, however, to introduce the classical (!) case of the acrobat who balances a billiard cue on his chin—with the ubiquitous monkey aloft—meanwhile propelling himself along the floor on a spherical ball. It is problematic which feat presents the greater difficulty, that of the acrobat who performs or that of the mathematician who analyses the performance.

N. W. McLachlan.

London,
25th August, 1932.

* When a is $-ve$ the coil adheres to the magnet on the right.

The Dyna ron Oscillator.

To the Editor, The Wireless Engineer.

Sir,—Mr. Colebrook called attention, in your issue of November, 1931, to the reluctance of the dynatron to oscillate at frequencies greater than 15 megahertz, and described a modification of the circuit for extending this range to 50 megahertz. In view of the admitted disadvantages of this method, which detract from the simplicity and stability of the normal system, those who employ this useful oscillator may be interested to know that the Mazda AC/S2 valve is particularly suitable for high-frequency work.

No difficulty was experienced with a specimen of this type of valve in obtaining strong oscillation at a frequency of 60 megahertz. Although this is higher than the upper limit quoted in the article referred to, in connection with the modified circuit, no special precautions were taken. The circuit was in fact one intended for frequencies of the order of 1 megahertz, and there is evidence that the frequency mentioned is not the limit. More care might be taken with regard to by-pass condensers, for example, and the wiring was not considered from the point of view of very high frequencies.

A static measurement showed a negative resistance in the region of the working point of about 2,000 ohms or less. Suitable operating conditions are:

Screen voltage 100
Anode voltage 15
Screen current 8–12 ma. according to the grid voltage, which is varied from zero to −2 to control the strength of oscillation. The exact working conditions vary considerably from valve to valve, as dynatron characteristics are less consistent than the more normal ones for which the valves are designed.

The anode-screen capacity of this type of valve is much less than that of the earlier AC/SG, but not so low as that of certain other types, which are, however, unsuitable in their characteristics.

Upper Norwood, S.E.19. M. G. Scroggie.

Abstracts and References.

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PROPAGATION OF WAVES.

SOME MEASUREMENTS OF UPPER-ATMOSPHERIC IONISATION.—E. V. Appleton and R. Naismith. (*Proc. Roy. Soc.*, July, 1932, Vol. 137, No. A 831, pp. 36–54.)

Authors' summary :—Experimental work on the reflection of wireless waves by the upper atmosphere has shown that if the frequency of waves, projected vertically upwards, is steadily increased, the Kennelly-Heaviside layer (Region E) is ultimately penetrated and reflection takes place at the upper region (Region F). The critical penetration frequency, for which reflection at Region E ceases and reflection at Region F begins, is found to vary diurnally and seasonally. From measurements of the critical penetration frequency made in south-east England the variation in the maximum ionisation content of the Kennelly-Heaviside layer has been studied. The value of this ionisation is found to be at a maximum about noon and at a minimum just before dawn. The diurnal variation curves are found to correspond very closely to the theoretical curves obtained by Chapman in his study of the atmospheric ionisation produced by a solar stream of monochromatic radiation. Summer noon ionisation is found to be about 2½ times as intense as winter noon ionisation.

KENNELLY-HEAVISIDE LAYER STUDIES EMPLOYING A RAPID METHOD [VISUAL OBSERVATIONS OF PULSE PATTERNS ON CATHODE-RAY OSCILLOGRAPH] OF VIRTUAL-HEIGHT DETERMINATION.—J. P. Schafer and W. M. Goodall. (*Proc. Inst. Rad. Eng.*, July, 1932, Vol. 20, pp. 1131–1148.)

On five frequencies between 1 604 and 6 425 kc/s. " The more important results may be summarised as follows : (1) On a large number of occasions during the night, a phenomenon has been observed apparently indicating an increase in the density of ionisation in the lower layer. This is important because the ionisation is usually assumed to decrease during the night hours. [The increase may be due to solar particles deflected to the dark side by the earth's magnetic field, or to collision between molecules of the atmosphere and meteoric matter.] (2) Reflections are often observed simultaneously from both ionised layers. An explanation of this phenomenon is given [see p. 1139]. (3) The virtual heights of the reflecting layers are rarely duplicated from day to day for a given time and frequency. (4) Large numbers of multiple reflections are frequently obtained representing a path distance of over 5 000 km for the last reflection. This fact indicates that the multiple-hop mode of propagation is probable for long-distance transmission."

APPARENT INCREASE OF LOWER LAYER IONISATION DURING THE NIGHT.—Schafer and Goodall. (*See* above abstract.)

SELECTIVE FADING AND IONOSPHERE HEIGHT MEASUREMENTS.—H. Plendl. (Programme of Sept. Meeting of Deutscher Phys. u. Math., p. 9, inset in *Zeitschr. f. tech. Phys.* No. 8, Vol. 13, 1932 : summary only.)

Observations on selective fading have shown that in the indirect propagation of wireless waves a selective rotation of polarisation occurs. The significance of this process in the methods of ionosphere height measurement is shown.

THE POLAR YEAR. RADIO RESEARCH BOARD EXPEDITION TO NORTHERN NORWAY.—(*Electrician*, 8th July, 1932, Vol. 109, p. 52.)

EFFECT OF RADIATION ON THE EQUILIBRIUM OF THE HIGHER LAYERS OF THE TROPOSPHERE, AND THE NATURE OF THE TRANSITION FROM TROPOSPHERE TO STRATOSPHERE.—K. R. Ramanathan. (*Beitr. z. Phys. d. fr. Atmos.*, No. 3, Vol. 18, 1932, pp. 196–208.)

THE " MIDDLE AIR " AND THE STRATOSPHERE.—R. Soreau. (Summary in *Rev. Gén. de l'Élec.*, 13–20 Aug., 1932, Vol. 32, pp. 50–51 D.)

VELOCITY OF SOUND IN THE STRATOSPHERE.—B. Gutenberg : Whipple. (Summary in *Sci. Abstracts, Sec. A*, July, 1932, Vol. 35, No. 415, p. 631.)

A reply to Whipple's criticisms referred to in May Abstracts, p. 277.

ÉTUDE ÉLECTROMÉTRIQUE DIRECTE DE LA CHARGE LIMITE D'UNE SPHÈRE CONDUCTRICE DANS UN CHAMP ÉLECTRIQUE IONISÉ (Direct Electrometric Study of the Limiting Charge of a Conducting Sphere in an Ionised Electric Field).—M. Pauthenier and R. Guillien. (*Comptes Rendus*, 11th July, 1932, Vol. 195, pp. 115–116.)

Experimental confirmation of the theoretical results dealt with in April Abstracts, p. 217—two.

CHARGE DES PETITES SPHÈRES DIÉLECTRIQUES DANS UN CHAMP ÉLECTRIQUE IONISÉ (The Charge of Small Dielectric Spheres in an Ionised Electrical Field).—M. Pauthenier, M. Moreau-Hanot and R. Guillien. (*Comptes Rendus*, 18th July, 1932, Vol. 195, pp. 213–215.)

Theoretical and experimental treatment of dielectric spherical particles on lines analogous to those for conducting particles (*see* abstract above).

THE INTERMEDIATE FREE PATH CASE IN THE THEORY OF A PLASMA.—Tonks. (*See* under " General Physical Articles.")

CHARACTERISTICS OF ELECTROMAGNETIC RADIATION FROM AIRCRAFT IN FLIGHT.—J. C. Coe and T. C. Rives. (*Rad. Engineering*, July, 1932, Vol. 12, p. 32.)

Summary of an Am.I.E.E. paper giving the results of 75 flights. Attenuation was found to be a function of altitude and frequency, absorption a function of frequency and time of day. Fading was determined by these factors. For ground distances of 0.4 mile or less, field strength decreased with altitude, whereas at one mile it changed little with altitude: for 4 miles or more it increased with altitude. There was no difference between day and night results, provided the same conditions obtained as to power, aerial, frequency and altitude, except that the distances free from fading were much less by night than by day. Tests in which fading was met with at distances under 60 miles indicated that the absorption undergone by the reflected or refracted ray was independent of the angle of the ray and of the distance travelled by it. No particular wavelength is mentioned in the summary.

Diurnal Variation of Predominating Directions for Short-Wave (40-Metre) Signals received in Schenectady.—E. H. Kanzelmyer. (*QST*, May, 1932, Vol. 16, p. 72.)

Effect of Iron Ore Deposits on Ultra-Short-Wave Communication.—Spangenberg. (*See* abstract under "Stations, Design and Operation.")

The Non-Uniform Transmission Line.—A. T. Starr. (*Proc. Inst. Rad. Eng.*, June, 1932, Vol. 20, pp. 1052–1063.)

Author's summary:—The problem of transmission of periodic waves along a transmission line, whose series impedance and shunt admittance per unit length vary as any powers of the distance from some point, is solved. The solution is given in terms of Bessel functions. A length of such a line is considered as a four-terminal network, and the more important parameters of the network are given. From these parameters one derives immediately the attenuation of current and voltage along the line. The solution is given for a line consisting of a number of parts, each of which is of the form described above. The line constants (so-called) need not vary continuously from one part to the next. The results can be applied to the cases of a tapered submarine cable, an overhead line with a pronounced sag, and end effects in a high tension line.

Recherches expérimentales sur la Dispersion de Liquides polaires dans le Domaine hertzien (Experimental Researches on the Dispersion in Polar Liquids, for the case of Radio Waves from 5 to 600 Centimetres).—P. Girard and P. Abadie. (*Comptes Rendus*, 11th July, 1932, Vol. 195, pp. 119–121.)

Experimental tests, using Drude's second method with special precautions, of the application of Debye's expression (for polarisation as a function of frequency) to the deduction of the dielectric constant of a medium containing permanent dipoles, for the range of frequencies in question. A discussion of the discrepancies between theory and the experimental results is given in the issue for 18th July, pp. 217–219: it appears that Debye's theory should be perfected by the introduction of some factor representing the molecular constitution.

Velocity of Propagation of Light *in Vacuo* in a Transverse Magnetic Field.—C. C. Farr and C. J. Banwell. (*Proc. Roy. Soc.*, Aug., 1932, Vol. 137, No. A 832, pp. 275–282.)

The result of the experimental investigation described in this paper is "that in a transverse magnetic field of effective value 17 992 gauss, the change in velocity of light *in vacuo* is less than one part in 2×10^7, or about 14 metres per second."

Velocity of Light Constant, Not Decreasing with Time.—O. C. Wilson: Gheury de Bray. (*Sci. News Letter*, 23rd July, 1932, Vol. 22, p. 53.)

A contradiction to de Bray's supposition dealt with in 1931 Abstracts, pp. 317–318.

Lorentz Double Refraction in Cubic Crystals.—F. Seitz. (*Phys. Review*, 15th June, 1932, Series 2, Vol. 40, No. 6, p. 1036.)

Abstract only. "In this paper the basis for an extension of the classical theory is given by writing

$$P_i = \alpha_{ij}E_j + \beta_{ijk}\frac{\partial E_i}{\partial x^k} + \gamma_{ijkl}\frac{\partial^2 E_j}{\partial x^k \partial x^l}$$

for the electric moment in unit volume P_i due to the electric intensity, E_j."

Remarks on the Reflection and Transmission of Light by Dissymmetric Media.—R. de Mallemann. (*Journ. de Phys. et le Rad.*, Series 7, No. 2, 1932, pp. 34 s–36 s.)

Nouvelles Propriétés optiques des Solides et des Liquides soumis à l'Action des Ondes ultra-sonores (New Optical Properties of Solids and Liquids submitted to the Action of Supersonic Waves).—P. Biquard and R. Lucas. (*Comptes Rendus*, 11th July, 1932, Vol. 195, pp. 121–123.)

Further development of the work referred to in September Abstracts, p. 530. See also Debye and Sears, below.

On the Scattering of Light by Supersonic Waves.—P. Debye and F. W. Sears. (*Proc. Nat. Acad. Sci.*, 15th June, 1932, Vol. 18, 409–414.)

The Diffraction of Elastic Waves at the Boundaries of a Solid Layer.—J. H. Jones. (*Proc. Roy. Soc.*, Aug., 1932, Vol. 137, No. A 822, pp. 325–343.)

The Determination of Thicknesses of the Continental Layers from the Travel Times of Seismic Waves.—A. W. Lee. (*Monthly Not., Geophys. Supp.*, No. 1, Vol. 3, 1932, pp. 13–21.)

Sur le Déplacement de l'Eau et sur la Nature des Ondes enregistrées dans les Explosions sous-marines (On the Displacement of Water, and the Nature of the Waves recorded, in Submarine Explosions).—J. Ottenheimer. (*Comptes Rendus*, 18th July, 1932, Vol. 195, pp. 203–205.)

ATMOSPHERICS AND ATMOSPHERIC ELECTRICITY.

LES ATMOSPHÉRIQUES ET L'ÉCLAIR (Atmospherics and Lightning).—R. A. Watson Watt. (*La Météorologie*, April-May-June, 1931, 7 pp.)

The writer's treatment of the question: "How far from a visible lightning flash have the atmospherics emitted by that flash sufficient amplitude to interfere with radio reception?" leads to the conclusion that normal flashes 3 000 km away will produce atmospherics of average loudness, and even at 10 000 km will produce audible disturbance in a receiver tuned to any commercial wavelength. To the further question: "Are there enough lightning flashes over the entire earth to account for all, or a great part of, the atmospheric interference in our receivers?" he replies in the affirmative, quoting Brook's estimate (which he regards as almost certainly a conservative one) of an average of 100 flashes per second. But he emphasises the fact that he does not maintain that every atmospheric is actually produced by a lightning flash: only that such a statement may be true.

METEOROLOGY AND THE RADIOGONIOMETRY OF ATMOSPHERICS.—R. A. Watson Watt. (*La Météorologie*, April-May-June, 1931, pp. 180–202: summary in *Rev. Gén. de l'Élec.*, 18th June, 1932, Vol. 31, p. 836.)

RELATION BETWEEN THE LENGTH OF AN OVERHEAD TELEPHONE LINE IN BARE WIRE AND THE NUMBER OF DAMAGING EFFECTS PRODUCED BY LIGHTNING ON THE APPARATUS AND CABLES CONNECTED TO THE LINE.—D. Stenquist. (*Ann. des P.T.T.*, July, 1932, Vol. 21, pp. 593–595.)

BLITZFORSCHUNGEN MIT 10^7 V (Lightning Researches at 10^7 Volts).—F. W. Peek, Jr. (*Zeitschr. V.D.I.*, 16th July, 1932, Vol. 76, No. 29, p. 714.)

A paragraph on Peek's success in generating voltages of 10^7 v, giving 18-metre sparks with a breakdown current of 50 000 A, discharging in 0.001 sec. With another arrangement, voltages of 10^6 v at 60 c/s frequency were obtained.

THE CONNECTION BETWEEN POINTS OF AN OVERHEAD LINE STRUCK BY LIGHTNING AND THE PRESENCE OF UNDERGROUND STREAMS: DIVINATION BY HAZEL TWIG.—Lehmann. (*Bull. Assoc. suisse d. Élec.*, 22nd July, 1932, Vol. 23, No. 15, pp. 386–387.)

An account of investigations undertaken for the largest electricity undertaking in Saxony. As regards the water divining side, the writer has proved (by the use of artificial electric fields) that the action of the hazel twig depends on changes of potential drop in the air.

SUNRISE INTERRUPTIONS [TO OVERHEAD LINES] ATTRIBUTED TO IONISATION OF HEAVISIDE LAYER [CAUSING INCREASED TENSION GRADIENT].—A. Menge: George and Brownlee. (*Elec. World*, 13th Feb., 1932, p. 331.)

A suggested explanation of the phenomenon referred to in 1931 Abstracts, p. 495. George, however, suggests that it is known that insulator leakage is a maximum at that time of day owing to fog and dew, particularly after a season of dry and dusty weather.

ELECTRIC DISCHARGE FROM WATER DROPS [AND THE DIFFERENCE BETWEEN POSITIVE AND NEGATIVE DISCHARGES, ETC.].—J. J. Nolan and J. G. O'Keeffe. (Summary in *Sci. Abstracts, Sec. A*, July, 1932, Vol. 35, No. 415, p. 636.)

SPARK DISCHARGES IN THE AIR, PART II: RELATION BETWEEN HIGH-FREQUENCY AND IMPULSIVE DISCHARGES.—Y. Asami. (*Journ. I.E.E. Japan*, June, 1932, Vol. 52 [No. 6], No. 527. English summary, pp. 73–75.)

STUDIES ON ELECTRIC DISCHARGE, PART VIII [DUST FIGURES]: DEVELOPMENT OF ELECTRIC DISCHARGE AS AFFECTED BY THE RESIDUAL CHARGE—STUDY WITH A UNIDIRECTIONAL PULSATING WAVE.—Toriyama and Sawa: Mochizuki. (*Journ. I.E.E. Japan*, May, 1932, Vol. 52 [No. 5], No. 526. English summaries, pp. 68–69: 69–71.)

ON ELECTRIC SPARKS [BETWEEN SURFACE OF CHARGED INSULATING PLATE AND AN EARTHED CONDUCTOR: DIFFERENCE IN APPEARANCE ACCORDING TO POLARITY].—T. Kobayasi. (*Proc. Phys.-Math. Soc. Japan*, Series 3, Vol. 13, No. 11, pp. 310–316.)

DESCRIPTION AND THEORY OF THE MESSIEN LIGHTNING ARRESTER [DEPENDING ON IONISATION BY RADIOACTIVITY].—J. Clément: Messien. (Summary in *Rev. Gén. de l'Élec.*, 16th July, 1932, Vol. 32, p. 19 D.)

THE NUMBER OF LANGEVIN IONS IN THE FREE ATMOSPHERE AT WASHINGTON, D.C.—G. R. Wait and O. W. Torreson. (*Phys. Review*, 15th June, 1932, Series 2, Vol. 40, No. 6, p. 1046.)

DETERMINATION OF THE COEFFICIENT OF IONISATION BY COLLISION [IN DRY AIR] USING LARGE PLATE DISTANCES AND HIGHER PRESSURES.—F. H. Sanders. (*Phys. Review*, 15th July, 1932, Series 2, Vol. 41, No. 2, p. 263.)

FEATURES OF THE CURRENT-SYSTEM OF THE UPPER ATMOSPHERE AS REVEALED BY THE DIURNAL MAGNETIC VARIATIONS AT HUANCAYO, PERU.—A. G. McNish. (*Phys. Review*, 15th June, 1932, Series 2, Vol. 40, No. 6, pp. 1046–1047.)

Abstract only: differences between values of the solar diurnal magnetic variation observed and those calculated on Chapman's theory may be explained on the assumption of a more dense current flow over the western hemisphere.

SLOW ELECTRONS MAKE POSSIBLE "POLAR LIGHT" IN LABORATORY.—V. Cofman : Dauvillier. (*Sci. News Letter*, 25th June, 1932, p. 401.)

On the experiments on the production of auroras in the laboratory dealt with in March Abstracts, p. 159. Dauvillier, who is a member of the French section of the Polar Year expedition, hopes to obtain a proof of the continuity of the aurora lights right round the polar region, as indicated by his laboratory experiments. *See* also April Abstracts, pp. 218–219.

RESULTS OF CINEMATOGRAPHIC MEASUREMENTS OF AURORAL HEIGHTS, AND PROOF OF THE OCCURRENCE OF INFRA-RED AURORAL RADIATION [AND OF AURORAL PENETRATION TO 65 KILOMETRES ABOVE THE EARTH].—W. Bauer. (Programme of Sept. Meeting of Deutscher Phys. u. Math., p. 9, inset in *Zeitschr. f. tech. Phys.*, No. 8, Vol. 13, 1932 : summary only.)

ULTRAVIOLET TRANSMISSION OF THE ATMOSPHERE.—R. S. Rockwood and R. A. Sawyer. (*Phys. Review*, 15th June, 1932, Series 2, Vol. 40, No. 6, p. 1047.)

Abstract only : the results obtained indicated "that in dry, clean air molecular scattering is sufficient to account for the depletion of solar radiation at λ 3 200."

SOME ATMOSPHERIC ELECTRICAL INSTRUMENTS FOR USE ON THE BRITISH POLAR YEAR EXPEDITION, 1932–1933.—P. A. Sheppard. (*Journ. Scient. Instr.*, August, 1932, Vol. 9, pp. 246–250.)

DIURNAL VARIATION OF COSMIC RAYS.—R. D. Bennett, J. C. Stearns and A. H. Compton. (*Phys. Review*, 15th July, 1932, Series 2, Vol. 41, No. 2, pp. 119–126.)

Authors' abstract :—The intensity of cosmic rays at an altitude of 3 900 metres was measured hourly over a consecutive period of 240 hours. The procedure eliminated the effects due to the variations of the temperature and possible variations of pressure of the gas in the chamber. The ionisation was about 1.5 ± 0.25 per cent more between 8 a.m. and 4 p.m. than between 8 p.m. and 4 a.m. If the variation is due to the soft component of the cosmic rays, these results are in satisfactory agreement with the results of other observers. Analysis of the data suggests that the portion of the space in the neighbourhood of the sun may emit cosmic rays more copiously than the remote regions. This makes doubtful the inference that the energy in the universe in the form of cosmic rays is comparable with that in the form of light.

VARIATION OF THE COSMIC RAYS WITH LATITUDE.—A. H. Compton. (*Phys. Review*, 1st July, 1932, Series 2, Vol. 41, No. 1, pp. 111–113.)

The full report, an article on which was dealt with in September Abstracts, p. 519. The least penetrating part of the cosmic rays seems to show most rapid variation with latitude. No significant variations with longitude have been found. "The variation of the cosmic rays with latitude which these measurements show is of just the kind to be expected if the rays consist of electrically charged particles which are deflected by the earth's magnetic field, the less penetrating rays being the more strongly affected."

VARIATION OF INTENSITY OF COSMIC ULTRA-RADIATION.—F. Lindholm. (Summary in *Sci. Abstracts, Sec. A*, July, 1932, Vol. 35, No. 415, p. 638.)

MEASUREMENTS OF COSMIC RADIATION IN NORTHERN SWEDEN.—A. Corlin. (*Lund Observatory Circular*, 25th March, 1932, and Note in *Nature*, 13th Aug., 1932, Vol. 130, p. 245.)

A preliminary account of measurements of the intensity of the cosmic radiation at Abisko. The intensity of the radiation is found to be closely constant even at the high latitude of 68°21. Humidity, as well as temperature, is found to have no perceptible direct influence upon the penetrating radiation.

THE ANALYSIS OF COSMIC-RAY OBSERVATIONS.—L. D. Weld. (*Phys. Review*, 1st June, 1932, Series 2, Vol. 40, No. 5, pp. 713–717.)

Author's abstract :—A method of rendering non-linear observation equations susceptible to least-square adjustment is adapted to observations on the absorption of cosmic rays in bodies of water, data on which have appeared from time to time ; the object being to obtain the most probable values of the constants of the assumed discrete components of the radiation. Applied to the most consistent data so far published, *viz.*, those reported by Millikan and Cameron in 1931, the adjustment shows that the quantitative conclusions deduced from them by the observers are not derivable from the data by the method of least squares.

THE SUN AS THE ORIGIN OF COSMIC RAYS.—V. Cofman : Dauvillier. (*Science*, 17th June, 1932, Vol. 75, Supp. p. 6.)

Report of an interview with Dauvillier. *Cf.* Abstracts, March and June, pp. 159 and 337 (two).

ÜBER DIE ZERTRÜMMERUNG VON MATERIE DURCH ULTRASTRAHLUNG (On the Disintegration of Matter by Cosmic Radiation).—E. G. Steinke and H. Schindler. (*Naturwiss.*, 24th June, 1932, Vol. 20, No. 26, pp. 491–493.)

This paper gives a critical discussion, with literature references, of the experimental evidence to date on the nature of the disintegration processes caused by cosmic radiation. The evidence as to the nature of the radiation is not yet decisive.

DEPENDENCE OF THE IONISATION PRODUCED BY THE COSMIC PENETRATING RADIATION UPON PRESSURE AND TEMPERATURE.—J. W. Broxon. (*Phys. Review*, 15th June, 1932, Series 2, Vol. 40, No. 6, pp. 1022–1023.)

"The writer has investigated the temperature effect in the ionisation produced by the penetrating radiation in the 13.8 litre spherical chamber described elsewhere (1931 Abstracts, p. 435) in detail, with the 5.5–6 ft water shield. With constant amount of air and a mean pressure of 162.1 atmospheres, the ionisation was observed to increase 7.0 % of the smaller value when the temperature was increased from 7.5° to 40.5° C. Under similar conditions, but with a mean pressure of 23.3 atmospheres, the ionisation increased 8.7 % of the smaller value when the temperature was increased from 14.45° to 47.25° C. . . . The indication is that the temperature effect may be nearly independent of the pressure. Apparent slight dependence of the ionisation upon time, rate of change of temperature or upon the previous condition of the gas has also been observed."

Einige prinzipielle Bemerkungen über Versuche mit Höhenstrahlungskoinzidenzen (Some Remarks on the Principles of Experiments with Cosmic Ray Coincidences).—L. Tuwim. (*Zeitschr. f. Phys.*, 1932, Vol. 76, No. 7/8, pp. 561–564.)

This paper gives arguments demonstrating the invalidity of the experimental basis for the supposed existence of two maxima of intensity of cosmic radiation, ascribed by Barnóthy and Forró (February Abstracts, p. 90) to the effect of the earth's magnetic field.

Untersuchungen am Elektronenzählrohr (Investigations on the Electron Counter [Reference to its Use in Determining the Ionising Power of Cosmic Radiation]).—J. N. Hummel. (*Zeitschr. f. Phys.*, 1932, Vol. 76, No. 7/8, pp. 483–504.)

A Cloud Expansion Chamber for Automatically Photographing the Tracks of Corpuscular Cosmic Rays.—T. H. Johnson, W. Fleisher, Jr., and J. C. Street. (*Phys. Review*, 15th June, 1932, Series 2, Vol. 40, No. 6, p. 1048.)

Messung der Ultrastrahlung in 16 000 m Höhe (Measurement of Cosmic Radiation at a Height of 16 000 m).—A. Piccard, E. Stahel, P. Kipfer. (*Naturwiss.*, 5th Aug., 1932, Vol. 20, No. 32, pp. 592–593.)

Cf. Sept. Abstracts, p. 519. This letter gives a preliminary discussion of the results of the experiments on cosmic radiation carried out during the ascent of the balloon F.N.R.S. from Augsburg on 27th May, 1931. The value found for the ionisation due to cosmic radiation at a height of 16 000 m is 197 ion pairs per cc per sec, but the results may have been vitiated by dampness and it is hoped that the next balloon ascent will provide a more reliable value.

Neue Messungen der Höhenstrahlung in grösseren Höhen (New Measurements of Radiation at Great Heights—Preliminary Communication).—G. A. Suckstorff. (*Naturwiss.*, 1st July, 1932, Vol. 20, No. 27, p. 506.)

Kolhörster has calculated (1931 Abstracts, p. 494) from earlier observations that the absorption coefficient of radiation at great heights should first slowly increase with height, reach a maximum between 6 and 7 km above the earth, then quickly fall until at 9 km height it has reached ground value. To test this prediction, two balloon ascents were undertaken, heights of 8 800 and 8 200 m being reached respectively. Good agreement with predicted values was found; above 6 000 m height there were large fluctuations in the intensity, coinciding with strong inversion layers.

On the Mechanism of the Phenomena of Ultra-penetrating Radiation (Cosmic Rays).—D. Skobelzyn. (*Comptes Rendus*, 25th July, 1932, Vol. 195, pp. 315–317.)

On the production of secondary rays (ultra-beta) some of which diverge *from below upwards.* " In this domain one finds oneself in the presence of new phenomena of interaction between a radiation of very high energy and the nucleus of the atom—phenomena whose complete interpretation on the lines of ordinary dynamics is perhaps impossible."

Terrestrial Magnetic Field and Corpuscular Radiation.—B. Rossi. (Summary in *Sci. Abstracts, Sec. A*, July, 1932, Vol. 35, No. 415, p. 638.)

Cosmic Ray Tracks occur in Groups of Two or Three.—G. L. Locher. (*Sci. News Letter*, 25th June, 1932, p. 405.)

The author concludes that these tracks are most likely produced by secondary electrons released when the cosmic rays (probably photons) strike an atom. " Electrically charged particles produced by the cosmic rays are much less numerous per inch along the tracks than had formerly been believed."

Zur Bestimmung der Natur der Höhenstrahlung durch Koinzidenzmessungen (On the Determination of the Nature of Cosmic Radiation from Coincidence Measurements).—J. N. Hummel. (*Physik. Zeitschr.*, 1st July, 1932, Vol. 33, No. 13, pp. 503–505.)

The apparatus described in this paper has been designed for the purpose of direct experimental determination of (1) the relation between the power of coincidence production and the possibility of ionisation production connected with a single cosmic ray, and (2) the specific ionisation by coincidence measurements. The counting chamber is cut into two or three portions by insulating walls perpendicular to its axis, with a common wire along the axis. The wire is connected to the positive pole of a voltage source and the chambers to the negative side of the source through high ohmic resistances. The voltage fluctuations across the resistances are shown by electrometers.

Experiments on the Corpuscular Cosmic Radiation.—J. C. Street and T. H. Johnson. (*Phys. Review*, 15th June, 1932, Series 2, Vol. 40, No. 6, p. 1048.)

The Direct Detection of Individual Cosmic Rays.—W. F. G. Swann and J. C. Street. (*Phys. Review*, 15th June, 1932, Series 2, Vol. 40, No. 6, p. 1049.)

PROPERTIES OF CIRCUITS.

Sur les Phénomènes de Synchronisation (The Phenomena of Synchronisation [and the Exact Processes of Beat-Note Formation]).—H. Abraham. (*Comptes Rendus*, 11th July, 1932, Vol. 195, pp. 116–118.)

The frequency of the beats between incoming signals and the receiver oscillations is generally regarded as equal to the difference of the frequencies of the two sources, and the extinction of the beats is supposed to indicate the exact agreement between the free oscillations of the receiver and the incoming oscillations. But the receiver is *not* " free " : it is coupled to the transmitting aerial (*cf.* Turpain and Sabatier, June Abstracts, p. 347) and this produces a " profound disagreement " between the above ideas and actual fact. When the beats cease, the receiving station is never strictly in tune with the transmitter. If the receiver oscillations could produce themselves freely, they would not be synchronised with the transmitter oscillations ; it is only thanks to the coupling that the receiver " locks " itself to the distant aerial. The transmitting frequency can then vary within quite wide limits : the receiver follows these variations strictly, without losing or gaining a single period.

The mechanism of these " lockings " is as follows : —the beat régime is composed of alternate coincidences and oppositions of phase which correspond, on account of the coupling, to alternations of a tendency to synchronisation and a tendency to desynchronisation. But a certain dissymmetry exists between the two half-régimes : the duration of the synchronising effect is greater than that of the desynchronising effect because in the first part of the time the natural oscillations of the receiver contribute to the maintenance of synchronisation, while in the other part they hasten the desynchronisation. The result is that the oscillatory régime of the receiver is made up of a series of almost perfect " lockings " to the incoming wave, separated by sudden " break-aways " which are almost instantaneous. *The beat note heard has as its period the intervals between successive " break-aways."* This is confirmed by the timbre of the beat note, in which a succession of shocks is easily recognised. An oscillogram also illustrates the effect : when a weak and a strong oscillating circuit are not coupled together, their interference current is sinusoidal, but when they are coupled, the intermittent " lockings " are clearly evident.

" The phenomena of radio-synchronisation just analysed are used automatically in listening to a distant station. It is therefore desirable that transmitting stations should not employ too deep a modulation and should allow a proportion of carrier wave to remain, sufficient to permit the receivers to ' lock.' " The phenomena, the writer also points out, enable mechanical or chronometric apparatus at various receiving stations to be maintained in strict synchrony " without one having to ask the transmitting station to provide any synchronising signals or modulations for the particular purpose."

A THEORETICAL COMPARISON OF COUPLED AMPLIFIERS WITH STAGGERED CIRCUITS.—J. R. Nelson. (*Proc. Inst. Rad. Eng.*, July, 1932, Vol. 20, pp. 1203–1220.)

Author's summary :—Detuned or staggered single tuned circuits are compared theoretically with the so-called band-pass or coupled circuits. The networks in each case are compared with each other by expressing the ratio of the input to output voltage in terms of the amplifications, A_0, of a single tuned stage. It is shown that approximately the same results are obtained up to optimum coupling by either method. If very broad curves are desired, coupled circuits give more amplification than staggered circuits. Resonance curves for each case are calculated. Some experimentally determined selectivity curves are given for staggered stages. These curve slopes bear out the theory given. Methods of obtaining the required detuning are discussed.

ELEKTRISCHE WELLEN IN VERZWEIGTEN NETZEN (Electric Waves in Branched Networks).—F. Ollendorff. (*Archiv f. Elektrot.*, July, 1932, Vol. 26, No. 7, pp. 457–470.)

Author's abstract :—This paper discusses the propagation of waves in networks with numerous branchings. Simple basic equations are deduced from the limiting case of a continuously branching network. It is shown that this structure unites the properties of a transformer and a lead, so that the properties of an unsymmetrical four-terminal network can be illustrated thereby. The form of the transients in a branched network is determined by complex integration. The high-frequency oscillations which arise can cause disturbances in the neighbourhood of the network ; a numerical estimate of their magnitude is given for wave phenomena in house installations and in tramway networks.

ON A GENERALISATION OF THE IDEA OF THE ANTI-RESONANT [STOPPING, REJECTOR] CIRCUIT. —M. Rousseau. (Summaries in *Sci. Abstracts, Sec. B*, July, 1932, Vol. 35, No. 415, p. 398, and in *Rev. Gén. de l'Élec.*, 13th–20th Aug., 1932, Vol. 32, pp. 49–50 D.)

A consideration of the mathematical theory of the simple anti-resonant circuit shows that the reasoning based on certain customary simplifications is not perfectly rigid mathematically. The writer then extends the theory to cover a number of associated circuits.

OSCILLATORY CONDENSER DISCHARGE.—M. Rousseau. (Summary in *Sci. Abstracts, Sec. B*, July, 1932, Vol. 35, No. 415, p. 373.)

Proceeding from Osnos' work on a damped oscillatory circuit, the writer deduces that the geometric mean between the inductive reactance and the total reactance equals half the ohmic resistance, that the condition for oscillatory discharge is that the time constant t of the system is greater than one-quarter of the time of relaxation, and that the square of the undamped period is the semi-mean harmonic of the square of the period of the damped oscillation and the square of $4\pi t$.

SUR LA STABILITÉ DU MOUVEMENT QUASI PÉRIODIQUE (On the Stability of Quasi-periodic Motion).—A. Witt : Kryloff and Bogoliuboff. (*Comptes Rendus*, 11th July, 1932, Vol. 195, pp. 101–103.)

With a concluding reference to the work of Kryloff and Bogoliuboff (July Abstracts, p. 403—three).

EQUIVALENT ELECTRICAL NETWORKS.—N. Howitt. (*Proc. Inst. Rad. Eng.*, June, 1932, Vol. 20, pp. 1042–1051.)

Author's summary :—The paper shows how to obtain, by a matrix multiplication, networks equivalent at all frequencies to a given network, as well as the networks with the least number of elements.

ON THE TIME ADMITTANCES OF TRANSMISSION NETWORKS.—J. L. Barnes and C. T. Prendergast. (*Journ. Math. and Phys.*, March, 1932, Vol. 11, pp. 27–72 : summary in *Proc. Inst. Rad. Eng.*, June, 1932, Vol. 20, p. 1072.)

QUADRIPOLES AND THEIR APPLICATIONS.—H. G. Baerwald. (Short summary in *Sci. Abstracts, Sec. B*, July, 1932, Vol. 35, No. 415, p. 397.)

SOME EXAMPLES OF SIMILARITY BETWEEN EQUATIONS REPRESENTING RELATIONS OF ELECTRICAL CIRCUITS.—Y. Watanabe. (*Journ. I.E.E. Japan*, May, 1932, Vol. 52 [No. 5], No. 526. English summary, p. 71.)

THE MAGNETIC FIELD INTENSITY NEAR A CIRCULAR LOOP CARRYING AN ELECTRIC CURRENT [THEORETICAL INVESTIGATION].—A. L. Fitch. (*Journ. Franklin Inst.*, Aug., 1932, Vol. 214, No. 2, pp. 215–221.)

SOME NOTES ON GRID CIRCUIT AND DIODE RECTIFICATION.—Nelson. (*See* under "Reception.")

TRANSMISSION.

A NEW CIRCUIT [OF GREATLY INCREASED POWER] FOR THE PRODUCTION OF ULTRA-SHORT-WAVE OSCILLATIONS [SYMMETRICAL PLATE AND FILAMENT LECHER SYSTEMS BETWEEN TWO TRIODES].—H. N. Kozanowski. (*Proc. Inst. Rad. Eng.*, June, 1932, Vol. 20, pp. 957–968.)

Description of the circuit referred to in July Abstracts, p. 404, and the experiments and reasoning leading to its development. The wavelengths used are of the order of 70 cms. Wavelength is determined by the length of the plate Lecher system, while the tuning of the filament Lecher system governs the amplitude of the oscillations. The same wavelength can be obtained even though the grid voltage is varied over a wide range. The output is at least 5 watts, as determined by photometric measurements on a lamp in an absorption antenna.

ON THE [SPLIT-ANODE] MAGNETRON OSCILLATIONS [TYPES A AND B].—K. Okabe, M. Isida and M. Hisida. (*Journ. I.E.E. Japan*, June 1932, Vol. 52 [No. 6], No. 527. English summary, p. 77.)

In type A oscillations the frequency is approximately independent of the external circuit, in type B it is governed chiefly by that circuit. No type A oscillations could be obtained with valves so constructed as to prevent the circular motion of the electrons. Push-pull connection was not necessary for the production of type B oscillations. The tangential distribution of space charge in a symmetrical magnetron is not uniform, especially where type A oscillations can be strongly produced. A new design of valve ("eccentric split-anode magnetron") is proposed for type A oscillations. In the first (theoretical) parts of the paper, the wavelength equation for the type A oscillations is rigorously derived by considering the effect of returning electrons on the primary emission.

ON THE PRODUCTION OF ULTRA-SHORT ELECTROMAGNETIC WAVES.—A. Giacomini. (*Phys. Review*, 1st July, 1932, Series 2, Vol. 41, No. 1, pp. 113–114.)

The writer has found that, under particular conditions, oscillations of very high frequency may be obtained by using valves with a heater element and a cathode coated with oxides. The circuit of Tank and Schiltnecht (1929 Abstracts, p. 389) was found suitable ; the cathode was connected to the negative terminal of the filament. A slight positive anode potential increased the amplitude of oscillations. "As the grid potential runs between 20 and 100 volts, a band of wavelengths between 180 and 50 cm can be obtained."

ÜBER DEN EINFLUSS VON GASEN AUF BARKHAUSENSCHWINGUNGEN (On the Influence of Gases on Barkhausen-Kurz Oscillations).—H. Rindfleisch. (*Ann. der Physik*, 1932, Series 5, Vol. 14, No. 3, pp. 273–298.)

From the author's summary :—This paper describes investigations of the influence of gases, in particular helium and neon, on B.-K. oscillations. The electrode arrangement used was that of a Schott-K valve. In all cases the effect of gas in the valve was to decrease the frequency, in addition to altering the intensity of the oscillations. It seems possible that many hitherto unexplained observations may be due to the indirect influence of this increase in wavelength (with fixed external circuit) on the intensity. The oscillation energy was an optimum in a high vacuum, but pressures up to 5×10^{-5}mm Hg gave no substantial decrease. With increasing pressure, oscillation onset occurred at lower grid voltages, corresponding to the displacement of the saturation point of the emission characteristic. Increase of pressure above 5×10^{-4} mm Hg had no further influence on this point.

Increase of pressure also caused displacement of maximum intensity towards smaller grid voltages and a very marked decrease of energy for higher voltages. In the case of chemically active gases, the very great variation in emission had a decisive influence on the behaviour of the valve. . . . The drop in intensity with increasing pressure is probably due to collision between electrons and gas atoms in the immediate neighbourhood of the filament. The inert gases employed showed no important differences in behaviour. Contrary to Knipping's hypothesis, the presence of gas is not necessary for the production of B.-K. oscillations.

GILL-MORRELL AND BARKHAUSEN-KURZ OSCILLATIONS.—G. Potapenko. (*Nature*, 13th Aug., 1932, Vol. 130, pp. 238–239.)

This letter comments on a letter by Cockburn (April Abstracts, p. 223) and disagrees with his division of the oscillations he observed into Gill-

Morrell and Barkhausen-Kurz oscillations; the writer is of the opinion that "all of them could be referred to one and the same type of Gill-Morrell oscillations." Remarks are also made on a letter by Megaw (July Abstracts, p. 404); the writer thinks that "the rôle of the space charges in the process of the generation of the Gill-Morrell oscillations is rather limited."

THE BARKHAUSEN-KURZ EFFECT ACCORDING TO WAVE MECHANICS.—K. Umeda: Schuster. (Summary in *Physik. Ber.*, 15th June, 1932, Vol. 13, No. 12, p. 1107.)

INVESTIGATIONS IN THE FIELD OF THE ULTRA-SHORT ELECTROMAGNETIC WAVES. IV. ON THE DEPENDENCE OF THE ULTRA-SHORT ELECTROMAGNETIC WAVES UPON THE HEATING CURRENT AND UPON THE AMPLITUDE OF THE OSCILLATIONS.—G. Potapenko. (*Phys. Review*, 15th July, 1932, Series 2, Vol. 41, No. 2, pp. 216–230.)

For the previous papers of this series *see* Abstracts, May, pp. 281–282, and September, p. 520. The writer finds that as the heating current is decreased the length of the normal waves increases and the length of dwarf waves of all orders decreases: this gives better agreement between observed and computed values. "The results of the experiments are in agreement with the theory of P. S. Epstein, which explains the discrepancy between the calculated and observed length of the normal and the dwarf waves as due to the influence of the alternating potentials appearing on the electrodes of the tube during oscillations. In the limit, at infinitely low amplitudes of these potentials, the ratio of the values of the products $\lambda^2 E_g$ for normal and for dwarf waves approaches the theoretical value within the limits of the experimental error."

ELECTRON OSCILLATIONS IN TRIODE VACUUM TUBES [THE RELATION BETWEEN THE VARIOUS TYPES—B.-K., PIERRET, AND HOLLMANN: TRANSMITTER AND RECEIVER FOR 17 CENTIMETRE WAVES].—S. Uda and T. Mikami. (*Journ. I.E.E. Japan*, June, 1932, Vol. 52 [No. 6], No. 527. English summary, pp. 78–79.)

SUMMARY OF WORK ON THE PRODUCTION OF ULTRA-SHORT WAVES.—Littmann. (*Electronics*, July, 1932, p. 236.)

Notice of a "useful summary" (largely mathematical) in *Funk, Berlin*, of the B.-K., G.-M., Hollmann, Möller, and Potapenko work, and of the present situation as regards the various theories.

THE GENERATION OF ULTRA-SHORT WAVES OF 1 METRE AND UNDER: VALVES FOR.—Rohde. (*See* under "Valves and Thermionics.")

THE TRANSMISSION AND RECEPTION OF ULTRA-SHORT WAVES THAT ARE MODULATED BY SEVERAL MODULATED HIGH FREQUENCIES.—M. von Ardenne. (*Proc. Inst. Rad. Eng.*, June, 1932, Vol. 20, pp. 933–940.)

English version of the paper dealt with in 1931 Abstracts, p. 224.

VERZERRUNGEN BEI DER MODULATION MITTELS EISENDROSSEL UNTERSUCHT AM MASCHINENSENDER (Distortion in Modulation by Iron-Cored Choke, investigated on the Machine Generator [and an Improved Modulation System]).—M. Pohontsch. (Summary in *Physik. Ber.*, 15th July, 1932, Vol. 13, No. 14, pp. 1347–1348.)

GREATLY INCREASED RANGE WITHOUT LOSS OF SPEECH QUALITY BY SUPPRESSION OF FREQUENCIES BELOW 1 000 CYCLES PER SEC.—J. P. Shanklin. (*QST*, June, 1932, Vol. 16, p. 37.)

NEW METHODS FOR THE MEASUREMENT OF MODULATION RATIO [USING CRITICAL VOLTAGE OF A NEON TUBE].—A. L. Minz. (*Westnik Elektrot.*, No. 11/12, 1931, Sec. I, pp. 387–389.)

THE ADVANTAGE OF MODERATE DEPTH OF MODULATION AND SUFFICIENT PROPORTION OF CARRIER WAVE, IN ENSURING TRUE SYNCHRONISATION BETWEEN TRANSMITTER AND RECEIVER.—Abraham. (*See* abstract under "Properties of Circuits.")

EMPLOYMENT OF POSITIVE ION SHEATH IN SIGNALLING BY FREQUENCY CHANGE.—Thomson-Houston Company. (*See* abstract under "Subsidiary Apparatus and Materials.")

THE INCREASE OF THE EFFICIENCY OF AN ELECTRON TUBE OSCILLATOR BY THE SIMULTANEOUS WORKING AT TWO DIFFERENT WAVELENGTHS.—S. I. Tetelbaum. (*Westnik Elektrot.*, No. 11/12, 1931, Sec. I, pp. 452–457: short summary in *Physik. Ber.*, 15th June, 1932, Vol. 13, p. 1169.)

PUSH-PULL ELECTRON-COUPLED OSCILLATORS [FOR STEADY FREQUENCY SHORT-WAVE WORKING].—Ross Jones: Dow. (*QST*, May, 1932, Vol. 16, pp. 40–41.)

Experimenting along the lines of Dow's article (April Abstracts, p. 222) Jones has developed a push-pull version of the "electron-coupled" oscillator which is "by far the steadiest self-controlled oscillator" he has ever worked. A plate voltage change of about 40% made a scarcely discernible frequency change.

THE DYNATRON OSCILLATOR: THE INTERDEPENDENCE OF ITS FREQUENCY VARIATION AND THE CONTENT OF HARMONICS.—J. Groszkowski: Colebrook. (*Wireless Engineer*, August, 1932, Vol. 9, No. 107, pp. 446–447.)

A long letter prompted by the Colebrook paper (Abstracts, January, p. 34) and subsequent correspondence (July, p. 404.)

ON THE FREQUENCIES OF DOUBLE CIRCUIT [R.F. AND A.F.] SCREEN-GRID VALVE OSCILLATORS.—N. W. McLachlan. (*Wireless Engineer*, August, 1932, Vol. 9, No. 107, pp. 439–444.)

Containing the analysis and experimental work carried out in connection with the writer's modulated-oscillation wavemeter.

PARASITIC OSCILLATIONS IN BROADCAST TRANSMITTERS [AND THEIR CURE].—A. D. Ring. (*Rad. Engineering*, June, 1932, Vol. 12, pp. 17–20.)

ELIMINATING THE 'PHONE MONOLOGUE: TWO WORKABLE SCHEMES FOR BREAK-IN OPERATION.—M. F. Chapin: G. Ewing. (*QST*, July, 1932, Vol. 16, pp. 13–14 and 18.)

BUILDING A LOW-COST 1 750-KC 'PHONE–C.W. TRANSMITTER [USING CLASS B MODULATOR AND TYPE 46 VALVES].—G. Grammer. (*QST*, July, 1932, Vol. 16, pp. 9–12.)

THE NON-UNIFORM TRANSMISSION LINE.—Starr. (*See* under "Propagation of Waves.")

RECEPTION.

SOME NOTES ON GRID CIRCUIT AND DIODE RECTIFICATION.—J. R. Nelson. (*Proc. Inst. Rad. Eng.*, June, 1932, Vol. 20, pp. 989–1003.)

Author's summary:—The equivalent input resistance of a grid leak and condenser in parallel and the combination in series with a diode or the grid-cathode circuit of a triode are calculated for various combinations by means of the static $I_g - E_g$ characteristics and an extension of the work of Colebrook and Peterson and Llewellyn. The equivalent internal resistance of the diode is also calculated and an expression for the equivalent generator is also derived. The relations between X, the grid condenser modulation frequency reactance, R, the grid leak, and m, the percentage modulation, to give good quality are considered theoretically and experimentally. The part played by the values of X, R, and m in the quality of the audio-frequency output was first considered by Terman and Morgan. Limiting values of X and R for the cases of the triode and diode are also estimated.

WIRELESS SIGNALS: THEIR MUTUAL INFLUENCE IN SIMULTANEOUS DETECTION.—E. V. Appleton and D. W. Fry. (*Electrician*, 15th July, 1932, Vol. 109, pp. 83–84.)

A short history of the work on "apparent demodulation" (first discussed by Beatty) leads to a description of the writers' recent experimental researches, the results of which were dealt with in September Abstracts, p. 523.

WHAT'S WRONG WITH OUR C.W. RECEIVERS? [SUGGESTED ELIMINATION OF "IMAGE" SIGNAL ON "OTHER SIDE OF ZERO BEAT" IN BEAT-NOTE RECEPTION, WITH INCREASED EFFECTIVENESS OF AUDIO-FREQUENCY SELECTIVITY].—J. J. Lamb. (*QST*, June, 1932, Vol. 16, pp. 9–16 and 90.)

A long discussion of selectivity in beat-note reception, leading to an exposition of the advantages of "off-set" beat-oscillator tuning (reducing the image response to —*e.g.*—some 15 db below the desired signal response) and the measures necessary to apply this system successfully to superheterodyne receivers. The essential features are the introduction of the oscillator signal into the plate circuit of the second detector (a species of plate modulation) and the use—if what the writer calls "one kilocycle selectivity" is to be obtained—of an exceptionally stable oscillator. An oscillator of the electron-coupled type is particularly suitable, since its output circuit presents a relatively high-resistance load to the detector and because the isolation of its plate from its frequency-generating circuit minimises the effect of detector output changes on the action of the oscillator.

The official superheterodyne on these lines displays the following features:—electrical and mechanical stability, single-signal c.w. selectivity, improved telephony selectivity, reduced overloading and cross-modulation effects, high sensitivity with better signal/background noise ratio and less valve hiss—"and without too many tubes." A description follows in the August issue, pp. 9–20 and 90, under the title "Short-Wave Receiver Selectivity to Match Present Conditions."

The preliminary section on r.f. selectivity includes a discussion on the measurement of the selectivity of beat-note receivers: owing to the effect of regeneration on selectivity, the test should be made at one of two recognised degrees of detector oscillation—"optimum" or (preferably) "standard," the latter being obtained by reducing the control from "optimum" till the audio-frequency output drops to 70% of its optimum value. Pp. 12–14 describe a simplified selectivity test (dispensing with a signal generator with accurate frequency calibration and means of measuring the input signal voltage precisely) applicable to superheterodynes and beat-note receivers with separate heterodyne.

THE SINGLE-SIGNAL SUPERHET.—Lamb. (*See* above abstract.)

APPLICATION OF THE CLASS B AUDIO AMPLIFIER TO A.C. OPERATED RECEIVERS.—L. E. Barton. (*Proc. Inst. Rad. Eng.*, July, 1932, Vol. 20, pp. 1085–1100.)

"The demand for increased power output . . . has reached a point where it is no longer economical to increase the output of the present class A output systems. The class B audio output system is a somewhat radical departure from the present system, and for a given cost permits an output of two or three times the power output of the present class A amplifier. This paper discusses the special circuit requirements of an a.c. receiver to use the new RCA-46 class B tube successfully in a class B audio output system . . . Although it is probable that the average listener does not use an average power greater than one-half watt, there are times when more power is desired, and the peak power requirements for an average of one-half watt is probably above 6 watts." Also, a higher power output permits refinements in the acoustic system for better fidelity at some expense of power. The difficulty in applying class B amplification in an a.c. receiver is the provision of bias, and this has now been solved by the RCA-46 zero-bias valve with two grids connected together as control grid, giving a three-element valve with comparatively high amplification factor.

THE A, B AND C OF AMPLIFIER CLASSIFICATIONS [EXPLANATION OF THE DIFFERENCES BETWEEN CLASS A, CLASS B, AND CLASS C AMPLIFIERS].—G. Grammer. (*QST*, June, 1932, Vol. 16, pp. 25–31.)

A BALANCED MODULATOR SUPER-REGENERATIVE CIRCUIT.—W. van B. Roberts : Armstrong. (*QST*, July, 1932, Vol. 16, pp. 19–20.)

To avoid the experience, common with ordinary super-regenerative circuits, of sustained oscillations setting in when the amplification is pushed too far. A symmetrical two-valve circuit is used, the signal-frequency circuit having its inductance split in the centre by a signal-frequency by-pass condenser. A source of interruption-frequency voltage is connected to the two sides of this by way of a transformer whose secondary is grounded at its middle point through a bias battery. Equal bias is thus applied to the two grids, while interruption-frequency and signal-frequency voltages are impressed on the two grids in opposite phases. The result is that a continuously applied i.f. voltage produces alternately a regenerative feed-back and an equal degenerative feed-back from the reaction coil to the tuned circuit, the latter feed-back undoing all that the former has done, with a little to spare owing to resistance both opposing building-up and aiding quenching.

NEW USE FOR OLD CIRCUIT [REVIVAL OF AUTOPLEX CIRCUIT, PARTICULARLY FOR MIDGET RECEIVERS].—H. G. Boyle. (*Rad. Engineering*, July, 1932, Vol. 12, pp. 22–23.)

More on the subject dealt with in January Abstracts, p. 36. Constructional data are given. "If operating properly, signals should come in with a strong hiss as resonance is approached, the hiss snapping out at resonance. In the original receiver the measured sensitivity over the broadcast band was between 2 000 and 2 500 microvolts with a band width of 28 to 32 at a thousand times resonance input."

AN ADVANCED TELEVISION AND SHORT-WAVE SUPERHETERODYNE RECEIVER [AVOIDING MOTOR-BOATING AND OTHER REACTION TROUBLES BY USE OF CARBORUNDUM DETECTORS IN BOTH STAGES].—Tanner. (*See* under "Phototelegraphy and Television.")

DER OWIN-EXPONENTIAL-EMPFANGER E 51 W (The Owin Radio Apparatus Works', Hanover, All-Mains Five-Valve Receiver using Exponential Valves).—(*Rad., B., F. f. Alle* August, 1932, pp. 364–367.)

With two screen-grid r.f. and two l.f. stages. Full-wave rectification, smoothing by resistances only, yet "marvellously quiet." Single-knob adjustment, 9 kc selectivity.

NOTES ON THE DESIGN OF RADIO RECEIVERS [LECTURE BEFORE RADIO CLUB OF AMERICA]. —L. Walsh. (*Rad. Engineering*, July, 1932, Vol. 12, pp. 7–10.)

G.E.C. 1932–33 RADIO PROGRAMME.—G.E.C. (*Electrician*, 15th July, 1932, Vol. 109, pp. 88–89 and 96.)

ENGINEERING ACOUSTICS : NO. 88. THE STENODE PRINCIPLE.—(*Electrician*, 5th Aug., 1932, Vol. 109, pp. 172–173.)

STRAIGHT SETS *versus* SUPERHETERODYNES.—(*Wireless Engineer*, Aug., 1932, Vol. 9, No. 107, pp. 427–428 : Editorial.)

EXTENSIVELY USED [U.S.A.] PATENTS RELATING TO AMPLIFYING CIRCUITS.—(*Electronics*, July, 1932, p. 221.)

A THEORETICAL COMPARISON OF COUPLED AMPLIFIERS WITH STAGGERED CIRCUITS.—Nelson. (*See* under "Properties of Circuits.")

THE APPLICATION OF PERMEABILITY TUNING TO BROADCAST RECEIVERS [AND THE USE OF POLYIRON].—R. H. Langley : Polydoroff. (*Rad. Engineering*, May, 1932, Vol. 12, pp. 17–22.)

The full paper, a summary of which was referred to in September Abstracts, p. 524.

MODERN PRODUCTION SENSITIVITY MEASUREMENT [RECEIVER TESTING EQUIPMENT FOR LARGE OR MEDIUM SIZE PLANTS].—R. F. Shea. (*Rad. Engineering*, July, 1932, Vol. 12, pp. 12–14.)

TESTING RADIO RECEIVERS ON THE ASSEMBLY LINE.—A. E. Thiessen : General Radio Company. (*Rad. Engineering*, June, 1932, Vol. 12, pp. 21–22.)

TESTING SET FOR BROADCAST RECEIVERS.—(*E.T.Z.*, 14th July, 1932, Vol. 53, p. 685.)

REDUCING RADIO INTERFERENCE FROM TRANSMISSION LINES.—F. B. Doolittle. (*Elec. World*, 30th April, 1932, p. 788.)

TESTING AND USING RADIO-INTERFERENCE CHOKE COILS [FOR POWER LINES].—B. E. Ellsworth. (*Elec. World*, 14th May, 1932, p. 863.)

TRANSIENT-PRODUCED OSCILLATIONS IN BRANCHED NETWORKS, AND THE INTERFERENCE CAUSED BY THEM.—Ollendorff. (*See* abstract under "Properties of Circuits.")

THE INCANDESCENT ELECTRIC LAMP AS A CAUSE OF RADIO INTERFERENCE.—Wider : Koetz. (*Bull. Assoc. suisse d. Élec.*, 5th Aug., 1932, Vol. 23, No. 16, pp. 425–426.)

SHORT-WAVE ADAPTORS FOR BROADCAST RECEIVERS. —Burne Jones & Company. (*Electrician*, 5th Aug., 1932, Vol. 109, p. 176.)

ONWARD MARCH OF SHORT-WAVE RADIO [AND THE R.M.A. STATEMENT ON SHORT-WAVE RECEPTION].—(*Rad. Engineering*, June, 1932, Vol. 12, pp. 25–26 and 36.)

MARCONI SHORT-WAVE RECEIVER TYPE RG. 31A [15 TO 200 METRES : SUITABLE FOR DUPLEX WORKING].—(*Marconi Review*, May–June, 1932, No. 36, pp. 20–26.)

"By confining by far the major portion of the gain to the i.f. filter amplifier, it has been possible to introduce 3 tuned circuits between the aerial and the first valve. By thus minimising shock excitation effects it is possible to carry out duplex reception with very small percentage separations from a nearby transmitter."

Über hochempfindliche Indikatoren für cm-Wellen (Highly Sensitive Indicators for Ultra-Short Waves below 10 Centimetres [Radiometer and Bolometer Reception]).—W. Zobel. (*Hochf:tech. u. Elek:akus.*, July, 1932, Vol. 40, No. 1, pp. 5–9.)

Experiments with the "Mass Radiator" of Glagolewa-Arkadiewa (1930 Abstracts, p. 158) showed great discrepancies between the writer's results and those of the inventor, and it was thought that these discrepancies were due to the use of bolometer methods of detection in place of the original thermo-element methods. This led to the writer carrying out systematic researches on detectors for these centimetre waves. Preliminary tests convinced him of the greatly inferior sensitivity of thermo-elements compared with bolometers and radiometers, so that he concentrated on the last two types of detector.

The paper describes two types of radiometer evolved, for wavelengths above and below 5 cm respectively, and two types of bolometer, for wavelengths above and below 4 cm. The bolometers are easier to construct, but the radiometers are much more sensitive and are freer from outside interference. Interferometer measurements with both types of detector are described, the source of radiation being a Hertz oscillator as used by Hasselbeck (July Abstracts, p. 399). Certain conclusions are drawn as to the natural wavelengths, damping, etc., of the various detectors. Thus it appears unlikely that a truly aperiodic detector, at any rate of the bolometer type, can be obtained by increasing the resistance.

An Ultra-Short-Wave Super-Regenerative Five Metre Receiver.—E. P. Hufragel and G. J. Herrscher. (*Radio Craft*, May, 1932, Vol. 3, p. 675.)

The Transmission and Reception of Ultra-Short Waves that are Modulated by Several Modulated High Frequencies.—von Ardenne. (*See* under "Transmission.")

AERIALS AND AERIAL SYSTEMS.

The Propagation of Radio Frequency Currents along a Wire of Finite Length.—F. W. G. White. (*Proc. Camb. Phil. Soc.*, 30th July, 1932, Vol. 28, No. 3, pp. 356–366.)

This theoretical paper contains a definition of the inductance L and capacity C per unit length of a single straight wire in free space; the writer also discusses the nature of the field round such a wire and shows that the complete expression for the current magnitude and distribution may be obtained from the solution of an integral equation. A method of treatment used by Moullin (1930 Abstracts, p. 46) is followed and it is shown that the product $LC = \frac{1}{c^2}$ when L and C are expressed in the same set of units (electromagnetic or electrostatic). The case of a tubular current is also considered and the usual wave equation is derived from Maxwell's equation for this case. The field round a long tubular wire with sinusoidal distribution of current consists of an electric force perpendicular to the surface and a magnetic force in circles about the axis.

"A small component parallel to the current, and in phase with it, is introduced by the charges upon the ends of the tubular conductor, and this component determines the radiation resistance. From this it follows that the radiation resistance could be increased by placing a capacity on the ends—thus increasing the charges there."

Circuit Relations in Radiating Systems and Applications to Antenna Problems.—P. S. Carter. (*Proc. Inst. Rad. Eng.*, June, 1932, Vol. 20, pp. 1004–1041.)

Author's summary :—Expressions for the self and mutual impedances within a radiating system are developed by the use of the generalised reciprocity theorem. These expressions are given in terms of the distributions of the electric field intensities along the radiators. A method for the determination of the field intensities is outlined. Formulas for the self and mutual impedances in several types of directional antennas are given.

Questions of practical interest in connection with arrays of half-wave dipoles ["but, due to the recent developments in directional antennas which we have made, arrays of half-wave dipoles have become of minor importance in R.C.A. Communications"], long parallel wires, and "V" type radiators are discussed. Different types of reflector systems are considered. Curves of the more important relations are shown. The mathematical development is shown in an appendix.

Transmission Lines [Transmitting and Receiving Feeders] for Short-Wave Radio Systems.—E. J. Sterba and C. B. Feldman. (*Proc. Inst. Rad. Eng.*, July, 1932, Vol. 20, pp. 1163–1202: *Bell S. Tech. Journ.*, July, 1932, Vol. 11, No. 3, pp. 411–450.)

Authors' summary :—The requirements imposed on transmission lines by short-wave radio systems are discussed, and the difference in the requirements for transmitting and receiving purposes is emphasised. Various line types are discussed, particular attention being given to concentric tube lines and balanced two-wire lines. The concentric tube line is particularly valuable in receiving stations where great directional discrimination is involved and low noise and static pick-up is required.

Excellent agreement between calculations and measurements is found for the high-frequency resistance of concentric lines, using the asymptotic skin effect formula of Russell. Other losses in correctly designed concentric tube lines are found to be negligible. Measured losses in two-wire lines are found to be greater than losses predicted by the asymptotic skin effect formula owing, in part, to losses brought about by unbalanced currents. Practical aspects of line construction such as joints, insulation and provision for expansion with increasing temperature are discussed. Some difficulties encountered in transmission line practice, such as losses due to radiation, reflections from irregularities, effects of weather, and spurious couplings between antenna and line are discussed.

TUNING DIPOLE AERIALS BY SHUNTED FLASH-LAMP COMBINED WITH WESTON PHOTRONIC CELL LEADING TO MICROAMMETER IN OPERATING ROOM.—(*QST*, June, 1932, Vol. 16, p. 38.)

WHEN A FRAME AERIAL IS WORTH WHILE.—A. L. M. Sowerby. (*Wireless World*, 5th August, 1932, Vol. 31, pp. 96–98.)

In populated places where there is considerable electrical machinery it is often found impossible with an open aerial to listen even to the local station without a background of interference which kills all enjoyment of broadcasting. The author points out that in these circumstances a properly balanced frame aerial will reduce considerably the noise/signal ratio; incidentally, reception should not be accompanied by side-band heterodyning, which even tone control cannot remove.

ELIMINATING BACKGROUND NOISE [FROM LIFT RELAYS, ETC., USING DIPOLE AERIAL WITH CLOSELY COUPLED TRANSFORMER AND TWO-WIRE SHIELDED CABLE LEADING TO SHORT-WAVE RECEIVER].—W. Bell. (*QST*, May, 1932, Vol. 16, p. 40.)

METOD FÖR BERÄKNING AV STRÅLNINGSMOTSTÅND SAMT DESS TILLÄMPNING VID UNDERSÖKNING AV ENKLA MULTIPELANTENNERS EFFEKTIVITET (A Method of Calculating Radiation Resistance, and Its Application to the Investigation of the Efficiency of Multiple Aerials of Simple Type).—E. T. Glas. (*Teknisk Tidskrift*, 6th Aug., 1932, Vol. 62, No. 32, Supp. pp. 123–127.)

EFFECT OF HEIGHT OF TRANSMITTING AERIAL (AIRCRAFT IN FLIGHT).—Coe and Rives. (*See* abstract under "Propagation of Waves.")

[INSULATED] RADIO TOWER TUNING AND LIGHTING.—V. V. Gunsolley. (*Rad. Engineering*, June, 1932, Vol. 12, pp. 7–8 and 12.)

"If the lighting circuits are not properly designed, the purposes of the insulated footings may be defeated partially, if not completely." This point is elaborated.

SHORT-WAVE BROADCAST TOWERS [BASE AND GUY INSULATORS FOR].—R. L. Jenner. (*Elec. World*, 20th Feb., 1932, pp. 360–361.)

VALVES AND THERMIONICS.

ÜBER SENDERÖHREN ZUR ERZEUGUNG VON METERWELLEN (Transmitting Valves for the Generation of Ultra-Short Waves of 1 Metre and Under).—L. Rohde. (*Hochf:tech. u. Elek: akus.*, July, 1932, Vol. 40, No. 1, pp. 3–5.)

"Down to 6 m the production of a few kilowatts no longer presents any very great difficulty, but any further shortening of the wavelength decreases the output, and it is to-day harder to produce 10 watts at 1 m than 10 kw at 6 m. The reasons for this are as follows:—too small external resistance, unfavourable phase conditions, and inadequate removal of heat." The writer briefly discusses these points: as regards the last, he mentions that an increase of heat radiation by the employment of blackened anodes would be practicable, if only the heating-up of the glass container by long-wave heat rays could be hindered. At present the only success in increasing the radiation of heat has been attained by increasing the effective surface by the use of network anodes.

He then gives a table of data of 16 commercial valves of different types suitable for wavelengths of 1 m and under. Most of these are Telefunken, but one G.E.C. water-cooled valve and two French "Metal" valves are added. The data, obtained experimentally by the writer, include the shortest wavelength at which the valve will oscillate without overloading, and the maximum power obtainable at that wavelength: the shortest wavelength (considerably longer, the ratio varying with the type of valve) at which the valve can be externally controlled, and the corresponding (considerably increased) output: and the inter-electrode capacities.

The last part of the paper deals with special valves designed by the writer as a result of his investigations. One of these, a water-cooled valve, gave particularly promising results (top line of Table 2) and the others, air-cooled, showed improved outputs and decreased minimum wavelengths. Thus the water-cooled type gave 650 w on the minimum wave of 320 cm (1 000 w on 430 cm when externally driven), while the smallest air-cooled type gave 2.5 w on the minimum wave of 100 cm, compared with 0.8 w given by the only commercial valve reaching down to that wavelength (French TMC). The lines governing the construction of all these new valves were:—the use of Schott instrument-glass, the elimination of metallic grid and anode supports by the use of glass and quartz (thus reducing the capacities), the employment of sturdy tungsten filaments and of thick connecting leads (in the water-cooled valve the molybdenum grid lead carried 25 A of r.f. current), a steep slope characteristic, and high anode temperatures with dark and roughened anode surfaces.

ECCENTRIC SPLIT-ANODE MAGNETRON FOR GENERATION OF TYPE A OSCILLATIONS.—Okabe, Isida and Hisida. (*See* abstract under "Transmission.")

DESIRABLE TUBE CHARACTERISTICS: A NEW POINT OF VIEW, WITH SPECIAL REFERENCE TO SCREEN-GRID AMPLIFIER TUBES [BY CONSIDERATION OF THE EQUIVALENT *Parallel* CIRCUIT].—G. D. Robinson. (*Rad. Engineering*, June, 1932, Vol. 12, p. 29.)

"The parallel circuit shows that for given values of mutual conductance and load impedance the amplification production by the tube and circuit increases rapidly with increase of internal resistance, so long as the latter is comparable to the load impedance. When internal resistance becomes much greater than load impedance, further increase in this produces little effect. It may be noticed that if the internal plate resistance becomes negative, a *decrease* in this negative resistance will further increase the amplification. . . . Increases in mutual conductance at the expense of decreases in internal plate resistance may be of no advantage." *Cf.* de Cola, June Abstracts, p. 349.

THE THEORY OF DISTORTION IN SCREEN-GRID VALVES [MATHEMATICAL INVESTIGATION, AND APPLICATION TO DESIGN OF SCREEN-GRID VALVES, PARTICULARLY OF VARIABLE-MU TYPE].—R. O. Carter. (*Wireless Engineer*, Aug., 1932, Vol. 9, No. 107, pp. 429–438.)

COEFFICIENTS OF NON-LINEAR DISTORTION OF AMPLIFYING TRIODES.—A. Clausing. (Extracts in *Ann. des P.T.T.*, July, 1932, Vol. 21, pp. 629–632.)

INSULATOR DEVELOPMENTS POINT TO NOISELESS A.C. TUBES.—H. L. Crowley. (*Rad. Engineering*, July, 1932, Vol. 12, p. 28.)

"The development of an insulator of fundamentally different chemical composition, possessing unusual properties," is claimed to eliminate the formation of valve-mirror and to reduce the noise level to the lowest value yet attained in practice. The new material is used both for the insulators and for the spacers.

A NEW LOW NOISE VACUUM TUBE.—G. F. Metcalf and T. M. Dickinson. (*Physics*, July, 1932, Vol. 3, No. 1, pp. 11–17.)

The full paper, a summary of which was dealt with in July Abstracts, p. 409. Authors' summary:—When commercial vacuum tubes are used to amplify small low-frequency voltages it is found that random disturbances of the order of 100 to 1 000 microvolts are present in the anode circuit. These disturbances exist almost entirely in the range below 100 c/s. and therefore fix the minimum voltage which can be measured over this low frequency band from 10 to 100 microvolts. These disturbances are shown to be caused by any or all of the following: (1) insulating material in or near electron path; (2) irregularity of filament emission; (3) gas; (4) positive ions emitted by filament; (5) insulating or foreign deposits on grid wires.

A tube has been developed in which the above effects are removed or reduced to a point where the disturbances are nearly that of the shot effect of the electrons, as limited by space charge. This allows the amplification of low-frequency voltages of less than 1 microvolt over the entire frequency band below 100 c/s.

A NEW 6-VOLT OUTPUT PENTODE [EVEREADY RAYTHEON LA].—(*QST*, May, 1932, Vol. 16, pp. 20–21.)

INDIRECTLY HEATED SCREEN-GRID VARIABLE-MU VALVES, TYPES V.DS AND V.MS4, FOR D.C. AND A.C. RESPECTIVELY.—General Electric Company. (*Electrician*, 5th Aug., 1932, Vol. 109, p. 176.)

TRIPLE-TWIN TUBES.—C. F. Stromeyer. (*Proc. Inst. Rad. Eng.*, July, 1932, Vol. 20, pp. 1149–1162.)

On the new valve dealt with in May and August Abstracts, pp. 285–286 and 463, its fundamental circuit and a push-pull circuit. An analysis of the "grid current compensation" is given from experimental data. Output and sensitivity are compared with a pentode and a triode of the same plate voltage rating: the triple-twin delivers nearly twice the pentode's power and three times that of the triode. "Its power sensitivity is many times greater than its contemporaries."

MORE NEW TUBES [PENTODE WITH LOW HUM LEVEL, OSCILLATING DETECTOR, DETECTOR OR VOLUME CONTROL VALVE, TWO-VOLT PENTODE, DETECTOR-AMPLIFIER, DIODE, AUTOMOBILE OUTPUT PENTODE, AND LOW NOISE-LEVEL VALVE P.J. 11].—L. Martin. (*Radio Craft*, May, 1932, Vol. 3, pp. 652–655.)

A TUBE FOR CLASS B AMPLIFIER SERVICE [RADIOTRON RCA-46 AND CUNNINGHAM C-46].—(*Rad. Engineering*, July, 1932, Vol. 12, pp. 16–18 and 20.)

THE RCA-46, A ZERO-BIAS OUTPUT VALVE FOR CLASS B OPERATION IN AN A.C. MAINS RECEIVER.—Barton. (*See* abstract under "Reception.")

NEW TUBES FOR CLASS B AUDIO: THE TYPE RCA-46 AMPLIFIER [ZERO BIAS] AND TYPE RCA-82 RECTIFIER.—G. Grammer. (*QST*, May, 1932, Vol. 16, pp. 14–15; *also* June, 1932, p. 36.)

A NEW ZERO-BIAS OUTPUT TUBE [TYPE ER-49, FOR CLASS B OPERATION IN 2-VOLT RECEIVERS].—J. R. Nelson: Raytheon Corporation. (*Rad. Engineering*, July, 1932, Vol. 12, pp. 11 and 34.)

FURTHER DESCRIPTION, AND CHARACTERISTICS, OF THE WUNDERLICH RADIO TUBE.—F. E. Terman. (*Rad. Engineering*, May, 1932, Vol. 12, pp. 25–28.)

See also July Abstracts, p. 409.

THE NEW 57 AS A HIGH GAIN AUDIO AMPLIFIER.—L. C. Waller. (*QST*, July, 1932, Vol. 16, pp. 17–18.)

PROGRESS IN TUBES.—(*Rad. Engineering*, July, 1932, Vol. 12, p. 36.)

A monthly feature. The present instalment includes the Type 41 intermediate power pentode, the C-57 triple-grid amplifier detector, and the RCA-55 and C-55 two-diode one-triode combination for simultaneous detection, amplification, and A.V.C.

A NEW GROUP OF RECEIVING TUBES [TYPES 56, 57 AND 58].—(*QST*, June, 1932, Vol. 16, pp. 35–36.)

Amplifier Tubes for Industrial Applications.—L. R. Harness. (*Electric Journ.*, May, 1932, Vol. 29, pp. 233–235.)

Costs in Radio Tube Manufacture.—T. E. Conway. (*Electronics*, July, 1932, pp. 222–223.)

Dynamic Transconductance Meters.—R. de Cola. (*Rad. Engineering*, June, 1932, Vol. 12, pp. 13 and 15.)

"Cheater Circuits" for Synthetic Testing of Mercury-Vapour Tubes [for Economy in Power and Apparatus].—J. L. Zehner: G.E.C. (*Electronics*, July, 1932, p. 224.)

Über den Ausbrennvorgang der im Vakuum geglühten Drähte. III (On the Burning Out Process of Wires Heated in Vacuo. III).—L. Prásnik. (*Zeitschr. f. Physik*, 1932, Vol. 77, No. 1/2, pp. 127–132.)

Continuation of the papers referred to in July Abstracts, p. 410; this part contains an approximate determination of the effect of including heat conductivity in the calculations of the previous papers.

The Investigation of the Thermal Inertia of a Filament by means of a Three-Electrode Kerr Cell.—Rohde and Schnetzler. (*See* end of abstract under "Phototelegraphy and Television.")

A Measurement of Boltzmann's Constant by means of the Fluctuations of Electron Pressure in a Conductor [containing Description of Attenuator System].—H. D. Ellis and E. B. Moullin. (*Proc. Camb. Phil. Soc.*, July, 1932, Vol. 28, No. 3, pp. 386–402.)

Authors' summary:—This paper describes a repetition of J. B. Johnson's determination of Boltzmann's constant by observing the thermal agitation of electrons in a conductor (1928 Abstracts, p. 581). The principle of the measurement is described and the various sources of error are examined separately. The attenuator system of the calibrating circuit is discussed in detail and mutual agreement established between the three different attenuating systems. The valve amplifier had a maximum response which could be arranged to occur at any frequency between 1 000 and 4 000 cycles/sec. The mean value of 52 determinations of Boltzmann's constant (with the amplifier set to 1 to 4 kc/s) was found to be 1.361×10^{-16} ergs per degree, with a probable error of 1.42%: this value is 0.8% less than the accepted value of 1.372×10^{-16} ergs per degree.

On Thermionic Currents Limited by Pure Electron Space Charge.—E. W. Thatcher. (*Phys. Review*, 15th June, 1932, Series 2, Vol. 40, No. 6, p. 1045.)

Evaporation and Migration of Thorium on Tungsten.—W. H. Brattain. (*Phys. Review*, 15th June, 1932, Series 2, Vol. 40, No. 6, p. 1044.)

The Surface Ionisation of Potassium by [Hot] Tungsten.—P. B. Moon and M. L. E. Oliphant. (*Proc. Roy. Soc.*, Aug., 1932, Vol. 137, No. A 832, pp. 463–480.)

Effect of a Glass Target on Cold Emission.—W. H. Bennett. (*Phys. Review*, 15th June, 1932, Series 2, Vol. 40, No. 6, pp. 1043–1044.) Abstract only.

The Energy Distribution of Electrons [Extracted from a Cold Tungsten Filament by means of a High Electrical Field] in Field Current Emission.—J. E. Henderson. (*Phys. Review*, 15th July, 1932, Series 2, Vol. 41, No. 2, p. 261.)

DIRECTIONAL WIRELESS.

The Performance of the Marconi-Adcock Direction Finder.—N. E. Davis. (*Marconi Review*, July–Aug., 1932, No. 37, pp. 17–21.)

See 1931 Abstracts, p. 619. The results of a large number of further observations are given and analysed in the present article. On Brussels ($\lambda = 509$ m, distance 210 miles) the system gave only 1.2% of night-time bearings with error greater than 3°, while with a Bellini-Tosi d.f. the corresponding percentage was 63.8. Those periods which are unsuitable for d.f. even with the Marconi-Adcock equipment are easily recognisable: they are generally of very brief duration, occurring at sunset at transmitter or receiver, and appear to be most severe on transmissions from a distance of 400 to 600 miles in the medium wavelength band.

Marconi Direction Finder Type D.F.G.9B [for Naval Purposes, using Small Shielded Frame Aerial].—(*Ibid.*, pp. 22–24.)

The Radio of the [Pan-American] Airways.—H. C. Leuteritz. (*Rad. Engineering*, June, 1932, Vol. 12, pp. 27–28 and 36.)

Five-Metre Airplane [to Ground Stations] Tests Overwhelmingly Successful.—Lyman. (*QST*, May, 1932, Vol. 16, pp. 34–36.)

A preliminary description, ending with a report by J. Lyman, of the amateur tests referred to in July Abstracts, p. 411. *See* also June issue, pp. 20–23 (particularly the transmitters used at various amateur stations).

ACOUSTICS AND AUDIO-FREQUENCIES.

An Automatic Reverberation Meter for the Measurement of Sound Absorption.—W. F. Snyder. (*Bur. of Stds. Journ. of Res.*, July, 1932, Vol. 9, No. 1, pp. 47–52.)

Working through a range of about 70 db, the rate of decay being measured over intervals as short as desired. Automatic control allows the measurements to be taken with but little attention on the part of the observer.

APPARENT REDUCTION OF LOUDNESS [DECIBEL REDUCTION TO PRODUCE APPARENT "HALVING"].—D. A. Laird, E. Taylor and H. H. Wille, Jr. (Short summary in *Sci. Abstracts, Sec. A*, July, 1932, Vol. 35, No. 415, p. 630.)

ACOUSTIC NOMENCLATURE AND DEFINITIONS [PHON AND DECIBEL].—C. F. Kemp: G.W.O.H. (*Wireless Engineer*, Aug., 1932, Vol. 9, No. 107, p. 448.)

A letter on the editorial dealt with in Aug. Abstracts, p. 466: G.W.O.H. replies, pointing out that the committee in question recommend a *new* meaning for the word "phon."

A METHOD OF [AUDIO-] FREQUENCY MEASUREMENT WITH THE CATHODE RAY OSCILLOGRAPH [USED AS SOURCE OF COMPARISON FREQUENCY AND AS INDICATOR].—L. A. Wood. (*Review Scient. Instr.*, July, 1932, Vol. 3, pp. 378–383.)

SOME ACOUSTIC AND TELEPHONE MEASUREMENTS [BRITISH POST OFFICE: INCLUDING LOUD SPEAKER TESTS].—H. R. Harbottle. (*Wireless Engineer*, Aug., 1932, Vol. 9, No. 107, pp. 451–452.)

Abstract of I.E.E. paper. Some specimen loud speaker characteristics are reproduced.

A METHOD OF MEASURING ACOUSTIC IMPEDANCE.—P. B. Flanders. (*Bell S. Tech. Journ.*, July, 1932, Vol. 11, No. 3, pp. 402–410.)

"An apparatus is described whereby acoustic impedances may be measured in terms of a known acoustic impedance and the complex ratios of two electrical potentiometer readings to a third."

ZUR DEFINITION DER BEGRIFFE DRUCKEMPFÄNGER UND BEWEGUNGSEMPFÄNGER (The Definition of the Titles "Pressure" and "Motion" Receivers).—K. Schuster. (*E.N.T.*, July, 1932, Vol. 9, pp. 235–238.)

PHASE-SENSITIVE "RECTIFIER BRIDGE" FOR MEASURING A DESIRED COMPONENT IN AN A.C. POTENTIAL.—Walter. (*See* abstract under "Measurements and Standards.")

A DEVICE FOR SEPARATING THE HARMONICS OF COMPLEX WAVES, WITH SPECIAL APPLICATION TO THE A.C. POTENTIOMETER [EXTENSION OF JOUBERT CONTACT MAKER].—D. C. Gall: Messrs. Tinsley. (*Journ. Scient. Instr.*, August, 1932, Vol. 9, pp. 262–264.)

Working very well up to the fifteenth harmonic of a 50-cycle fundamental. Phase as well as magnitude is determined.

EINE EINFACHE METHODE DER HARMONISCHEN ANALYSE (A Simple Method of Harmonic Analysis).—F. Nachtikal. (*E.NT.*, July, 1932, Vol. 9, p. 282.)

Depending on the graphical representation of the function round a cylinder whose circumference represents a certain fraction *k* of the whole period, and the projection of this cylinder on to a plane surface, giving a closed curve superposed *k* times on itself.

LOUD SPEAKERS WITH INDEPENDENT CONTROL ADDED TO RADIO RECEIVERS.—W. L. Parsons. (*Rad. Engineering*, May, 1932, Vol. 12, p. 29.)

ON A CHARACTERISTIC TEMPERATURE POINT IN ROCHELLE SALT CRYSTALS.—Schulwas-Sorokin. (*See* under "Measurements and Standards.")

THE ELECTRICAL PROPERTIES OF ROCHELLE SALT MIXED CRYSTALS.—B. Kurtschatow and M. Eremejew. (*Phys. Zeitschr. der Sowjetunion*, No. 1, Vol. 1, 1932, pp. 140–154.)

ELECTRO-MECHANICAL RECTIFICATION [AND ITS EFFECT ON REPRODUCTION].—P. K. Turner: McLachlan. (*Wireless Engineer*, July, 1932, Vol. 9, No. 106, p. 395.)

The writer observed the phenomenon described by McLachlan (Aug. Abstracts, p. 464) but unlike him found the effect quite important, particularly when a low and a high note occur simultaneously: the high note is then modulated by the low note "and the result is very distressing." The trouble is cured by suitable shaping of the poles so that the leakage fields are symmetrical.

A NOVEL LOUD-SPEAKER MOVEMENT [EDDY-CURRENT DRAG FROM ROTATING DISC].—Gladenbeck. (*Wireless World*, 22nd July, 1932, Vol. 31, p. 57.)

A SENSITIVE MOVING-COIL MICROPHONE OF HIGH QUALITY: ADAPTING THE MOVING-COIL MICROPHONE TO COMMERCIAL USE: MOUNTINGS, CONNECTORS AND AMPLIFIER FOR MOVING-COIL MICROPHONE.—Thuras: Giles: Leuvelink. (*Bell Lab. Record*, May, 1932, Vol. 10, No. 9, pp. 314–326.)

D.C. GRAMOPHONE AMPLIFIER [WITH UNDISTORTED 5 WATT OUTPUT].—R. A. Fereday. (*Wireless World*, 29th July, 1932, Vol. 31, p. 80.)

AN EFFICIENT MINIATURE CONDENSER MICROPHONE SYSTEM.—H. C. Harrison and P. B. Flanders. (*Bell S. Tech. Journ.*, July, 1932, Vol. 11, No. 3, pp. 451–461.)

"This paper describes a laboratory model of a Wente-type condenser microphone of high efficiency and an associated coupling amplifier which are of such small size that reflection and phase-difference effects are of negligible importance within the audible frequency range; while the cavity is so proportioned that its resonance effect is an aid rather than a detriment to uniformity of response in a constant sound field."

STEUERBARE LICHTQUELLEN FÜR DIE TONAUFZEICHNUNGEN (Controllable Light Sources for Sound-on-Film Recording).—F. Skaupy. (*Fernsehen u. Tonfilm*, July, 1932, Vol. 3, No. 3, pp. 139–143.)

Including illustrated descriptions of a new Tobis lamp and of the cathode-ray arrangements of Breusing and von Hartel (*cf.* Hatschek, Aug. Abstracts, p. 465).

Voices Beautified for Radio by Ingenious Mechanisms.—O. H. Caldwell. (*Sci. News Letter*, 25th June, 1932, p. 400.)

On the use of compensators and filters in broadcasting circuits to give pleasing qualities to a speaker's voice. It is suggested that it would be possible to make a "political candidate speak simultaneously with a shrill Yankee twang in New England, a Southern drawl in Dixie, and a breezy western accent in the West."

The Delusiveness of Filtering Compound Sounds.—M. F. Meyer. (*Science*, 15th July, 1932, Vol. 76, No. 1959, pp. 54–55.)

A letter ending :—" Let us repeat our warning. Electric filters do not filter out sensations. They physically destroy 'Fourier Components.' It is true that in ninety (or more) cases out of a hundred the sensations are also gone. But the exceptions—the sensations unexpectedly remaining—are of far greater importance for acoustical science, for they prove that *the cochlea, while being the analyser, is not a Fourier analyser*."

Der Klangfärber, ein neuer Einzelteil für bessere Rundfunkwiedergabe (The Tone Control Adjustment, a New Component for Better Broadcast Reproduction). — E. Schwandt : Rhein. (*Rad., B., F. f. Alle*, August, 1932, pp. 357–361.)

The Rhein tone controller is essentially a differential condenser, though in its practical form it is made of a combination of two step-by-step condensers. The home construction of such a device, and the best way of connecting it, are here discussed at some length.

Der Teilnehmer-Endverstärker (The Subscriber Output Amplifier).—Winzheimer and Reppisch. (*Hochf : tech. u. Elek : akus.*, July, 1932, Vol. 40, No. 1, pp. 15–29.)

Part II of the paper referred to in August Abstracts, p. 465. Part III is still to follow.

Beiträge zur Bemessung von Verstärkern für Rundgesprächseinrichtungen (Contributions to the Design Calculations of Amplifiers for Multiple Address Systems).—H. Reppisch. (*E.N.T.*, July, 1932, Vol. 9, pp. 239–242.)

The Loudness of Sound.—N. W. McLachlan. (*Wireless World*, 29th July, 1932, Vol. 31, pp. 78–80.)

Owing to the frequency-sensitivity curve of the ear, at low volume level music sounds thin because low-pitched instruments are not heard, but as the volume is increased the low frequencies become reproduced at a greater rate than the high. These phenomena of hearing, which have an important bearing on the volume level to be aimed at in broadcast reproduction, are here dealt with in considerable detail.

The Nature of the Vowels [Investigation by Sound-on-Film Technique].—E. W. Scripture. (*Rep. on Discussion on Audition, Phys. Soc. London*, June, 1931, pp. 44–52.)

Analysis of Noises and Musical Sounds.—E. Meyer. (*Ibid.*, pp. 53–61.)

Acoustic Measuring Instruments.—C. V. Drysdale. (*Ibid.*, pp. 62–78.)

Absolute Measurement of Sound-Amplitudes and Intensities.—E. N. da C. Andrade. (*Ibid.*, pp. 79–81.)

The Measurement of Noise.—A. H. Davis. (*Ibid.*, pp. 82–91.)

PHOTOTELEGRAPHY AND TELEVISION.

Ein Beitrag zur Berechnung von Fernsehapparaten (A Contribution to the Calculation [and Specification] of Television Apparatus).—R. Thun. (*Fernsehen u. Tonfilm*, July, 1932, Vol. 3, No. 3, pp. 157–159.)

Suggestions as to definitions of the various factors involved in practically all systems. They are as follows :—(1) Number of lines. (2) Picture fineness, defined as the ratio of the area of a light spot on a dark background, giving at the receiver one-third of the brightness contrast of the original, to one thousandth of the total picture area. This one thousandth part is taken in order to make the characteristic number, defining the "fineness," of a convenient size. The one-third contrast is taken because a picture element is distinguishable if two-thirds of the original contrast is lost, provided the latter is of an average nature. The characteristic number corresponds approximately to the usual picture element number divided by 1 000. In many systems it is not a constant, in which case the maximum, mean and minimum finenesses should be given. (3) Picture brightness : maximum, mean and minimum. The mean brightness is a constant only in certain systems, such as the Thun variable speed system. (4) Picture change per second. (5) Brightness change per picture element. The characteristic numbers of (4) and (5) are often equal, but in some systems this is not the case. The five characteristics are not independent of each other : thus for a given band breadth the product of the picture change and mean fineness is in most cases a constant, as is the product of mean fineness and picture brightness. But in comparing different systems, instead of combining the characteristics into one figure of merit it is better to keep them separate and to specify the relations between them.

Each of the characteristic numbers can be resolved into three components, of which one depends on the particular system, the second on the constructional components, and the third on both these factors. This point is elaborated and illustrated by examples, for the brightness control and the variable speed systems.

The Peck Television System.—W. H. Peck. (*Rad. Engineering*, June, 1932, Vol. 12, p. 22.)

Short article on the system dealt with in June Abstracts, p. 353—two.

New Television Home Receiver with Mirror Wheel, Larger Screen and Special Kerr Cell.—Baird Company. (*Electrician*, 8th July, 1932, Vol. 109, p. 30 : *Engineer*, 29th July, 1932, Vol. 154, p. 111.)

VISION AND SOUND ON ONE WAVE.—Columbia Broadcasting System. (*Television*, August, 1932, p. 204.)

LE PROBLÈME DE LA TRANSMISSION EN TELEVISION (The Problem of Television Transmission—Baird, Lyon and Stoyanowsky System).—E. Labin: Baird Company. (*Génie Civil*, 9th July, 1932, Vol. 101, No. 2, pp. 29–32.)

Based on the "Visiotelephony" service referred to in August Abstracts, p. 467.

DESIGN OF LENS SCANNING SYSTEMS FOR TELEVISION.—I. Bloch. (*Rad. Engineering*, June, 1932, Vol. 12, pp. 9–12.)

AN ADVANCED TELEVISION AND SHORT-WAVE SUPERHETERODYNE RECEIVER [AVOIDING MOTOR-BOATING AND OTHER REACTION TROUBLES BY USE OF CARBORUNDUM DETECTORS IN BOTH STAGES].—R. W. Tanner. (*Rad. Engineering*, July, 1932, Vol. 12, pp. 25–27.)

"The results obtained with this circuit have been more than satisfactory. On television, eastern stations have been brought in in Michigan through heavy interference from the Chicago 45 line stations and with exceptionally fine detail." It allows true single control without an auxiliary vernier condenser.

PRINTED PAGE BY RADIO ["RADIOTYPE" SYSTEM ON THE "BREMEN"].—Radiotype and Debeg Radio Companies. (*Rad. Engineering*, July, 1932, Vol. 12, p. 32.)

Cf. September Abstracts, p. 531—Guth.

THE DISTORTIONS IN THE CATHODE-RAY OSCILLOGRAPH AT HIGH MEASURING VELOCITIES.—Klemperer and Wolff. (*See* under "Subsidiary Apparatus and Materials.")

EINE NEUE METHODE ZUR MESSUNG DES NACHLEUCHTENS VON GASENTLADUNGEN (A New Method of Measuring the After-Glow of Discharges in Gas [and the Limitations of the Neon Lamp in Television]).—L. Rohde and K. Schnetzler. (*Zeitschr. f. tech. Phys.*, No. 8, Vol. 13, 1932, pp. 358–363.)

By means of a symmetrical three-electrode Kerr cell, a comparison was made of the brightnesses of glow during the two phases of a glow-discharge tube fed (as it would be in television) by radio-frequency current rectified by a half-wave rectifier, so that during one phase the light was due to after-glow. Various gases were introduced in turn into the discharge tube (including sodium vapour).

It was found that the decay time was of the order of 10^{-7} sec in the negative glow and 10^{-6} in the positive column, and that it increased somewhat with increasing gas pressure, but was independent of wavelength between 100 and 1 000 metres. It is concluded that the use of a neon lamp in television is limited by after-glow to frequencies not exceeding about 10^5 c/s. In a subsidiary experiment the tube was fed with unrectified r.f. current, so that an equal glow for both phases might have been expected. This did not as a rule occur: directly the discharge became striated, it took place almost always (always, if the number of striae was even) only in one half of the period, the favoured half-period being alternated. This is attributed to a swinging of the electrons between the striae (*cf.* Rohde, July Abstracts, p. 399).

The writer ends by pointing out other possible applications of the special three-electrode Kerr cell. It will give a direct and clear picture of the relations in the two phases of any process: examples mentioned are the investigation of the thermal inertia of a filament and the examination of an electrical process by means of a constant light source and an auxiliary source.

SOURCES OF LIGHT FOR TELEVISION [MODERN FLAT PLATE AND CRATER LAMPS].—A. E. Lyle. (*Rad. Engineering*, May, 1932, Vol. 12, pp. 16 and 24.)

BEGLEITERSCHEINUNGEN BEIM ELEKTRO-OPTISCHEN KERREFFEKT IM HOCHFREQUENZFELDE (Phenomena accompanying the Electro-Optical Kerr Effect in a High-Frequency Field).—H. Hoyer and L. Pungs. (*Physik. Zeitschr.*, 15th July, 1932, Vol. 33, No. 14, pp. 531–534.)

Authors' summary:—The "strip" effect in a Kerr field observed by Sircar (Abstracts, 1930, pp. 49–50) and Cotton and Mouton (June, p. 354), particularly at high frequencies, and the occurrence of an additional sluggish double refraction in the Kerr cell, are explicable as effects of the heating due to dielectric losses, which gives rise to a very regular current in the Kerr field and double refraction due to deformation in the glass walls of the Kerr cell.

CONTROLLABLE LIGHT SOURCES FOR SOUND-ON-FILM RECORDING.—Skaupy. (*See* under "Acoustics and Audio-frequencies.")

POWER INPUT AND DISSIPATION IN THE POSITIVE COLUMN OF A CAESIUM DISCHARGE.—F. L. Mohler. (*Bur. of Stds. Journ. of Res.*, July, 1932, Vol. 9, No. 1, pp. 25–34.)

THE U-SHAPED OSRAM SODIUM VAPOUR LAMP. (*Television*, Aug., 1932, pp. 211–212.)

ÜBER MESSUNGEN AN SELEN-SPERRSCHICHT-PHOTOZELLEN (Measurements on Selenium Attenuating Layer Photoelectric Cells).—L. Bergmann. (*Physik. Zeitschr.*, 1st July, 1932, Vol. 33, No. 13, pp. 513–519.)

Author's summary:—In selenium attenuating layer photoelectric cells based on the front wall effect ["Vorderwandeffekt"] the photoelectric current is a linear function of the intensity of illumination only in the case when the resistance of the external circuit is vanishingly small compared with the resistance of the cell. As the external resistance becomes greater, the curvature of the intensity of illumination/current characteristic steadily increases. The same effect occurs in the curve connecting photoelectric current with the illuminated area of the cell. The photoelectromotive force tends towards a saturation value as the illumination increases. These results are of importance for the application of the cells to photometry.

Photo-E.M.F. of Selenium.—V. Brazzoduro. (Summary in *Sci. Abstracts, Sec. A*, July, 1932, Vol. 35, No. 415, pp. 645–646.)

The cells tested were of the second type, constructed according to Uljanin's method by fusing selenium between platinised glass.

Photoelectricity and Rectification in Cuprox Rectifiers.—V. Brazzoduro. (*Ibid.*, p. 646.)

Photoelectricity and Rectifiers: Comparison between Cuprox and Selenium Rectifiers.—R. Deaglio. (*Ibid.*, p. 646.)

Ein Beitrag zum Kristall- und Sperrschichtphotoeffekt (Contribution to the Knowledge of the Crystal and Attenuating Layer Photoelectric Effect).—W. Bulian and H. Schreiber. (*Naturwiss.*, 1st July, 1932, Vol. 20, No. 27, p. 506.)

A preliminary note on experiments on the fore- and rear-wall effects in cuprous oxide cells, which seem to show that the different crystalline structure of the cuprous oxide in the two cases is not sufficient to explain the difference in current direction, as assumed by Scharf and Weinbaum (August Abstracts, p. 469).

The Caesium-Oxygen-Silver Photoelectric Cell. An Investigation of the Relations in a Composite Photoelectric Surface.—C. H. Prescott, Jr., and M. J. Kelly. (*Bell S. Tech. Journ.*, July, 1932, Vol. 11, No. 3, pp. 334–367.)

Authors' abstract:—Technique is described permitting the formation of caesium-oxygen-silver photoelectric cells under controlled conditions. It is shown that the essential conditions are a quantitative control of the degree of oxidation of the silver cathode base and the amount of caesium generated, together with a regulation of the amount of chemical interaction by a control of the time and temperature of the heat treatment. Variations in sensitivity to integral light at 2 710° K colour temperature are shown as a function of the initial amounts of oxygen and caesium and the time of heat treatment. Small amounts of oxygen were permitted to react with the standard cathode surface. The sensitivity of the cathode fell but recovered due to the diffusion of free caesium to the surface from the underlying material. The effects are shown in relation to the integral sensitivity and the spectral response from 6 000 Å to 10 000 Å.

The effects of depositing minute amounts of free caesium upon the standard cathode surface are also shown in relation to the spectral response. The active surface of the cathode appears to be a film of free caesium of atomic dimensions adsorbed upon a matrix of caesium oxide and silver containing free caesium and a small amount of silver oxide. The spectral characteristics of the photoelectric response appear to depend largely upon the thickness of the surface film of free caesium. This film thickness is determined by the caesium concentration in the underlying matrix and is maintained by a diffusion equilibrium.

The Application of Photoelectric Cells Sensitive in the Infra-Red to Stellar Photometry [and the Reduction of the "Dark Current" in Caesium-Oxide-on-Silver Photocells].—J. S. Hall. (*Proc. Nat. Acad. Sci.*, May, 1932, Vol. 18, pp. 365–367.)

Lag in Gas-Filled Photocells.—F. Ollendorff. (Programme of Sept. Meeting of Deutscher Phys. u. Math., p. 6, inset in *Zeitschr. f. tech. Phys.*, No. 8, Vol. 13, 1932: summary only.)

Among the results, it is found that the dependence of the cell a.c. on the illumination frequency shows a hitherto unknown resonance effect near certain frequencies, which is closely connected with the migration velocity of the ions.

Gas-filled Photoelectric Cells.—P. W. Timofeev and N. S. Chlebnikov. (*Westnik Elektrot.*, No. 11/12, 1931, Sec. I, pp. 464–471.)

See April Abstracts, p. 233.

A Photoelectric Cell Circuit [Special Modification of Hull Circuit for Wide Linear Response: Mathematical Analysis].—G. A. Woonton and R. G. Elson. (*Canadian Journ. of Res.*, April, 1932, Vol. 6, pp. 444–451.)

"In this paper it is shown that a vacuum tube circuit of special design is capable of linear response to the varying conductivity of a photoelectric cell. A method is suggested whereby light intensities of widely different magnitudes can be compared. The circuit is shown to be extremely stable." The mathematical analysis of the valve circuit (screen-grid for stability) having a resistance R between filament and grid, and a photocell between grid and plate, shows that if the resistance C of the cell (defined as the reciprocal of the cell conductivity at constant anode voltage but with varying light flux) is kept very much larger than R, and sufficient negative grid bias is applied, the plate current is equal to $\frac{1}{C} g_m R(E_g + E_p)$, where g_m is the mutual conductance and E_g and E_p are the grid and plate potentials respectively.

The Distribution of Silver and Sodium between Glass and Nitrate- or Bromide-Enamels, in the State of Equilibrium.—A. Güntherschulze and O. Mohr. (*Zeitschr. f. tech. Phys.*, No. 8, Vol. 13, 1932, pp. 356–358.)

Sur un nouveau Phénomène photo-électrique (A New Photoelectric Phenomenon [Increase of Resistance of Thin Films of Silver, Gold, Platinum, etc., on Glass, produced by the Action of Light]).—Q. Majorana. (*Comptes Rendus*, 18th July, 1932, Vol. 195, pp. 226–228: *Nature*, 13th Aug., 1932, Vol. 130, p. 241.)

MEASUREMENTS AND STANDARDS.

THE PRECISION FREQUENCY MEASURING SYSTEM OF R.C.A. COMMUNICATIONS, INC.—H. O. Peterson and A. M. Braaten. (*Proc. Inst. Rad. Eng.*, June, 1932, Vol. 20, pp. 941–956.)

Authors' summary :—A frequency measuring system is described wherein transmitter frequencies are accurately compared with the harmonics from a precision, piezoelectric frequency standard. Through the medium of a system of multivibrators and a synchronous clock the frequency of the standard oscillator is referred to the time interval defined by the rotational frequency of the earth.

Harmonics from a 100-kc crystal oscillator are fed into a frequency measuring receiver along with the transmitter signals. The receiver is equipped with a small vernier condenser having a micrometer scale which is used to make the measurements. The position of a signal in the frequency spectrum relative to known harmonics from the standard oscillator is obtained by direct interpolation from the micrometer readings of the tuning points of the signal and the adjacent harmonics between which it lies. To allow greater precision in making measurements, harmonics 10 kc apart are used. Methods used in measuring broadcast, high, and ultra-high frequencies are described.

A discussion of errors is given. The total probable maximum error of a routine measurement at 20 000 kc (15 m) with this system is $\pm$ 59 cycles or 0.0003 per cent. At broadcast frequencies a measurement can be made to 0.2 cycle.

The operating aspects of the system are discussed. The number of measurements made each month is indicated and the various uses to which these measurements have been put are described.

ÜBER EINE NEUE GLEICHRICHTERMESSANORDNUNG (A [Balanced] Rectifier Measuring Circuit [Phase-Sensitive "Rectifier Bridge" for Indicating or Measuring a Desired Component in an Alternating Potential, particularly suitable for Audio-frequency Use]).—C. H. Walter. (*Zeitschr. f. tech. Phys.*, No. 8, Vol. 13, 1932, pp. 363–367.)

The arrangement consists essentially of two rectifier circuits working with linear characteristics and feeding a single d.c. meter. The one circuit receives the sum, the other the difference, of the potential to be measured and an auxiliary a.c. potential. It is applicable to many electrical measuring purposes, is free from inertia, and with suitable design is constant as regards time and independent of temperature.

A METHOD OF [AUDIO-] FREQUENCY MEASUREMENT WITH THE CATHODE-RAY OSCILLOGRAPH [USED AS SOURCE OF COMPARISON FREQUENCY AND AS INDICATOR].—L. A. Wood. (*Review Scient. Instr.*, July, 1932, Vol. 3, pp. 378–383.)

A METHOD OF MEASURING ACOUSTIC IMPEDANCE.—Flanders. (*See* under "Acoustics and Audio-frequencies.")

DESIGN OF RESISTORS [RESISTANCE BOXES AND FIXED STANDARDS] FOR PRECISE HIGH-FREQUENCY MEASUREMENTS.—L. Behr and R. E. Tarpley. (*Proc. Inst. Rad. Eng.*, July, 1932, Vol. 20, pp. 1101–1113: Discussion, pp. 1114–1116.)

Authors' summary :—New shielded and unshielded resistance boxes and fixed standards of resistance for use in precise a-c measurements are described in detail, and numerical values are given for the residual inductance or capacitance of the individual coils and of the boxes at various settings, and for the resistance error at 1 and 50 kc.

A new coil construction and two new types of decades are used. In one of the resistance boxes, for any setting of the dials, only one coil of each decade is in the circuit, while the idle coils are completely disconnected, and in addition the configuration of the circuit inside the box remains constant for all settings of the dials.

MARCONI PORTABLE FIELD STRENGTH MEASURING EQUIPMENT [14 TO 2 000 METRES].—(*Marconi Review*, May–June, 1932, No. 36, pp. 14–19.)

"It is believed that no other similar equipment exists which is capable of such a high ratio of maximum to minimum field intensity measurement over such a wide range of frequencies." The advantages of the superheterodyne receiver, as used in this equipment, are discussed in the final section.

A METHOD OF MEASURING THE EFFECTIVE RESISTANCE OF A CONDENSER AT RADIO FREQUENCIES, AND OF MEASURING THE RESISTANCE OF LONG STRAIGHT WIRES.—E. B. Moullin. (*Proc. Roy. Soc.*, July, 1932, Vol. 137, No. A 831, pp. 116–133.)

Author's summary :—The resistance of a high frequency circuit usually exceeds the calculated resistance of the inductance coil, and the discrepancy is often attributed to the condenser. This paper describes an experimental method of separating the total resistance into a component due to the resistance of the conductors of the coil and a component which is independent of the coil. The method consists in using similar coils wound with wires of different specific resistance and in plotting the measured resistance of the circuit against the calculated resistance of the coil. The result is found to be a straight line not passing through the origin, thus showing there is a component of resistance which does not depend on the conductivity of the wire in the coil; the intercept on the resistance axis shows the resistance of the condenser at the frequency in use. The slope of the line gives a measure of the amount by which the true resistance of the coil exceeds the calculated resistance, and this can be used to examine the self-capacity correction.

The manner in which the resistance of a condenser depends on frequency and capacity can be studied from the intercepts given by a family of such lines. An example of such an analysis is given, and it is found that the condenser tested has a constant series resistance and a constant power factor in the insulation.

The coils used for the experiments were long, narrow rectangles, and for such the skin effect formula for a long straight wire is applicable without modification. For frequencies between 3 and 10 million c/s the measured resistance of a wire agrees with the calculated value.

ÜBER DIE MESSUNG DER ELEKTRISCHEN FELDSTÄRKE AN LEITEROBERFLÄCHEN (On the Measurement of Electrical Field Strength at the Surface of Conductors).—H. Jenss. (*Archiv f. Elektrot.*, July, 1932, Vol. 26, No. 7, pp. 471–490.)

The principle of the method described here is to deduce the field strength required (generally at the surface of some kind of electrode) from the measurement of the very small partial capacity between a surface section from one electrode and the other electrode. Necessary precautions and possible errors are described and the theory of the procedure is discussed.

ZUR STROMVERDRÄNGUNG IN ZYLINDRISCHEN ROHRLEITERN (On the Current Compression in Cylindrical Tube Conductors [Skin Effect Formula]).—E. Grünwald. (*Archiv f. Elektrot.*, July, 1932, Vol. 26, No. 7, pp. 513–517.)

This paper contains the derivation of a formula in series form for calculating the increase of effective resistance of cylindrical tube conductors, due to skin effect.

MEASUREMENT OF IMPEDANCES.—H. F. Trewman: Starr. (*Wireless Engineer*, Aug., 1932, Vol. 9, No. 107, pp. 447–448.)

A criticism of Starr's paper dealt with in September Abstracts, p. 534, particularly of the method of determining sign.

THE CAMPBELL-SHACKLETON SHIELDED RATIO BOX.—L. Behr and A. J. Williams, Jr. (*Proc. Inst. Rad. Eng.*, June, 1932, Vol. 20, pp. 969–988.)

Intended to serve as the nucleus of a one-to-one bridge for the accurate comparison of impedances. The transformer used in it operates effectively over the range from 50 to 50 000 cycles per second, and in that range the limit of error is considered to be the greatest of the following terms: ± 0.01 ohm (resistance, inductive or capacitive reactance); ± 0.01 per cent.; or $\pm 2\pi \times$ frequency $\times 10^{-7}$ micromhos (conductance, inductive or capacitive admittance). The first is the limiting factor in the measurement of low impedances, the second in the measurement of intermediate impedances, while the third applies to high values.

ON THE METHOD OF MEASURING A.C. POWER [AND POWER FACTOR] WITH A TRIODE.—A. Okitsu. (*Journ. I.E.E. Japan*, June, 1932, Vol. 52 [No. 6], No. 527. English summary pp. 75–77.)

MEASUREMENT OF THE SELECTIVITY OF BEAT-NOTE RECEIVERS.—Lamb. (*See* abstract under "Reception.")

MEASUREMENTS OF SMALL CURRENTS USING PHOTRON TUBES.—L. R. Hafstad. (*Phys. Review*, 15th June, 1932, Series 2, Vol. 40, No. 6, p. 1044.)

A NEW METHOD [VIBRATING CONDENSER] OF MEASURING CONTACT POTENTIAL DIFFERENCES IN METALS.—W. A. Zisman. (*Review Scient. Instr.*, July, 1932, Vol. 3, pp. 367–370.)

DIE EMPFINDLICHKEIT DER NULLINSTRUMENTE BEI BRÜCKENSCHALTUNGEN ZUM MESSEN VON WECHSELSPANNUNGEN (The Sensitivity of Null Instruments in Bridge Circuits for the Measurement of Alternating Voltages).—W. Spielhagen. (*Zeitschr. f. Physik*, 1932, Vol. 77, No. 5/6, pp. 346–351.)

VISIBLE NULL INDICATOR FOR A.C. BRIDGES [COMBINATION OF A.C. MICROAMMETER OR GALVANOMETER AND TRIODE].—E. H. W. Banner. (*Journ. Scient. Instr.*, July, 1932, Vol. 9, p. 236.)

A STANDARD MICROVOLTER USING SECOND HARMONIC PRINCIPLE [FOR GENERATING AND MEASURING VERY WEAK R.F. VOLTAGES FOR CALIBRATING SIGNAL GENERATORS, OBTAINING PERFORMANCE DATA ON RECEIVERS, ETC.]—W. F. Diehl. (*Electronics*, July, 1932, pp. 230–231 and 246.)

A LINEAR ELECTRONIC VOLTMETER.—J. L. McLaughlin. (*QST*, May, 1932, Vol. 16, pp. 18–19 and 21.)

For r.m.s. values. The circuit is that of the well-known automatic grid bias detector with the addition of an adjustable minimum grid bias control. "Since this type of rectifier is ideally suited for use as the basis of a tube voltmeter, it is a wonder that nobody has suggested its use for this purpose before." The instrument gives a direct-reading linear voltage scale: it has compensated grid, plate and filament supply (50% change produces less than 1% error), and a full scale range of 100 v with a total grid-plate supply of 225 v; changing the valve for another of the same make and type introduces a variation in calibration of less than 5%.

RADIO MEASURING INSTRUMENTS: TYPES AND APPLICATIONS.—E. H. W. Banner. (*Elec. Review*, 27th May, 1932, Vol. 110, pp. 769–770.)

USING THE VACUUM-TUBE VOLTMETER [FOR RADIO SERVICING, ETC.]—B. B. Bryant. (*Radio Craft*, May, 1932, Vol. 3, p. 676.)

INTERNATIONAL COMPARISON OF ELECTRICAL STANDARDS.—G. W. Vinal. (*Bur. of Stds. Journ. of Res.*, June, 1932, Vol. 8, pp. 729–749.)

RADIO DISSEMINATION OF THE NATIONAL STANDARD OF FREQUENCY.—J. H. Dellinger and E. L. Hall. (*Rad. Engineering*, May, 1932, Vol. 12, pp. 23–24.)

THE QUARTZ OSCILLATOR.—T. D. Parkin. (*Marconi Review*, July–Aug., 1932, No. 37, pp. 1–16.)

A survey, with particular attention to the Marconi Company's work and practice. In the section on frequency indication the luminous resonator of Giebe and Scheibe is mentioned, and a description given of the Marconi quartz "spot wave" indicator (with triode and meter) in which the anode is brought to zero current when at rest by the use of a grid bias battery: when the transmitter is of the correct frequency, the crystal is of practically zero impedance and the meter shows a current.

Another section deals with the defects of quartz crystals and the difficulties encountered in their use—*e.g.*, "stepping" and "jumping," and the variation of frequency with temperature.

DISCUSSION ON "QUARTZ PLATE MOUNTINGS AND TEMPERATURE CONTROL FOR PIEZO-OSCILLATORS" [SPUTTERED FILM REPLACED BY SOFT METAL RUBBED ON: SUGGESTED POSSIBILITY OF OBTAINING ZERO FREQUENCY/TEMPERATURE COEFFICIENT BY COMPENSATING HOLDER PRESSURE].—V. J. Andrew: Heaton and Lapham. (*Proc. Inst. Rad. Eng.*, June, 1932, Vol. 20, p. 1064.)

On the paper dealt with in May Abstracts, p. 293.

SILVERING ELECTRODES ON QUARTZ CRYSTALS: A WARNING.—Parsons. (*QST*, May, 1932, Vol. 16, p. 21.)

Referring to Parsons' paper (June Abstracts, p. 355) a correspondent points out that solutions containing both silver and alcohol should be disposed of at once, as a fulminate of silver is formed after a few hours which is highly explosive.

PIEZOELECTRIC QUARTZ IN VIBRATION [INTERFEROMETER STUDY OF SURFACE VIBRATIONS].—G. Wataghin and G. Sacerdote. (Short summary in *Sci. Abstracts, Sec. A*, July, 1932, Vol. 35, No. 415, p. 603.)

"The absence of an acceleration-Doppler effect is established for accelerations up to the order of 10^8 cm/sec^2."

A PIEZOELECTRIC OSCILLATOR OF IMPROVED STABILITY [USING A SCREEN-GRID VALVE AND GIVING A CONSTANCY WITHIN 4.9×10^{-6}].—J. K. Clapp. (*Gen. Radio Exper.*, Dec., 1931, Vol. 6, pp. 1–4.)

THE DESIGN OF TEMPERATURE CONTROL APPARATUS FOR PIEZO OSCILLATORS.—V. J. Andrew. (*Review Scient. Instr.*, July, 1932, Vol. 3, pp. 341–351.)

THE ELECTRIC NETWORK EQUIVALENT OF A PIEZOELECTRIC RESONATOR.—K. S. Van Dyke. (*Phys. Review*, 15th June, 1932, Series 2, Vol. 40, No. 6, pp. 1026–1027.) Abstract only.

PIEZOELECTRICITY [AND THE TESTING OF VARIOUS CRYSTALS].—G. Greenwood and D. Tombonlian. (Summary in *Sci. Abstracts, Sec. A*, July, 1932, Vol. 35, No. 415, p. 635.)

ÜBER EINEN CHARAKTERISTISCHEN TEMPERATURPUNKT BEI SEIGNETTESALZKRISTALLEN (On a Characteristic Temperature Point in Rochelle Salt Crystals).—R. D. Schulwas-Sorokin. (*Zeitschr. f. Physik*, 1932, Vol. 77, No. 7/8, pp. 541–546.)

The writer has observed a very sharp maximum of the piezoelectric and dielectric constants of Rochelle salt at 22.5° C. in a very narrow temperature interval.

MODERN DEVELOPMENTS IN PRECISION TIMEKEEPERS.—A. L. Loomis and W. A. Marrison. (*Elec. Engineering*, Aug., 1932, Vol. 51, pp. 542–549.)

GEARLESS CLOCK [SYNCHRONOUS MOTOR WITH FOUR MOVING PARTS, SLOWEST REVOLVING TWICE PER DAY, FASTEST ONCE PER SECOND: VERNIER CASCADE PRINCIPLE].—L. W. Watts: Chubb. (*Elec. World*, 30th April, 1932, pp. 784–785; *Electrician*, 5th Aug., 1932, p. 166.)

SLOW MOTION MOTOR WILL RUN INDEFINITELY [FOR CLOCK, FREQUENCY INTEGRATOR, ETC.].—(*Elec. Engineering*, May, 1932, Vol. 51, pp. 319–320.) *See* above abstract.

SYNCHRONISATION OF THE BALANCE WHEELS OF CLOCKS.—Salmon-Legagneur and Bertrand-Lepaute. (*Comptes Rendus*, 4th July, 1932, Vol. 195, pp. 26–27.)

Clocks driven off the mains suffer from the defect that they stop if there is a momentary interruption of current. Auxiliary spring drive involves much complication. The writers therefore recommend the use of a spring-driven clock (wound automatically by a motor) synchronised by the action of the mains current on a very light armature built into the balance wheel.

AN UNRECOGNISED PROPERTY OF THE REVERSIBLE PENDULUM.—P. R. Heyl. (*Bur. of Stds Journ. of Res.*, May, 1932, Vol. 8, pp. 657–658.)

"In a reversible pendulum which carries two planes and is supported from either plane in turn upon the same knife-edge, it is found that the correction for a circularly rounded knife-edge eliminates itself."

DETERMINATION OF QUALITY AS A BASIS FOR COMMODITY STANDARDS.—F. W. Reynolds. (*Review Scient. Instr.*, July, 1932, Vol. 3, pp. 371–377.)

AN EXPERIMENTAL MACHINE FOR MEASURING FINE WIRE.—F. H. Rolt and C. O. Taylerson. (*Journ. Scient. Instr.*, August, 1932, Vol. 9, pp. 256–260.)

SUBSIDIARY APPARATUS AND MATERIALS.

ÜBER DIE EIGENSCHAFTEN UND DIE BERECHNUNG DER MEHRFACHEN BRÜCKENFILTER (The Properties and Calculation of the Multiple Bridge Filter).—A. Jaumann. (*E.N.T.*, July, 1932, Vol. 9, pp. 243–281.)

Bridge-circuit filters have recently been dealt with by Cauer, Bode and others, but their calculations lead to very involved final formulae. The present lengthy paper, on the other hand, develops a number of simple and practical formulae, curves, etc., whose application to the design of bridge filters is illustrated by examples. By means of simple transformation formulae the corresponding suppression filters may be obtained. Literature references on the theory of quadripoles and wave filters are given at the end.

KATHODENSTRAHLOSZILLOGRAPHISCHE AUFNAHME UNMITTELBAR AUF PHOTOPAPIER (Cathode-Ray Oscillographic [Internal] Recording Direct on Photographic Paper).—W. Förster. (*Zeitschr. f. tech. Phys.*, No. 8, Vol 13, 1932, pp. 373–374.)

Direct internal recording on paper (thus avoiding the necessity for preparing a diapositive of the original plate before it is possible to obtain a black-line record on a white ground) has hitherto been rendered impossible owing to the moisture content of the paper and the emission of gas under the action of the ray. The special properties of the big Dresden oscillograph (Abstracts, 1930, p. 642, and 1931, p. 452) enable these difficulties to be neglected, as a specimen oscillogram on commercial bromide paper shows.

DIE VERZERRUNGEN IM KATHODENOSZILLOGRAPHEN BEI HOHEN MESSGESCHWINDIGKEITEN (The Distortions in the Cathode-Ray Oscillograph at High Measuring Velocities).—H. Klemperer and O. Wolff. (*Archiv f. Elektrot.*, July, 1932, Vol. 26, No. 7, pp. 495–502.)

Authors' summary:—In the reproduction of electrical phenomena by the cathode-ray oscillograph, various errors of measurement occur in the range of highest velocity. These arise chiefly from the capacity of the measuring circuit [the deviating plates], whose time constant determines the errors. Further distortion is caused by the finite time taken by the beam to traverse the deviating system. In this paper the writers start from the equation of motion of the electron and calculate the voltage reproduced by the oscillograph for simple wave-fronts (rectangular, oblique and exponential) and for harmonic phenomena. The dimensions of the deviating system must be chosen to fit the permissible error of measurement. A diagrammatic representation is given of the connection between beam velocity, length of deviating plates, deviation sensitivity and maximum measuring frequency attainable with given error.

EINE METHODE ZUR RADIALEN ABLENKUNG AN DER BRAUNSCHEN RÖHRE (A Method of Radial Deflection in the Cathode-Ray Oscillograph [Circular Time Base with Radial Deflection]).—G. Goubau. (*Hochf:tech. u. Elek:akus.*, July, 1932, Vol. 40, No. 1, pp. 1–3.)

A new version of the Goubau circular time base, corresponding very closely to the arrangement evolved by the Radio Research Station, Slough, dealt with in Sept. Abstracts, pp. 535–536.

THE AMPLIFIER-OSCILLOGRAPH APPLIED TO THE STUDY OF DIELECTRICS WITH CONTINUOUS POTENTIALS.—S. K. Waldorf. (*Physics*, July, 1932, Vol. 3, No. 1, pp. 1–10.)

Observations could be begun within one or two thousandths of a second after the specimen had had the d.c. voltage applied. The sensitivity was 1.6×10^{-8} A per mm deflection—about 300 000 times that of the oscillograph alone. *See* also September Abstracts, pp. 536–537, for paper on the amplifier.

DIE ABHÄNGIGKEIT DER HELLIGKEIT DES ELEKTRONENSTOSSLEUCHTENS DES CALCIUMWOLFRAMATES VON DER ENERGIE DER STOSSENDEN ELEKTRONEN (The Dependence of the Brightness of the Light Emitted by Calcium Tungstate under the Impact of Electrons on the Energy of the Electrons).—A. Güntherschulze and F. Keller. (*Zeitschr. f. Physik*, 1932, Vol. 77, No. 7/8, pp. 528–533.)

VERZÖGERUNGSCHALTUNGEN BEI AUFNAHMEN MIT DEM KATHODENSTRAHL-OSZILLOGRAPHEN (Delay Circuits for Recording with the Cathode-Ray Oscillograph [Comparison between Surge Line Circuits and Condenser Circuits, with Description of a Condenser Circuit with Adjustable Delay Time]).—H. Baatz, M. Freundlich and W. Holzer. (*E.T.Z.*, 21st July, 1932, Vol. 53, pp. 696–698.)

EIN KIPPRELAIS SEHR KURZER SCHALTZEIT (A Trip Relay with Very Short Response Time, for C.-R. Oscillographs).—M. Knoll and M. Freundlich. (*E.T.Z.*, 14th July, 1932, Vol. 53, pp. 669–673.)

A three-triode circuit with a delay of only $1\text{–}3 \times 10^{-7}$ sec, low impulse voltage (1–300 v), responding to very short impulses (of the order of 10^{-7} sec), and mains driven.

THEORY OF VOLTAGE DIVIDERS AND THEIR USE WITH CATHODE-RAY OSCILLOGRAPHS.—M. F. Peters, G. F. Blackburn and P. T. Hannen. (*Bur. of Stds. Journ. of Res.*, July, 1932, Vol. 9, No. 1, pp. 81–114.)

BERECHNUNG DER DURCH GLIMMTEILER STABILISIERTEN STROMQUELLEN BEI VORGEGEBENER STROMENTNAHME (The Calculation of a Mains Unit stabilised by the Glow-Discharge Potential Divider, for a Given Current Output).—L. Körös and R. Seidelbach. (*Hochf:tech. u. Elek:akus.*, July, 1932, Vol. 40, No. 1, pp. 9–14.)

Körös' device has already been dealt with in 1930 Abstracts, p. 408. The present paper gives the numerical treatment of a multiple stabiliser tube with *n* electrodes, practical formulae being obtained which in Section III are applied to the design calculations of a mains unit for a telegraphy receiver with three stages of r.f. amplification and an output valve, biased to give rectification, with a relay in its anode circuit.

The r.f. stages take a total of 10 mA, the output stage anything between 0 and 50 mA. The unit is required to work off 220 V a.c. mains whose probable voltage fluctuations are taken as ± 10%. Fig. 6 shows the circuit: an iron ballast resistance R_h is included to act as a coarse stabiliser of the mains voltage. The calculations show that with the given combination, neither 10% mains fluctuations nor output-valve current-changes from 0 to 50 mA, nor even the complete disconnection of the whole receiver, can produce any appreciable variation in the potential-divider voltages. The final sub-section 6 shows the enormous superiority of the device over ohmic potential-dividers, both as regards stabilising effectiveness and power consumption.

[TRANSMITTER] D.C. PLATE SUPPLY FROM FORD SPARK COILS.—V. Davis. (*QST*, June, 1932, Vol. 16, p. 17.)

B POWER SUPPLY DEVICES FOR AUTOMOBILE RADIO.—H. E. Thomas and L. P. Kongsted. (*Rad. Engineering*, June, 1932, Vol. 12, pp. 14–15.)

PRODUCTION TESTING OF SMALL POWER TRANSFORMERS.—R. M. Hukle. (*Rad. Engineering*, July, 1932, Vol. 12, pp. 21–22.)

PRIMARY BATTERY IMPROVEMENTS: AMMONIUM PERSULPHATE AS A DEPOLARISER.—A. M. Codd. (*Elec. Review*, 1st July, 1932, Vol. 111, pp. 14–15.)

A NEW BATTERY [DRY CELL WITH DEVICE FOR SEALING IN THE ACTIVE INGREDIENTS BUT GIVING FREE EXIT TO EVOLVED GASES].—Siemens Company. (*Elec. Review*, 3rd June, 1932, Vol. 110, p. 817.)

ARTICLES ON THE DRUMM ACCUMULATOR.—(*Elec. World*, 12th March and 16th April, 1932, pp. 478 and 694.)

THE RAPID CHARGING OF ACCUMULATOR BATTERIES.—A. E. Lange. (*E.T.Z.*, 28th July, 1932, Vol. 53, pp. 716–718.)

ELECTROLYTIC VALVE ACTION AND ELECTROLYTIC RECTIFIERS.—E. Newbery. (*Proc. Roy. Soc.*, July, 1932, Vol. 137, No. A 831, pp. 134–145.)

Author's summary:—The behaviour of various valve electrodes and rectifying electrodes has been investigated with the aid of the cathode-ray oscillograph.

Valve action is due to the formation of an adherent insulating anodic film which is permeable to H ions but not to the anions present. Rectifying action occurs when such a film is not reducible by the electrolytic hydrogen produced on it, and is also unchanged by further anodic action. The film responsible for the rectifying action of an aluminium electrode is the oxide only. Hydration of this oxide destroys its rectifying efficiency.

ON THE NATURE OF ELECTRON MOTION IN CRYSTALS AND ITS SIGNIFICANCE IN THE ELECTRICAL BEHAVIOUR OF SOLIDS [INCLUDING RECTIFYING ACTION].—L. Nordheim. (*Metallwirtsch.*, Nos. 9 and 10, Vol. 11, 1932, pp. 121–124 and 135–138.)

PHOTOELECTRICITY AND RECTIFICATION, PAPERS ON.—Brazzoduro: Deaglio. (*See* under "Phototelegraphy and Television.")

BEHAVIOUR OF THE COPPER-CUPROUS OXIDE RECTIFIER AT HIGH FREQUENCIES.—W. P. Place. (*Phys. Review*, 15th June, 1932, Series 2, Vol. 40, No. 6, p. 1054.)

PAPERS ON THE ELECTRICAL AND OPTICAL BEHAVIOUR OF SEMI-CONDUCTORS.—A. Völkl: P. Guillery. (*Ann. der Physik*, 1932, Series 5, Vol. 14, No. 2, pp. 193–215: 216–220.)

A NOTE ON THE THEORY OF RECTIFICATION.—A. H. Wilson. (*Proc. Roy. Soc.*, 1st June, 1932, Vol. 136, No. A 830, pp. 487–498.)

This paper develops a theory of rectification of which "the essential point is that it is the potential difference which causes the asymmetry in the current. The difference in potential between the two components changes the number of electrons which can pass from one component to the other, while the high field [in the gap between the components] only affects the transmission coefficient, and makes the passage of the electrons easier or more difficult."

VARIOUS DRY-PLATE RECTIFIER PATENTS.—(*Elektrot. u. Masch:bau*, 17th April, 1932, Vol. 50, p. 253.)

A NEW ARC-IN-AIR RECTIFIER FOR VERY HIGH VOLTAGES AND POWERS.—E. Marx. (*E.T.Z.*, 4th August, 1932, Vol. 53, No. 31, pp. 737–738.)

THE FUNDAMENTAL TECHNICAL PRINCIPLES AND THE APPLICATIONS OF RECTIFIERS AND INVERTERS WITH GRIDS.—M. Schenkel. (*E.T.Z.*, 11th August, 1932, Vol. 53, No. 32, pp. 761–786.)

CURRENT DIRECTORS: THE USE OF CONTROLLED GAS DISCHARGES: RECTIFIERS, INVERTERS, ETC.—H. Laub. (*Elektrot. u. Masch:bau*, 29th May and 5th June, 1932, Vol. 50, pp. 317–325 and 332–338.)

GLÜHKATHODENGLEICHRICHTER MIT GASFÜLLUNG (Gas-filled Hot-Cathode Rectifiers—Part I).—A. Gehrts. (*Zeitschr. f. tech. Phys.*, No. 7, Vol. 13, 1932, pp. 303–308.)

A theoretical survey with some practical details. (i) Rectifiers with a gas filling of 0.01 to 0.001 mm Hg (high-voltage rectifiers), and (ii) with a gas filling of 0.5 to 50 mm Hg (low-voltage rectifiers). A bibliography of 58 items is included in this first part. For the second and final part, and another long bibliography, see *ibid.*, No. 8, pp. 350–356.

INVESTIGATIONS ON THE INFLUENCE OF THE ELECTRON EMISSION AT THE ANODE ON THE OCCURRENCE OF BACK DISCHARGES IN THE MERCURY VAPOUR RECTIFIER.—E. Kobel. (*Bull. Assoc. suisse des Élec.*, 8th July, 1932, Vol. 23, No. 14, pp. 344–348.)

ENGINEERING FEATURES OF GAS FILLED TUBES.—Steiner, Gable and Maser. (*Elec. Engineering*, May, 1932, Vol. 51, pp. 312–318.)

CHARACTERISTICS OF A [GRID CONTROLLED] MERCURY VAPOUR TUBE.—A. C. Seletzky and S. T. Shevki. (*Elec. Engineering*, July, 1932, Vol. 51, pp. 500–505.)

The direction of the grid current is found to depend not only on the instantaneous polarity of the grid but also on the magnitude of both the grid voltage and the plate current. Inverse plate current flows whenever grid current is flowing during the negative half-cycle of plate voltage.

IMPROVEMENTS IN ELECTRIC DISCHARGE TUBES [REDUCTION OF SECONDARY EMISSION FROM GRID BY INCREASING HEAT RADIATION].—Philips' Company. (Patent summary in *Rev. Gén. de l'Élec.*, 30th July, 1932, Vol. 32, p. 40 D.)

RECTIFIER FILTER CIRCUITS.—R. Lee. (*Electric Journ.*, April, 1932, Vol. 29, pp. 186–192.)

Using Fourier analysis and giving a considerable amount of data.

ELIMINATION OF HARMONICS SUPERPOSED ON A CONTINUOUS CURRENT.—(Patent summary in *Rev. Gén. de l'Élec.*, 30th July, 1932, Vol. 32, p. 38 D.)

BEMERKUNGEN ZUM ENTWURF VON EISENDROSSELSPULEN (Remarks on the Design of Iron-Cored Choking Coils).—J. Hak. (*E.T.Z.*, 7th July, 1932, Vol. 53, pp. 649–652.)

NOTES ON THE EVAPORATION OF AG, BE, CR, AND SI [DEPOSITION OF THIN METALLIC FILMS].—C. H. Cartwright. (*Review Scient. Instr.*, June, 1932, Vol. 3, pp. 298–304.)

DER EVOLVENTEN-TRANSFORMATOR (The Transformer with Evolute Core).—R. Edler: Vidmar: Zopp. (*Bull. Assoc. suisse des Élec.*, 8th July, 1932, Vol. 23, No. 14, pp. 348–352.)

MAGNET STEELS AND PERMANENT MAGNETS.—K. L. Scott. (*Elec. Engineering*, May, 1932, Vol. 51, pp. 320–323.)

ILLIUM [A NEW ALLOY].—(*Zeitschr. V.D.I.*, 14th May, 1932, Vol. 76, No. 20, p. 479.)

A new American alloy of nickel, chromium, copper, molybdenum and tungsten, with admixture of iron, manganese, silicon and carbon. It is particularly resistive to heat and corrosion, and shows no porosity even in thin sheets.

CONSTRUCTION OF THERMO-ELEMENTS BY ELECTRODEPOSITION.—H. Kersten and R. Schaffert. (*Review Scient. Instr.*, April, 1932, Vol. 3, pp. 189–195.)

A PRECISION THERMO-JUNCTION NEEDLE.—R. W. Brown. (*Journ. Scient. Instr.*, June, 1932, Vol. 9, pp. 198–200.)

TUNED SELECTIVE RELAY ON FERRARI ROTATING DISC PRINCIPLE.—(French Pat. 721275, Landis and Gyr, pub. 1st March, 1932: summary in *Rev. Gén. de l'Élec.*, 28th May, 1932, Vol. 31, p. 178 D.)

THE "STROBOGLOW," A PORTABLE STROBOSCOPE.—W. E. Bahls and D. D. Knowles. (Summary in *E.T.Z.*, 12th May, 1932, Vol. 53, pp. 461–462.)

AN AIR-BUBBLE METHOD OF MEASURING VERY SMALL ANGLES OF ROTATION—DOWN TO 0.27 SEC.—G. Siadbei. (*Comptes Rendus*, 18th April, 1932, Vol. 194, pp. 1334–1336.)

SENSITIVE ELECTROSCOPES [THREE TYPES].—C. Lukens. (*Review Scient. Instr.*, May, 1932, Vol. 3, pp. 239–247.)

CONSTRUCTION OF THERMO-RELAY AMPLIFIERS [FOR INCREASING THE SCALE DISTANCE OF A MIRROR INSTRUMENT WITHOUT LOSS OF RESOLVING POWER].—C. H. Cartwright. (*Review Scient. Instr.*, May, 1932, Vol. 3, pp. 221–224.)

DER ZEITDEHNER MIT MECHANISCHER REGELUNG DER BELICHTUNG ALS HILFSMITTEL FÜR DIE TECHNISCH-PHYSIKALISCHE FORSCHUNG (The [Thun] Time-Extender with Mechanical Light Regulation as an Auxiliary in Technical-Physical Research [High-Speed Cinematography]).—W. von Ohnesorge: Thun. (*Zeitschr. f. tech. Phys.*, No. 7, Vol. 13, 1932, pp. 299–302.)

First part of a full paper on the device referred to in 1931 Abstracts, p. 51 (Ende).

AN ELECTROSTATIC ALTERNATOR [GIVING PURE SINE WAVE AND VARIOUS SPECIAL WAVE FORMS].—C. A. Culver. (*Physics*, June, 1932, Vol. 2, pp. 448–456.)

A rotating device with fixed and rotating electrodes whose shape can be chosen so as to give the required wave form. In the model illustrated the frequency is 120 c/s.

A MEASUREMENT OF BOLTZMANN'S CONSTANT BY MEANS OF THE FLUCTUATIONS OF ELECTRON PRESSURE IN A CONDUCTOR [CONTAINING DESCRIPTION OF ATTENUATOR SYSTEM].—Ellis and Moullin. (*See* under "Valves and Thermionics.")

A THREE-DIMENSIONAL ADJUSTMENT OF AN ELECTRODE *in Vacuo*.—J. L. Miller and J. E. L. Robinson. (*Journ. Scient. Instr.*, August, 1932, Vol. 9, pp. 264–265.)

A DEVICE FOR SEPARATING THE HARMONICS OF COMPLEX WAVES.—Gall. (*See* under "Acoustics and Audio-frequencies.")

A SIMPLE METHOD OF HARMONIC ANALYSIS.—Nachtikal. (*See* under "Acoustics and Audio-frequencies.")

A MACHINE FOR THE GRAPHICAL STUDY OF THE COMPOSITION OF SIMPLE HARMONIC MOTIONS.—T. Soller. (*Review Scient. Instr.*, July, 1932, Vol. 3, pp. 352–355.)

EIN GERÄT ZUR AUTOMATISCHEN REGISTRIERUNG VON SEHR KLEINEN TEMPERATURÄNDERUNGEN BEI GROSSEM MESSBEREICH (An Apparatus for the Automatic Recording of Very Small Temperature Changes over a Wide Range [suitable for H.F. Calorimetry: Temperature Changes down to 1/10 000°C]). —H. Rieche. (*Zeitschr. f. tech. Phys.*, No. 8, Vol. 13, 1932, pp. 374–377.)

ELASTIC STOP NUT [WITH UNTHREADED FIBRE COLLAR] APPLICATIONS IN THE RADIO INDUSTRY.—H. B. Thomas. (*Rad. Engineering*, July, 1932, Vol. 12, pp. 19–20.)

THE USE OF THE POSITIVE ION SHEATH ON AN ELECTRODE TO GIVE A VARIABLE CONDENSER EFFECT: EMPLOYMENT OF SUCH A CONDENSER IN SIGNALLING BY FREQUENCY CHANGE. — Thomson-Houston Company. (Patent summary in *Rev. Gén. de l'Élec.*, 30th July, 1932, Vol. 32, p. 40 D.)

ELECTROLYTIC CONDENSERS FOR THE TRANSMITTER. —W. M. Bailey. (*Rad. Engineering*, July, 1932, Vol. 12, p. 15.)

ON THE THEORY OF THE PAPER CONDENSER.— M. I. Mantrov. (*Westnik Elektrot.*, No. 11/12, 1931, Sec. III, pp. 119–121.)

EFFECT OF IONISATION ON IMPREGNATED PAPER INSULATION.—K. S. Wyatt. (*Elec. World*, 30th July, 1932, pp. 152–154.)

A NEW INSULATING MATERIAL, PARTICULARLY FOR CATHODE CONSTRUCTION IN A.C. VALVES. —Crowley. (*See* abstract under "Valves and Thermionics.")

A METHOD FOR THE PURIFICATION OF RUBBER AND PROPERTIES OF THE PURIFIED RUBBER. —A. T. McPherson. (*Bur. of Stds. Journ. of Res.*, June, 1932, Vol. 8, pp. 751–758.)

MULTI-PLY PRESSPAPERS: PROCESSES OF MANUFACTURE.—A. R. Dunton. (*Electrician*, 8th July, 1932, Vol. 109, pp. 54–56.)

INSULATIONS—VARNISHES, ETC.: PART VII.— A GENERAL DISCUSSION OF THE TECHNICAL OUTLOOK.—H. Warren. (*Electrician*, 22nd July, 1932, Vol. 109, pp. 107–109.)

STATIONS, DESIGN AND OPERATION.

THE WAVELENGTH PROBLEM.—Noel Ashbridge. (*Wireless World*, 19th and 26th August, 1932, Vol. 31, pp. 146–148 and 183–184.)

The writer discusses the problem of frequency separation and interference. Curves showing the sideband energy transmitted across the a.f. spectrum provide an explanation of certain phenomena of sideband heterodyning. He points out that with a 9 kc/s separation reproduction without interference above about 4'000 c/s cannot be counted on at the limit of the service area, and stresses the fact that there are two alternatives for the future, namely to retain the present 9 kc separation and to ensure good quality reproduction for those living in areas of high field strength, or to have a wider separation and reduce the number of stations in Europe.

PRESENT POSITION OF ORGANISATION OF THE INTERNATIONAL CONTROL OF FREQUENCIES: THE U.S.A. CONTROL ORGANISATION.— (*Journ. télégraphique*, Feb., 1932, Vol. 56, pp. 41–46.)

FREQUENCY DEVIATION TOLERANCE AT BROADCAST STATIONS [THE NEW 50 CYCLE TOLERANCE]. —(*Rad. Engineering*, June, 1932, Vol. 12, p. 34.)

FREQUENCY CONTROL MONITOR FOR BROADCAST STATIONS.—Western Electric Company. (*Rad. Engineering*, May, 1932, Vol. 12, p. 30.)

BROADCAST CHANNELS FOR CANADA.—(*Rad. Engineering*, June, 1932, Vol. 12, pp. 30 and 36.)

THE MENACE TO BROADCASTING: "CLEAR CHANNELS" [FOR RURAL LISTENERS: WORKED BY ONLY ONE HIGH-POWER STATION] BEING DESTROYED UNDER PRESSURE OF POLITICAL EXPEDIENCY.—(*Electronics*, July, 1932, pp. 216–217.)

GOVERNMENT-OWNED RADIO BROADCASTING IS OUT [FEDERAL RADIO COMMISSION'S REPORT TO U.S.A. SENATE].—(*Rad. Engineering*, June, 1932, Vol. 12, pp. 31–32.)

REMOTE CONTROL OF BROADCAST PROGRAMMES.— G. W. Haug. (*Rad. Engineering*, June, 1932, Vol. 12, pp. 23–24.)

THE PARALLEL WORKING OF RADIO BROADCAST STATIONS.—S. I. Panfilov. (*Westnik Elektrot.*, No. 11/12, 1931, Sec. I, pp. 446–452.)

POLISH NATIONAL BROADCASTING.—(*Marconi Review*, May–June, 1932, No. 36, pp. 27–29.)

WESTINGHOUSE RADIO STATION AT SAXONBURG, PA. [FOR BROADCASTING AND EXPERIMENTAL WORK].—R. L. Davis and V. E. Trouant. (*Proc. Inst. Rad. Eng.*, June, 1932, Vol. 20, pp. 921–932.)

THE NEW BROADCASTING CENTRE, THE "POSTE PARISIEN," OF THE COMPAGNIE GÉNÉRALE D'ÉNERGIE RADIOÉLECTRIQUE.—Le Duc and Sallard. (*Rev. Gén. de l'Élec.*, 23rd July, 1932, Vol. 32, pp. 115–121.)

A VISIT TO THE NEW INSTALLATIONS OF THE EIFFEL TOWER RADIO STATION.—J. P. Delatour. (Summary in *Rev. Gén. de l'Élec.*, 23rd July, 1932, Vol. 32, pp. 30–31 D.)

SHORT WAVE BEAM BROADCASTING FROM SPAIN TO AMERICA.—(*Rad. Engineering*, July, 1932, Vol. 12, p. 32.)

NEW METHODS FOR THE MEASUREMENT OF MODULATION RATIO [USING CRITICAL VOLTAGE OF A NEON TUBE].—A. L. Minz. (*Westnik Elektrot.*, No. 11/12, 1931, Sec. I, pp. 387–389.)

TWO-WAY RADIOTELEPHONE CIRCUITS [CONNECTION TO LAND LINES: THE USE OF "VODASES"].—S. B. Wright and D. Mitchell. (*Proc. Inst. Rad. Eng.*, July, 1932, Vol. 20, pp. 1117–1130: *Bell S. Tech. Journ.*, July, 1932, Vol. 11, No. 3, pp. 368–382.)

Authors' summary:—This paper deals with the problems of joining long-distance radiotelephone transmission paths to the ordinary telephone plant. It gives the possibilities and limitations of various methods of two-way operation of such circuits where the radio channels employ either long or short waves. It also describes the special terminal apparatus for switching the transmission paths under control of voice currents, and lists the advantages of using voice-operated devices [anti-singing—whence the name "vodas"].

RADIOTELEPHONE EXPERIMENTS OVER SHORT DISTANCES [LINKING ISOLATED SETTLEMENTS, ETC., IN B.C. AND ALASKA: WAVELENGTHS 50 TO 200 METRES].—C. H. McLean. (Summary in *Elec. Engineering*, Aug., 1932, Vol. 51, p. 586.)

COASTAL WIRELESS: RADIO TELEPHONE APPARATUS TO BE INSTALLED AT EIGHT MORE STATIONS.—Marconi Company. (*Electrician*, 20th May, 1932, Vol. 108, p. 698.)

Particularly useful for ships not hitherto equipped with wireless, messages to and from shore being telephonic, the rest of the way telegraphic.

THE MARCONI SYSTEM FOR DISTANT CONTROL BY WIRELESS OF FOG SIGNALS [WORKING BETWEEN LIGHT VESSELS IN THAMES ESTUARY].—(*Marconi Review*, July–Aug., 1932, No. 37, pp. 25–28.)

The most recent version of the oscillating balance wheels principle. Reliable operation over 15 miles has been obtained: the lightship installations named are 8 miles apart.

RADIATION OF MULTIPLE MODULATED CARRIER WAVES DUE TO COMMON PLATE BATTERY FOR TRANSMITTER AND RECEIVER, IN ULTRA-SHORT-WAVE WORKING (FIVE METRE WAVES).—L. Spangenberg. (*QST*, May, 1932, Vol. 16, pp. 23–24.)

In an article entitled "The Bloomfield Radio Club's 'Five-Metre' Field Day." Another point mentioned was that the locating of a station in the middle of a group of iron ore deposits had no bad effect on communication.

A PORTABLE 56-MC [ULTRA-SHORT-WAVE] TRANSMITTER-RECEIVER.—F. A. Gunther. (*QST*, May, 1932, Vol. 16, pp. 30–32.)

GENERAL PHYSICAL ARTICLES.

TREATMENT BY WAVE MECHANICS OF THE PROBLEM OF THE FREE ELECTRON UNDER THE SIMULTANEOUS INFLUENCE OF A HOMOGENEOUS MAGNETIC FIELD AND A PLANE ELECTROMAGNETIC WAVE (COMPTON EFFECT IN A MAGNETIC FIELD).—F. Lüdi. (*Helvet. Phys. Acta*, No. 6, Vol. 4, pp. 375–397.)

ÜBER DIE KANALBREITE VON ELEKTRONENLAWINEN (On the Canal Breadth of Electron Avalanches).—F. Ollendorff. (*Archiv f. Elektrot.*, 22nd March, 1932, Vol. 26, No. 3, pp. 193–199.)

This paper contains an estimation of the canal breadth of an electron avalanche from statistical considerations concerning the mingling of the electrons and the gas molecules.

AN EXPERIMENT IN SUPPORT OF THE HYPOTHESIS OF A TIME LAG IN THE FARADAY EFFECT.—F. Allison and J. L. Condon. (*Phys. Review*, 15th June, 1932, Series 2, Vol. 40, No. 6, pp. 1021–1022.)

THE STRUCTURE OF ELECTRON WAVES.—L. Infeld. (Summary in *Sci. Abstracts*, *Sec. A*, July, 1932, Vol. 35, No. 415, p. 582.)

A study of the structure of the de Broglie electron waves in a metrical field, based on a recasting of Dirac's system of wave equations for the free electron into a form analogous to Maxwell's electromagnetic equations and then into general covariant form. The electron waves, corresponding to a stream of electrons moving with uniform velocity, exhibit a group structure in the direction of motion, amplitude and electron density varying periodically; the "wavelength" of this amplitude fluctuation depends on the average electron density.

INTERCONVERSION FACTORS FOR NUMBERS IN ENERGETIC AND RELATED UNITS.—C. H. D. Clark. (*Phil. Mag.*, August, 1932, Series 7, Vol. 14, No. 90, pp. 291–297.)

This paper presents a convenient table for the conversion of numbers between the various systems of energetic units and of units which, though not possessing the dimensions of energy, are "capable of derivation from the older units by means of terms involving fundamental physical constants."

TWO PROBLEMS IN POTENTIAL THEORY.—T. C. Fry. (*Bell Tel. Syst. Monograph B*-671: *American Mathematical Monthly*, April, 1932, Vol. 39, pp. 199–209.)

"A [mathematical] study of the potential fields set up by two surfaces resembling those used in electron guns."

THE INTERMEDIATE FREE PATH CASE IN THE THEORY OF A PLASMA.—L. Tonks. (*Phys. Review*, 15th June, 1932, Series 2, Vol. 40, No. 6, p. 1046.)

Abstract only of a paper on the theory of ion motions and potential distribution in the uniform positive column for the case where the ion velocity is proportional to the square root of the field strength. In a mercury arc this case gives results agreeing fairly satisfactorily with experimental results.

ELEKTRONEN, PROTONEN UND DER SOGENANNTE ELEKTRONENMAGNETISMUS (Electrons, Protons and the So-Called Electron Magnetism).—A. Güntherschulze. (*Zeitschr. f. Physik*, 1932, Vol. 74, No. 9/10, pp. 692–706.)

This paper contains an attempt to deduce quasi-stationary electromagnetic phenomena from three types of electrical force acting between electrons and protons.

THE FORCE ACTING BETWEEN MOVING CHARGES.—A. D. Fokker and C. J. Gorter. (*Zeitschr. f. Physik*, 1932, Vol. 77, No. 3/4, pp. 166–169.)

Authors' summary :—" This paper gives a short discussion of formulae derived from the classical theory for the force acting between moving charges, and it is shown that they disagree with those given by Güntherschulze " [in the paper referred to above].

RELATIVISTIC THEORY OF THE INTERACTION OF TWO CHARGED PARTICLES.—A. D. Fokker. (*Physica*, No. 5, Vol. 12, 1932, pp. 145–152 : in French.)

ON THE NATURE OF ELECTRON MOTION IN CRYSTALS AND ITS SIGNIFICANCE IN THE ELECTRICAL BEHAVIOUR OF SOLIDS [INCLUDING RECTIFYING ACTION].—L. Nordheim. (*Metallwirtsch.*, Nos. 9 and 10, Vol. 11, 1932, pp. 121–124 and 135–138.)

MISCELLANEOUS.

SIMPLIFIED METHOD FOR CALCULATING PERIODICITIES.—S. R. Savur. (*Indian Journ. Phys.*, 29th Feb., 1932, Vol. 6, pp. 527–541 : short summary in *Sci. Abstracts, Sec. A*, July, 1932, Vol. 35, No. 415, p. 565.)

AN ALTERNATIVE TO THE REJECTION OF OBSERVATIONS.—H. Jeffreys. (*Proc. Roy. Soc.*, July, 1932, Vol. 137, No. A 831, pp. 78–87.)

PROPERTIES OF HARMONIC FUNCTIONS OF TWO VARIABLES IN AN OPEN AREA LIMITED BY PARTICULAR LINES.—C. de la Vallée Poussin. (*Comptes Rendus*, 11th July, 1932, Vol. 195, pp. 92–94.)

ROYAL SOCIETY CONVERSAZIONE : CATHODE-RAY OSCILLOGRAPH IN RADIO RESEARCH : IN MEASURING TELEGRAPH TIME DISTORTION : THERMIONIC ELECTROMETERS : PHOTO-CONDUCTIVITY OF DIAMONDS : ETC.—(*Electrician*, 20th May, 1932, Vol. 108, pp. 694–695.)

FORECAST OF THE 1932 BERLIN RADIO EXHIBITION.—(*Rad., B., F. f. Alle*, Aug., 1932, pp. 350–357.)

AMATEUR RADIO IN GREAT BRITAIN.—J. Clarricoats. (*QST*, May, 1932, Vol. 16, pp. 44 and 76–82.)

An article by the honorary secretary of the Radio Society of Great Britain.

EXPERIMENTAL STUDY OF CATHODE RAYS OUTSIDE OF THE GENERATING TUBE.—W. D. Coolidge and C. N. Moore. (*Gen. Elec. Review*, Aug., 1932, Vol. 35, pp. 413–417.)

AN ELECTRIC MOTOR WORKING ON THE KINETIC ENERGY OF GASEOUS IONS.—H. Chaumat and E. Lefrand. (*Comptes Rendus*, 25th July, 1932, Vol. 195, p. 305.)

INCREASED RESOLUTION IN MICROSCOPY BY TELEVISION TECHNIQUE : THE USE OF QUARTZ CRYSTALS FOR SCANNING.—E. H. Synge. (*Phil. Mag.*, Feb., 1932, Vol. 13, pp. 297–300.)

An addition to the writer's suggestion dealt with in 1931 Abstracts, p. 286.

DETERMINATION OF THE TENSILE STRENGTH OF THIN WIRES BY PIEZOELECTRIC METHODS.—F. Seidl. (Summary in *Zeitschr. V.D.I.*, 25th June, 1932, Vol. 76, No. 26, p. 641.)

ULTRA-MICROMETRIC AND OTHER ELECTRICAL METHODS OF MEASURING PRESSURES AND DISPLACEMENTS.—G. Sacerdote. (*L'Elettrot.*, 5th July, 1932, Vol. 19, pp. 485–495.)

A comprehensive illustrated survey with a bibliography of 33 items.

VIBRATIONS AND STRAINS ACCURATELY DETERMINED [ELECTRO-MAGNETIC ULTRA-MICROMETER PRINCIPLE].—General Electric Company. (*Elec. World*, 23rd April, 1932, p. 723.)

[HIGH-FREQUENCY] OSCILLATOR STABILISES A.C. WELDING ARC.—J. B. Gibbs. (*Elec. World*, 27th Feb., 1932, p. 405.)

PHOTRONIC CELL A DIRECT AID TO BETTER LIGHTING.—A. H. Lamb. (*Elec. World*, 16th April, 1932, pp. 692–694.)

PHOTOELECTRIC CELLS : SOME OF THEIR APPLICATIONS TO INDUSTRY [COUNTING GIFT COUPONS : ALARM FOR BREAKAGE OF DELIVERY IN PAPER MILLS, ETC.]—(*Elec. Review*, 15th July, 1932, Vol. 111, pp. 81–82.)

HEAT TEMPERING OF [MOTOR CAR] VALVES CONTROLLED BY PHOTOCELLS.—F. L. Prentiss. (*Electronics*, July, 1932, p. 232.)

MAGNETO-OPTICAL METHOD OF CHEMICAL ANALYSIS [DEPENDING ON LAG OF FARADAY EFFECT].—J. W. Buchta : Allison. (*Physics*, July, 1932, Vol. 3, No. 1, pp. 54–56.) *See* also Allison and Condon, under " General Physical Articles."

EXPERIMENTS ON HAZEL TWIG WATER DIVINING : THE CAUSE OF THE ACTION.—Lehmann. (*See* abstract under " Atmospherics and Atmospheric Electricity.")

EMERGENCY EMPLOYMENT COMMITTEE REPORT [WITH NUMBERS OF APPLICANTS WITH VARIOUS QUALIFICATIONS].—(*Proc. Inst. Rad. Eng.*, June, 1932, Vol. 20, pp. 905–911.)

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.

DIRECTIVE SYSTEMS.

Application date, 23*rd December*, 1930. *No.* 369660.

A number of hertzian oscillators are arranged in star-formation and are energized from a ring-shaped coil with successive phase-displacement so as to radiate a circularly-polarised wave. A reflector may be utilized to neutralise backward radiation. Maximum reception is secured by a similar aerial system arranged in a parallel plane to the transmitter.

Patent issued to S. Salto.

ELIMINATING MAINS HUM.

Convention date (*Germany*), 7*th January*, 1930. *No.* 370925.

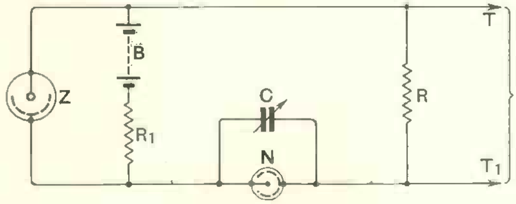
Ripple from rectified plate voltage is eliminated automatically in a valve of the external-grid type containing helium, argon, or like gas at a pressure of from 10^{-4} to 10^{-2} mm. of mercury. In this known type of valve the electron stream flows at right-angles to the longitudinal axis of the bulb which is elliptical in cross-section. Owing to the inertia of the ions of the contained gas the valve discriminates between high frequencies and low to the extent of cutting-out the 50-cycle supply frequency, even when the filament is energised directly with raw A.C. current. As regards modulation frequencies, it is stated that the amplification through the valve decreases with increasing frequency, giving a relatively full and deep timbre when the valve is used as a rectifier.

Patent issued to Telefunken Ges. für Drahtlose Telegraphie m.b.h.

MODULATING BY LIGHT.

Convention date (*U.S.A.*), 7*th February*, 1930. *No.* 370912.

A neon tube N is connected in series with resistances R, R_1 across a D.C. source B, and is shunted by a condenser C so that it generates continuous



No. 370912.

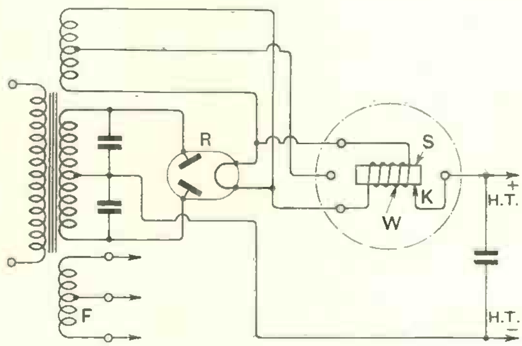
oscillations the frequency of which are determined in part by the effective value of the applied voltage. A photo-sensitive cell Z is shunted in series with the resistance R_1 across the battery B. The effect of illuminating the cell Z is to reduce its resistance which, in turn, increases the potential drop across the resistance R_1 and so reduces the effective voltage applied across the neon tube. In this way the oscillation frequency is varied in accordance with the intensity of the light directed on to the cell Z.

Patent issued to Associated Telephone and Telegraph Co.

"ON AND OFF" SWITCHES.

Application date, 12*th January*, 1931. *No.* 371018.

To ensure that the H.T. supply to a broadcast receiver is switched on and off in correct sequence with the filament current, a winding W in parallel with the filament supply to the rectifying valve R is used to heat a bimetallic strip S, causing the latter to bend over and make contact at K with the + H.T. terminal. This can only occur after the valve filaments have been energised for a definite interval of time from the secondary winding



No. 371018.

F. Once made, the contact K remains closed so long as the valve filaments are lit, but automatically breaks the H.T. circuit a short time after the filament supply has been switched off.

Patent issued to A. F. Bulgin.

TUNING CONTROLS.

Application date, 29*th December*, 1930. *No.* 370409.

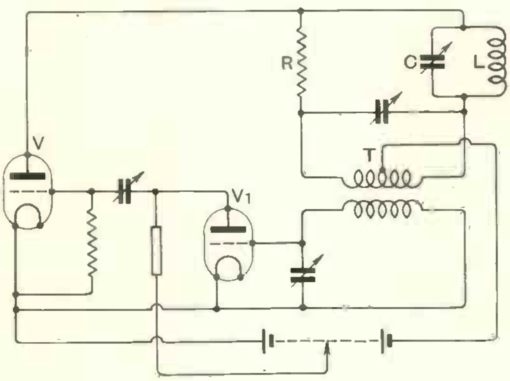
In a transformer-coupled receiver, particularly designed for direction-finding, the various coils in the input and intervalve circuits are rotatably mounted and connected through bevel-gearing to a central shaft. Each coil unit comprises separate primary and secondary windings corresponding to two different wavebands. The ends of the coils are brought out to fixed switches on each unit, and the change-over from one waveband to another is effected simultaneously by rotating a control knob on the central shaft.

Patent issued to Marconi International Marine Communication Co., Ltd., and F. Woods.

STABILISING OSCILLATION-GENERATORS.

Convention date (Germany), 3rd April, 1930.
No. 371575.

The frequency-stabilising effect of the ordinary "flywheel" circuit in a back-coupled generator is increased by deriving from it a back-coupling voltage which shows a sharply marked phase-change when any variation occurs in the generated frequency. As shown in the figure, a tuned transformer *T* is energised in part from the flywheel circuit *L*, *C* and in part through a shunt resistance *R*. The resultant voltage is transferred to the grid of the main oscillator *V* through an auxiliary valve V_1 which is adjusted to the upper part of the characteristic curve so as to limit the amplitude of the feed-back energy.



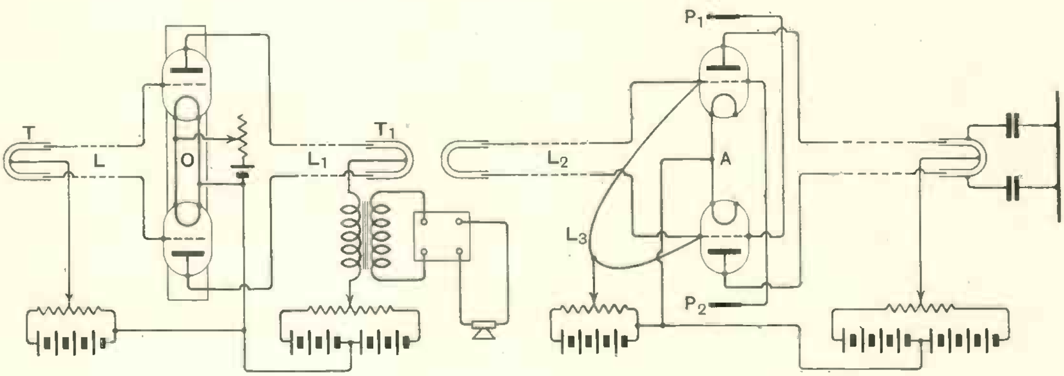
No. 371575.

Patent issued to Telefunken Ges. für Drahtlose Telegraphie m.b.h.

SHORT-WAVE AMPLIFIERS.

Convention date (U.S.A.), 17th September, 1930.
No. 372660.

Relates to amplifiers of the type in which the grid carries a relatively high positive potential, whilst the anode operates either at a negative or a small positive bias, so as to increase the speed of the electron stream beyond the point at which it may prejudice the handling of ultra-short wavelengths. According to the invention the valve circuits are tuned by Lecher wires *L*, L_1, terminating in "trombone" sliders, *T*, T_1. A quarter-wave loop line L_3 may also be used to feed the operating potentials to the grids. As shown, a push-pull oscillator *O* is coupled through the leads L_1, L_2 to an amplifying stage *A*, the valves of which are fitted with capacity plates P_1, P_2 inserted reciprocally from grid to anode to prevent self-oscillation.



No. 372660.

Patent issued to Marconi's Wireless Telegraph Co., Ltd.

GANGED TUNING-CONTROL.

Application date 22nd May, 1931. No. 366836.

Two or more variable condensers of the compression type are operated in succession by cams mounted on a common control spindle. One condenser may be inserted in series with the aerial input whilst the other serves to control reaction. An elastic volume control is then obtained by increasing first one condenser to a maximum and thereafter increasing the second from minimum to maximum. Or the condensers may be arranged to control alternatively either the strength of received wireless signals or the volume from a gramophone pick-up.

Patent issued to General Electric Co., Ltd., and W. H. Peters.

LOUD-SPEAKERS.

Convention date (U.S.A.), 18th April, 1930.
No. 372533.

In order to reduce resonance effects, the cabinet containing a loud-speaker is provided with internal partitions which form auxiliary resonating chambers. The internal chambers are so shaped or dimensioned as to resound only within the normal resonance frequency of the main cabinet. When resonating they develop a low-pressure region so as to reduce excessive response in the main chamber, though they do not interfere with the proper reproduction of frequencies, particularly the lower notes, falling outside the resonance range of the main cabinet.

Patent issued to Marconi's Wireless Telegraph Co., Ltd.

WIRELESS NAVIGATION SYSTEMS.

Convention date (U.S.A.), 6th May, 1930. No. 371552.

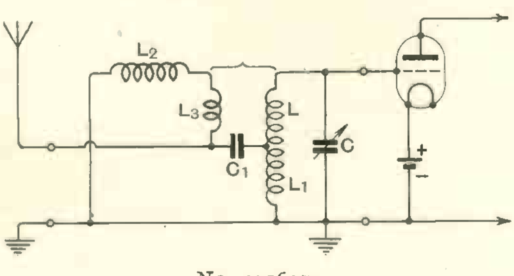
To facilitate navigation, particularly of aircraft, large areas of land or sea are continuously "covered" by directed beams of wireless energy. One line of parallel transmitters radiate from North to South, whilst a second set operate East and West, so as to form an intersecting network. Each "zone" transmitter is distinguished by a progressive frequency of modulation. The navigator can then ascertain his position at any time by noting the characteristics of the received signals, these being sufficient to identify any particular "square" on a key map of the system. It is stated that the parallel beacon transmitters are spaced apart by twenty miles, and give no appreciable overlap up to a range of 600 miles.

Patent issued to M. Wallace.

CONSTANT-COUPLING CIRCUITS.

Convention date (U.S.A.), 20th August, 1930. No. 371697.

To maintain uniform amplification over the whole tuning-range the input is branched across two parallel paths, one comprising a relatively large fixed inductance L_2 and a primary winding L_3 coupled to the secondary winding L of the tuned circuit L, C, whilst the other path consists of a fixed capacity C_1 in series with a part L_1 of the secondary winding L. The coils L_3 and L_1 are wound with opposite polarities relatively to the input terminals. The branch containing the inductances L_2, L_3 is made resonant at a frequency lower than the lowest frequency within the tuning range, so that the circuit is inductively reactive, whilst the parallel branch C_1, L_1 is capacitatively reactive over the tuning range. In this way the effective coupling between the primary and secondary circuits falls off as the tuning frequency is increased. A similar circuit arrangement may be employed as an intervalve coupling.



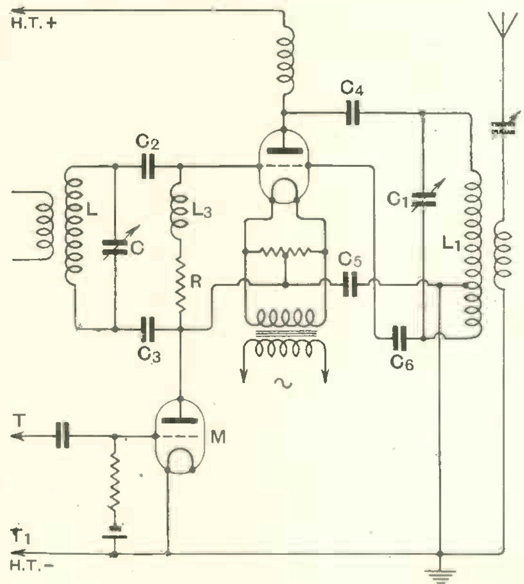
No. 371697.

Patent issued to Hazeltine Corporation.

MODULATING SYSTEMS.

Application date, 12th February, 1931. No. 372414.

To improve efficiency particularly when applying a high percentage of modulation, the modulating-valve is arranged in series with and on the low-tension side of the generating or amplifying stage. As shown, the anode of the modulating-valve M is connected to the cathode side of the grid-leak R and stopping-choke L_3 of the amplifying-valve V, the cathode of the modulator being connected to earth and to negative high-tension. The amplifying stage has a tuned input L, C and a tuned output L_1, C_1, both provided with blocking condensers C_2 . . . C_5. A neutralizing condenser C_6 is applied to the amplifier as shown. Signalling voltages are applied across the terminals T, T_1. The blocking condensers C_4, C_5 should have high reactance to the modulating-frequencies and low reactance to the carrier frequency.



No. 372414.

Patent issued to Marconi's Wireless Telegraph Co., Ltd., and W. T. Ditcham.

AUTOMATIC VOLUME CONTROL.

Convention date (U.S.A.), 7th July, 1930. No. 372155.

When a receiver fitted with means for ensuring automatic gain control is being tuned, the background noise from static and similar disturbances is very marked at all points on the condenser dial where no carrier wave is present, or where the carrier is only present at less than useful strength, since at these points the gain control sets the valves to maximum sensitivity. In order to avoid disconcerting noises due to this cause a mechanical relay device is connected, preferably in the intermediate-frequency stage of a superheterodyne receiver, so as to short-circuit the loud speaker or otherwise render it inoperative whenever the received carrier-wave falls below a predetermined strength.

Patent issued to Marconi's Wireless Telegraph Co., Ltd.

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