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Editorial

Some Further Points in the Design of Coupled Circuit Filters

IN the last number we discussed a method of explaining the band-pass characteristics of an ordinary coupled-circuit filter by considering the two modes of resonant oscillation, but we pointed out that the method has defects in that it does not lead to useful formulae for the operating characteristics of the filter. The adjustment of the circuits to give these resonant oscillations is, in fact, in some cases not the same as that which a more rigorous treatment of the problem shows to be necessary for the correct design of the filter.

This is a point of some importance and forms the basis of a criticism by Alsleben of the work of Feldtkeller and Tamm. If the filter shown in Fig. 1 (page 289 of June *W.E.*)—a two-circuit filter—be replaced by the equivalent two-mesh filter as shown in Fig. 2, then $L_1 = L_1' + M$ and $L_2 = L_2' + M$, so that if in Fig. 1 $C_2/C_1 = L_1/L_2 = n$, then L_1'/L_2' cannot be equal to n as we assumed in explaining the action of Fig. 2. If, however, the filters of Figs. 2 or 3 be replaced by the equivalent three-mesh filter as shown in Fig. 4, then K_2/K_1 is not equal to L_1/L_2; hence the two side circuits are not in tune. If one starts from the assumption that these circuits are tuned, i.e., that $K_1L_1 = K_2L_2$, then, unless $K_1 = K_2$ and $L_1 = L_2$, the filter is equivalent to Fig. 2 with $L_1'/L_2' = C_2/C_1$ or Fig. 3 with $C_1'/C_2' = L_2/L_1$ as we assumed. This, however, is equivalent to detuning the two circuits of Fig. 1. If the two circuits are identical this difficulty does not arise, but if they are not, one has to bear in mind that tuning the two side circuits of Fig. 4 to the same frequency does not give a tuned filter, but one equivalent to Fig. 1 with the two circuits somewhat detuned. If in Fig. 4 $L_1/L_2 = n$, then the filter is tuned if $(K_2 + K_3) = n(K_1 + K_3)$, that is, if the circuits are each tuned separately to the same frequency with the coupling condenser K_3 connected in parallel with the circuit condenser K_1 or K_2. It is a mistake, however, to assume that the filter in Fig. 4 is equivalent to a two-circuit filter with these values of the capacitance. The equivalent two-circuit filter would have capacitances of $K_1 + K_2K_3/(K_2 + K_3)$ and $K_2 + K_1K_3/(K_1 + K_3)$, which are also in the ratio $1/n$, and represent the capacitance of each condenser in parallel with the other two in series. When K_3/K_2 is small, i.e., with weak coupling, these approximate to $K_1 + K_3$ and $K_2 + K_3$ respectively.

Another point to be noted is that a perfectly tuned filter with identical circuits does not give a perfectly symmetrical resonance curve. At first sight one might think that this is not in agreement with the symmetrical parabola in Fig. 2 of Dr. Mallett's paper referred to below, but, as he explains, all the vectors have to be divided by ωM, where ω is assumed to be constant. This assumption is usually made but is, of course, not strictly correct, so that, although the parabola would indicate two equal minimum vectors, the reciprocals of which should give equal humps on the resonance curve, they have to be divided by ωM, where ω is obviously different for the two humps. It is not suggested that this approximation is not justified in practice—we are going to make it—but it should not be overlooked when investigating slight dissymmetry caused, say, by accidental detuning of the circuits.

The performance of a filter is usually represented by a resonance curve, the ordinates of which give the output current or voltage at various frequencies for an input current or voltage of constant amplitude. In investigating the action of the filter it is preferable to adopt the reverse process and, assuming the output to be fixed in magnitude and phase, to plot the vector representing the input. The locus of this vector is a parabola. Although the representation of an alternating current quantity by a parabola was explained by Bloch in 1917* its application to coupled circuits is due to Mallett† whose methods have been followed in all subsequent papers. One can plot the ratio of input e.m.f. to secondary current, or of input current to the voltage across the secondary condenser, or of input e.m.f. to the voltage across the secondary condenser; in the first case the resulting vector is an impedance, in the second an admittance, and in the third a numeric, but in every case its locus is a parabola or approximates to one.

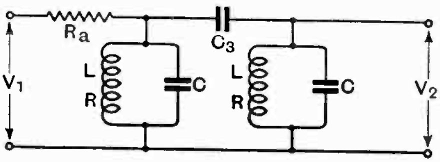

Fig. 5.

We may take as an example the filter problem investigated by Kafka. This is shown in Fig. 5 where the two circuits are identical and R_a is the internal A.C. resistance of the valve preceding the filter.

* *Die Ortskurven der Graphischen Wechselstromtechnik.*

† *E.W. and W.E.*, p. 437, August, 1928; *Proc. Roy. Soc.*, *A* Vol. 117, 1928, pp. 331–350.

If Y be the admittance of each of the tuned circuits then $Y = \dfrac{R}{\omega^2 L^2} + j\left(\omega C - \dfrac{1}{\omega L}\right)$, and $Z_3 = -j(1/\omega C_3)$ is the impedance of the coupling condenser. Then

$$V_1/V_2 = (1 + R_a Y)(1 + Z_3 Y) + R_a Y$$
$$= 1 + Z_3 Y + R_a Y(2 + Z_3 Y)$$

The reference frequency taken is not that of the tuned circuits, nor that of the single circuits of the equivalent two-circuit filter, but $\omega_0 = 2\pi f_0 = 1/\sqrt{L(C + C_3)}$.

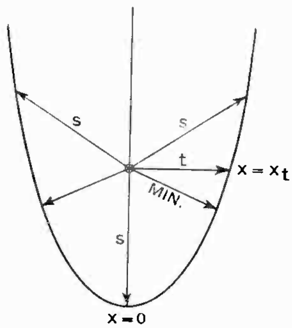

Fig. 6.

From the June editorial it will be seen that the two resonant frequencies are given by $\omega_2 = 1/\sqrt{LC}$ and $\omega_1 = 1/\sqrt{L(C + 2C_3)}$. Hence $\omega_0^2 = 2\,\omega_1^2\omega_2^2/(\omega_1^2 + \omega_2^2)$.

Let $\dfrac{\omega}{\omega_0} = \eta$ and $1 - \dfrac{\omega_0^2}{\omega^2} = 1 - \dfrac{1}{\eta^2} = x$

$k = C_3/(C + C_3)$, $D = R_a/\omega_0 L$, $d = R/\omega_0 L$

With these substitutions the above formula becomes

$$V_1/V_2 = \frac{x}{k}\left(1 + \frac{2Dd}{\eta^2}\right) + j\frac{1}{k}\left[D\eta(x^2 - k^2) - \frac{d}{\eta^3}\left(1 + \frac{Dd}{\eta^2}\right)\right]$$

This represents an unsymmetrical parabola-like curve, but if the usual approximation be made by putting $\eta = 1$ this becomes

$$V_1/V_2 = \frac{1 + 2Dd}{k}x + j\left(\frac{D}{k}x^2 - s\right)$$

where $s = kD + \dfrac{d}{k}(1 + Dd)$, which, is independent of frequency. The locus of V_1/V_2 is now a symmetrical parabola (Fig. 6).

When $x = 0$, i.e., when $\omega = \omega_0$, $V_2/V_1 = -js$.

If x_t be the value of x for which the j component vanishes, $x_t^2 = \frac{ks}{D}$, and if the corresponding value of V_2/V_1 be t, then

$$t = \frac{1 + 2Dd}{k} x_t.$$

The form of the parabola is fixed by the ratio $t/s = F$ which therefore determines the shape of the resonance curve.

Since the real component is proportional to x a linear scale of x can be plotted along the horizontal; this scale is fixed by the value $x_t = \sqrt{(ks/D)}$ where the parabola cuts the horizontal axis. For any value of the frequency the value of x can be calculated and a vertical drawn from the corresponding point on the scale to cut the curve at a point P; the reciprocal of the vector OP is the ordinate of the resonance curve at that frequency.

Let $\Delta f = f - f_0 = \eta f_0 - f_0 = f_0(1/\sqrt{1-x} - 1)$; then since the x scale is linear the frequency scale is not linear, but if x is small, i.e., in the neighbourhood of resonance, $\Delta f = f_0 \frac{x}{2}$ approximately, so that the frequency scale can be taken as linear on both sides of the origin. This is equivalent to saying that the resonance curve plotted to a frequency base is approximately symmetrical about f_0 over the range in which we are interested.

Conditions for Obtaining Band-Pass Characteristics

For a hump on the resonance curve the value of V_1/V_2 must be a minimum. The formula above may be written thus

$$V_1/V_2 = s\left[F\frac{x}{x_t} + j\left(\frac{x^2}{x_t^2} - 1\right)\right]$$

and therefore for a minimum value of $|V_1/V_2|$ we put

$$\frac{d}{dx}\left[F^2\frac{x^2}{x_t^2} + \left(\frac{x^2}{x_t^2} - 1\right)^2\right] = 0$$

whence $$\frac{x_h}{x_t} = \pm\sqrt{1 - \frac{F^2}{2}}$$

Hence x_h can only be real, i.e., humps can only occur on the resonance curve if $\frac{F^2}{2} < 1$, i.e., if $t < \sqrt{2}s$.

If x be put equal to x_h in the formula for $|V_1/V_2|$ it is found that $|V_1/V_2|_h = sF\sqrt{1 - \frac{F^2}{4}}$ and the reciprocal of this gives the height of the humps on the resonance curve.

Band Width

What shall we call the width of the band? Some authors limit it to the points at which the ordinate is equal to the mid-ordinate, whereas others extend it until the ordinate falls to half this value. If one adopts the former definition, then the limiting vectors will have the same length as the mid-point, viz. s, as shown in Fig. 6; for this to occur

$$F^2\frac{x^2}{x_t^2} + \left(\frac{x^2}{x_t^2} - 1\right)^2 = 1$$

whence $$\frac{x}{x_t} = \pm\sqrt{2 - F^2}$$

Hence the band extends from

$$x/x_t = -\sqrt{2 - F^2} \text{ to } x/x_t = +\sqrt{2 - F^2}$$

Since $\Delta f = f_0 \frac{x}{2}$ approximately, the whole band width

$$f_2 - f_1 = f_0 x_t \sqrt{2 - F^2}$$

in which the values of x_t and F can be substituted.

If one regards as the limits of the band the points at which the ordinates are reduced to half the value at ω_0, then

$$\left|\frac{V_1}{V_2}\right| = 2s \text{ and } F^2\frac{x^2}{x_t^2} + \left(\frac{x^2}{x_t^2} - 1\right)^2 = 4$$

whence

$$\frac{f_2 - f_1}{f_0} = x_t\sqrt{1 - \frac{F^2}{2} + \sqrt{\left[3 - \left(1 - \frac{F^2}{2}\right)^2\right]}}$$

The Mid-Point Ordinate

The ordinate of the resonance curve for ω_0 will be a maximum when the coupling is so adjusted that s is a minimum. Putting $ds/dk = 0$

we have $$\frac{d}{dk}\left[kD + \frac{d}{k}(1 + Dd)\right] = 0$$

whence $$k_{op} = \sqrt{\frac{d}{D}(1 + Dd)}$$

and $$s_{min} = 2\sqrt{Dd(1 + Dd)}$$

$$= \frac{2}{\omega_0 L}\sqrt{R_a R\left(1 + \frac{R_a R}{\omega_0^2 L^2}\right)}$$

The reciprocal of this gives the maximum possible value of the ordinate at ω_0, but it is not a point of much importance in the present connection as it occurs at a coupling

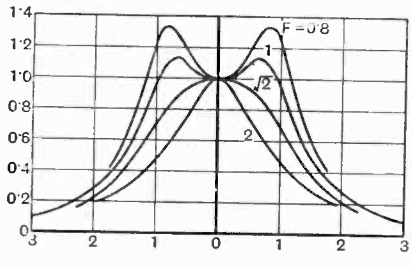

Fig. 7.

which does not give two humps and at which therefore the filter does not possess band-pass characteristics.

Best Value of F

We have seen that for humps to appear on the resonance curve F must be less than $\sqrt{2}$. If F is greater than this the curve approximates to a single-circuit resonance curve; if it is much smaller than this the humps become too pronounced, and exaggerate the side-bands at the expense of the carrier, with resulting distortion. To obtain the best results F should be about unity and the filter should be designed on this assumption. Fig. 7 shows the resonance curves for four values of F, viz. 0.8, 1.0, $\sqrt{2}$, and 2; the ordinates represent $|V_2/V_1|$ in terms of its value at $\omega = \omega_0$; the abscissae represent x/x_t and are therefore approximately proportional to frequency deviation from the mid-point frequency. The point $x/x_t = 1$ corresponds approximately to a frequency deviation $\Delta f = \frac{f_0}{2}\sqrt{\frac{ks}{D}}$.

By comparing Figs. 6 and 7, it is seen why the humps, which correspond to the minimum values of the vector in Fig. 6, occur at value of x a little less than x_t. It is also obvious from Fig. 7 that one has little choice in the value of F and may safely take $F = 1$ as a basis of design.

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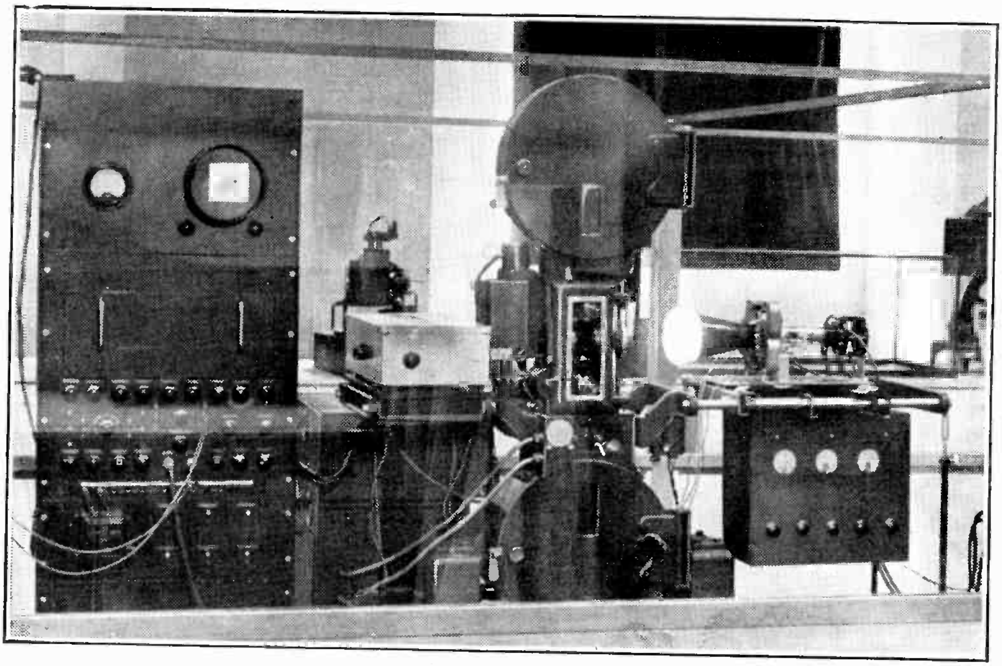


When the Alexandra Palace television transmitter is not operating, signals for the demonstrations at the Television Exhibition, Science Museum, South Kensington, are provided by this Cossor film transmitter which is situated in the main hall. The exhibition, which will continue for three months, was opened by Lord Selsdon, on June 10th. Times of opening each day were given in our last issue.

The Double Superheterodyne Receiver*

By R. I. Kinross

Introduction

THE general principles involved in a double superheterodyne receiver are as follows :—

The desired signal, after passing through a suitable aerial filter is changed by means of a mixer valve to a frequency higher than any to which the receiver is called upon to tune. This ensures that second channel interference can only be experienced from signals lying well outside the band of frequencies covered by the receiver and thus should be rendered negligible by the design of a suitable aerial filter. Further, the whole of the European M.W. & L.W. broadcast transmitters (150–1,500 kc/s) may be tuned in with one sweep of the oscillator tuning condenser.

In order to get the best compromise possible between adjacent channel selectivity and top note response, a second mixer is added to reduce the first intermediate frequency to a conventional low value, such as 125 kc/s, and the receiver from this point onwards follows standard modern practice. Since the first intermediate frequency is fixed, obviously the oscillator of the second mixer will also be of fixed frequency.

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

Choice of First Intermediate Frequency

Fig. 1 shows in a skeleton form the simplest arrangement for a double superheterodyne receiver.

The signal, after passing through a signal frequency filter is changed to a frequency of 1,600 kc/s and after passing through a 1,600 kc/s filter is changed to 125 kc/s by means of a fixed oscillator of 1,725 kc/s.

A receiver built on these lines will be found to produce numerous unmodulated phantom carriers which, if they appear at a frequency close to that of a transmitter which it is desired to receive, will render the latter useless by producing a heterodyne whistle varying in pitch as the desired signal is tuned through. The causes of some of these phantom carriers is shown in Fig. 2, which illustrate that the difference frequency between harmonics of the two oscillators will produce the first I.F. frequency. Thus, if any voltage from the two oscillators is picked up at the signal grid of either frequency changer at an amplitude comparable with that of the signal to be received, interference

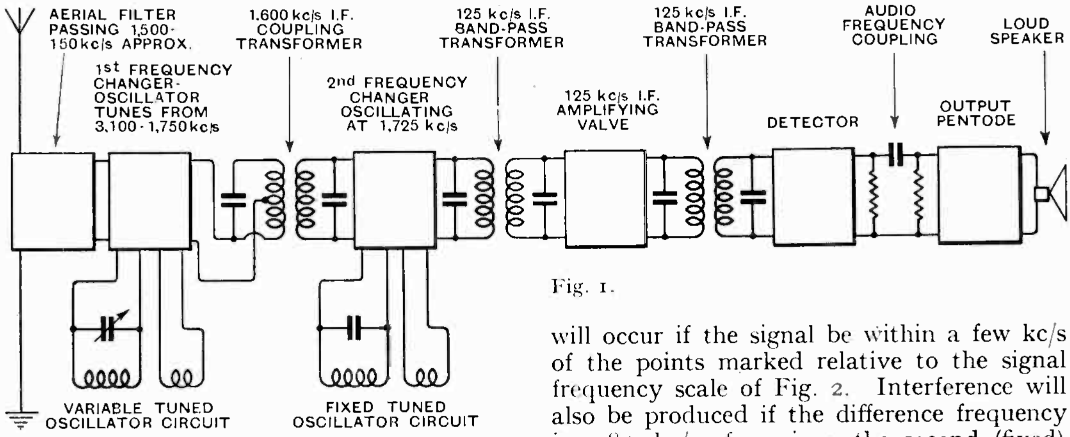


Fig. 1.

will occur if the signal be within a few kc/s of the points marked relative to the signal frequency scale of Fig. 2. Interference will also be produced if the difference frequency is 1,850 kc/s, for, since the second (fixed) oscillator is 1,725 kc/s, 125 kc/s will thus be produced to an extent depending on the selectivity of the 1,600 kc/s I.F. tuned circuits : which introduces us to the fact that the second frequency changer is subject to its own second channel problems, but, as the problem at hand is such as to merit our undivided attention and the one of second channel interference at the second frequency changer is not one to be lightly dwelt on *en passant*, we will leave it for the moment and deal with it more fully later.

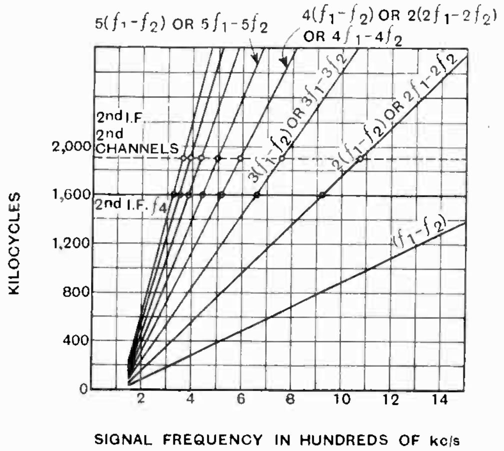


Fig. 2.—*Radio frequencies to be received* = 1,500 *kc/s to* 150 *kc/s*; f_3 *first L.F.* = 1,600 *kc/s*; f_1 *first oscillator* = 5,100 *kc/s to* 1,750 *kc/s*; f_4 *second L.F.* = 125 *kc/s*; f_2 *second oscillator (fixed)* = 1,725 *kc/s.*

Returning to Fig. 2 it will be noticed that lines of interference have been called by two or more alternative expressions, such as $3(f_1 - f_2)$ or $3f_1 - 3f_2$ which mathematically are obviously the same. Physically, however, the first designates the third harmonic of the difference between the fundamentals of the two oscillators, and the second designates the difference frequency between the third harmonics of each of the two oscillators. Thus, even if in practice we could produce oscillators of negligibly low harmonic content it would avail us nought if rectification of the difference frequency occurred (as it assuredly would to a certain extent) in any of the valves up to and including the second frequency changer.

Now the first oscillator works at a frequency differing from that of the first intermediate frequency by an amount equal to that of the signal frequency being received. And the frequency of the second oscillator differs from that of the first I.F. by an amount equal to that of the second I.F. chosen. It will thus be seen that for any given value of signal frequency and second I.F. the difference frequency between the two oscillators will be independent of the value of first I.F. chosen. In other words, Fig. 2 holds good for any value that may be chosen for the first I.F., and a glance at it will show that if we increase this value, only the higher harmonics of the oscillators will produce phantom signals. It must be remembered, however, that the susceptibility of the second frequency changer to second channel troubles is dependent solely on the selectivity of the first I.F. filter circuits. Thus, if we wish to maintain the gain and selectivity of the first I.F. circuits, we must keep these at as low a frequency as possible. We therefore, have two conflicting claims to consider in determining a suitable value for the first intermediate frequency.

In practice it is found impossible even by extensive decoupling and screening to reduce the interaction of the two oscillators to a negligible amount unless we arrange matters in such a way that only difference frequencies produced by the fourth or higher harmonics of the two oscillators can produce the first I.F.

For this condition to obtain, yet using the lowest I.F. possible, the difference frequency produced by the third harmonics of the two oscillators must cause interference just outside the waveband to be covered (say at 1,510 kc/s), thus giving the following expressions using the nomenclature shown in Fig. 2 and a second I.F. of 125 kc/s.

$$3f_1 - 3f_2 = f_3 - 250 \text{ kc/s} \quad .. \quad (I)$$

$$f_1 = f_3 + 1{,}510 \text{ kc/s} \quad .. \quad (II)$$

$$f_2 = f_3 - 125 \text{ kc/s} \quad .. \quad (III)$$

which gives $f_3 = 5{,}155$ kc/s which is the lowest value which we may adopt for the first I.F.

Even under those conditions it will still be necessary completely to screen the two oscillators from each other and to decouple practically every lead that emerges from the screens by means of highly non-inductive condensers and short wires. Interaction may then in practice be cut down to a very small amount and the effect of the two fourth harmonics will only cause a slight chirrup not easily noticeable.

We are now in a position to see how we

are placed with regard to second channel interference at the second frequency changer. At 5,155 kc/s using a moderately compact coil in a can, we may expect a reduction of 10 : 1 for a frequency 250 kc/s off resonance.

Thus, for the arrangement shown in Fig. 1 the second frequency changer second channel ratio will barely be 100 : 1. This is not nearly a high enough standard for modern conditions and a ratio of 10,000 : 1 should be aimed at. This will, therefore, necessitate four 5,155 kc/s tuned circuits loosely coupled to each other. In practice it will be found very difficult to prevent leakage from the beginning to the end of such a filter and it will be found best to include a valve between the first and second pairs of coupled circuits.

There is, however, an even more insidious form of interference than that from a signal removed by twice the second I.F. frequency from the desired signal. As is well known in designing a conventional superhet, a signal removed from the desired signal and, in consequence, from the local oscillator, by half the I.F. frequency will cause interference owing to the rectification and consequent doubling of the resulting difference frequency. In the best modern types of frequency changer the response of the latter to an image of this type is usually 1/1000th of that which it gives to the correct signal, but this depends largely on the magnitude of the signal applied. This ratio, together with that usually provided by the pre-selectors of a conventional superhet, is usually sufficient to render the interference negligible. In the case of the double superhet outlined in Fig. 1, however, we have no pre-selection for the second frequency changer except that provided by the 5,155 kc/s I.F. filter, which must therefore be capable of discriminating between a signal of 5,155 kc/s and one of 5,217½ kc/s.

Further, there is a certain amount of amplification before the second frequency changer (for we cannot afford to use two valves nowadays and not make them pay their way), and this will reduce what we might call the discriminating power of the second frequency changer to about 100 : 1.

Fig. 3 shows the order of selectivity provided by a pair of 5,155 kc/s circuits requiring a screening can 4in. high and 2¼in. diameter to a signal 62½ kc/s removed from resonance. The maximum theoretical image ratio for the receiver can therefore only be $7^2 \times 100 =$ 4,900 : 1 and the actual image ratio, if we are content with a gain of 12 : 1 in this stage and use a similar coupling for the first pair of circuits, will only be $4.9^2 \times 100 =$ 2,400 : 1, which is probably the best commercial compromise possible, but still below the standard set by a well-designed conventional 6-valve superhet.

Even to obtain this ratio, extreme care will have to be taken to keep the circuits correctly tuned for it can be shown that an error of 0.2 per cent. in capacity in the four 5,155 kc/s tuned circuits will halve the image ratio of the receiver as a whole.

A higher second intermediate frequency, such as 400 kc/s would, of course, make matters easier, but even the best 400 kc/s band-pass filter will be worse than a mediocre one employing 125 kc/s from the point of view of selectivity, loss of side-bands and stable gain. Since the whole object of designing a double superhet is to render available the principle of single-span tuning to receivers of the highest performance, increasing the second intermediate frequency

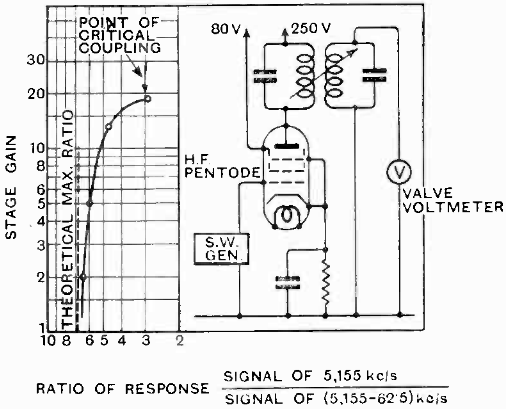


Fig. 3.

cannot be considered as a solution to this problem of second channel interference at the second frequency changer. Also most unpleasant noises would be sure to result when the receiver was tuned through 400 kc/s.

This, then, constitutes one of the reasons for the eventual addition of a rough aerial tuner ganged to the first oscillator variable condenser. The full reasons for its addition will be given later on, but it may be said here that its inclusion will ensure that the worst image ratios obtaining at the second frequency changer will be over 10,000 : 1.

Effect of Inter-Electrode Capacity of Second Frequency Changer Valve

A certain amount of capacity will always exist between the signal grid and oscillator anode of a pentagrid type frequency changer. At ordinary broadcast frequencies this is of little consequence, but in the case under discussion this capacity will be sufficient to transfer some of the second oscillator voltage into the 5,155 kc/s I.F. tuned circuit connected to the signal grid of the second frequency changer since the former is tuned to a frequency only 125 kc/s, *i.e.*, 2½ per cent. different in frequency from that of the oscillator. The effect of this voltage will be to swing the signal grid to such a potential that grid current will flow unless the signal grid be biased back so far initially that full advantage of the conversion conductance of the valve cannot be taken. Even if this course be adopted, the 5,155 kc/s I.F. grid circuit will be found incapable of providing the degree of selectivity of which theoretically it should be capable. The reason for this lies in the fact that a certain mutual conductance exists between the signal grid and oscillator anode of the pentagrid. This mutual conductance which may be of the order of 0.1 mA per volt, is such that an increase in negative potential on the signal grid produces an increase in oscillator anode current. From this it will be seen that with an inductive oscillator anode load, degeneration will occur in the signal grid circuit.

The following remedies may be resorted to :

1. Neutralise the inter-electrode capacity in question as shown in Fig. 4.

2. Make the oscillator anode load capacitive.

3. Use a lower $\frac{L}{C}$ ratio for the 5,155 kc/s tuned circuit.

The first method is theoretically the soundest. The setting of the neutralising condenser is, however, extremely critical and should be done with a valve voltmeter connected across the signal grid tuned circuit. Image ratios may be improved approximately five-fold if this be correctly carried out. Unfortunately, the same setting will not hold for different samples of the same type of valve with the result that if the valve has to be changed at a later date the receiver may be completely unstable, due to over-neutralisation or may be suffering badly from images. Since re-setting the neutralising condenser varies the capacity across

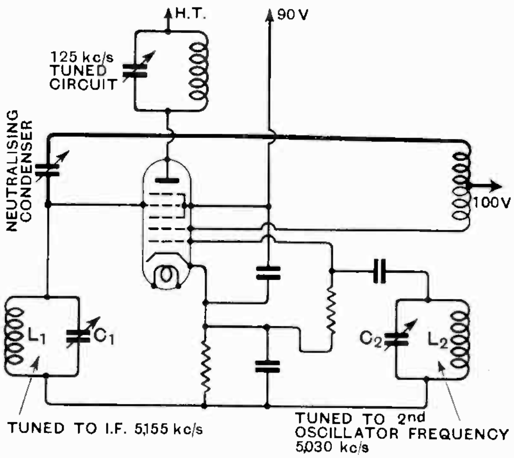


Fig. 4.

C_1 (Fig. 4) it will be seen that the operation is not one that can be carried out easily outside a laboratory without involving a good deal of trial and error in attempting to adjust matters on an ordinary aerial.

The objection to the second suggestion is that the 5,155 kc/s tuned circuit will " pull " the oscillator tuned circuit because of the capacity existing between signal and oscillator grids, and will result in very poor frequency stability, the result of which will be dealt with later.

This leaves us with only the third alternative which might be described as " a brute force method."

It will not yield as good results as the first alternative, but owing to the smaller effect of inter-electrode capacity will give better results than may be obtainable from an unneutralised circuit of higher dynamic impedance.

Aerial Circuit

It was hoped originally that the only requirements of the aerial circuit would be a high step up over the band 1,500 to 150 kc/s and as sharp a cut-off as possible outside this band. A special transformer for this purpose was designed having a response as shown in Fig. 5.

Cross-modulation, however, proved troublesome. This not only took the form of the modulation of a powerful signal being superimposed on other signals, but also the form of two local stations mixing in the first valve and producing sum or difference frequencies modulated by both transmissions. The magnitude of the latter effect may be judged by the following figures:

A 4,000 μV signal of 1,500 kc/s applied simultaneously with a 80,000 μV signal of 1,000 kc/s would produce the equivalent of a 50 μV signal at 500 kc/s. The product of the first two signal strengths is constant for a given valve so that it will be appreciated that many images will occur with a reasonably efficient aerial when listening after dark.

For this reason and, as previously stated, to improve fractional second channel ratios at the second frequency changer, a special variable aerial pre-selector was designed.

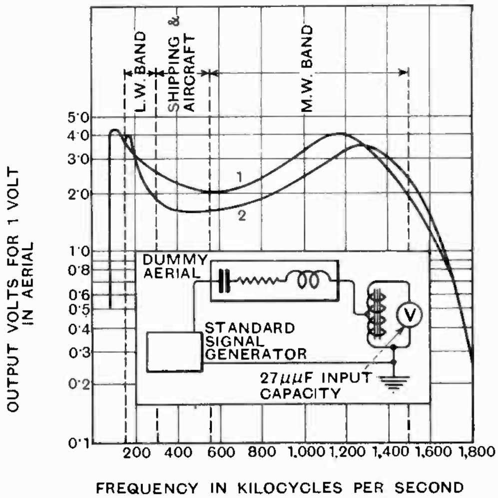


Fig. 5.—*Curve* 1, *aerial of* 0.0003 *R.F. capacity, curve* 2, *aerial of* 0.0002 *R.F. capacity, each tapped* ⅓ *from low potential end of winding.*

In the ordinary way, to cover the band 150–1,500 kc/s without switching, it would be necessary to resort to the expedient of ganging together a variometer and a variable condenser since neither of these are capable of a much bigger reactance ratio than 20 : 1 by themselves, whereas a total ratio of LC of $\left[\frac{1{,}500}{150}\right]^2 = 100:1$ is required.

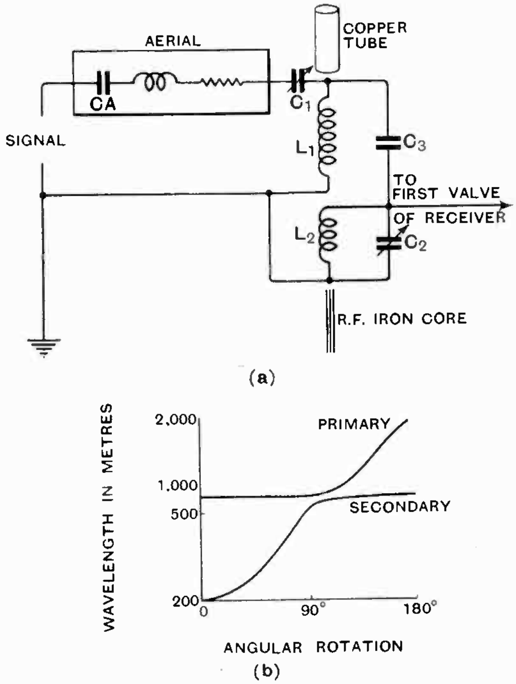


Fig. 6.

Fig. 6 shows how it is possible to dispense with the variable ganged condenser.

L_1 and L_2 which are respectively the primary and secondary windings of the tuner, are wound alongside each other on the same former. The latter is arranged to slide from inside the copper tube to a position on the iron core. Thus the secondary will emerge from the copper and slide on to the iron, closely followed by the primary and the coupling is mainly capacitive on M.W. (*via* C_3) and inductive on L.W. The coils are made of such an inductance and tuned with such a capacity (L_2 by C_2 and L_1 by C_1 in series with the aerial capacity) that the secondary tunes from 200 to 570 metres and the primary from 700 to 2,000 metres. Assuming the movement of the device to be transformed to an angular rotation of 180 deg., the resonance obtainable at any setting may be seen from Fig. 6 (*b*).

It will be seen from this that at any particular setting two resonances are obtainable.

Since, as stated above, the coupling on medium wave is largely *via* C_3, the resonance at 700 metres which occurs throughout the medium wave-band is not of sufficient magnitude to cause trouble. The resonance at 570 metres remains at a fair amplitude throughout the long wave-band but in the superhet receiver in which it is used, as a rough pre-selector, has not been found to cause any trouble. If it did cause trouble, matters could possibly be arranged for the secondary to slide on to some core which would damp out the M.W. resonance.

As the arrangement stands at present, it is possible to obtain a step-up from the signal to the first valve of between 3 : 1 and 12 : 1 throughout the waveband 150 to 1,500 kc/s.

The movement of the coil is determined by a specially shaped cam ganged to the oscillator condenser.

An advantage of this system is that neither primary nor secondary coil need be trimmed accurately, any adjustment necessary being carried out by means of C_1 and C_2 on the finished receiver.

A skeleton diagram (Fig. 7) of the circuit eventually adopted shows what steps are taken to avoid S.W. interference. Plain second channel interference at the first mixer comes from the band 10.46 to 11.81 megacycles and can easily be eliminated by tuning a rejector circuit to about 11.1 Mc. By making the rejector circuit of very fine wire, spaced between turns and tuning with only about 2 $\mu\mu$F it is possible also to eliminate for all practical purposes S.W. fractional second channel interference. An acceptor circuit to earth is included to avoid any risk of interference from a signal of 5,155 kc/s (the first I.F.).

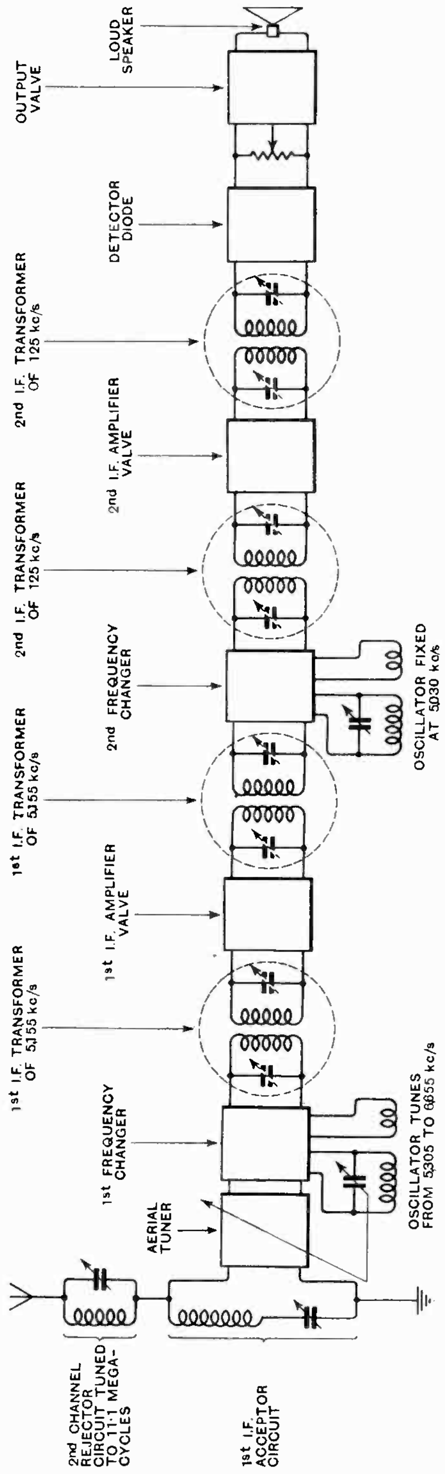


Fig. 7.

Frequency Stability

Owing to the necessary adoption of a first I.F. as high as 5,155 kc/s a small percentage change in frequency of the first and second oscillators will appear as a considerably larger percentage on the broadcast waveband. This manifests itself in three objectionable ways.

(i) Drift of either oscillator during warming up period of receiver (about 40 minutes after first switching on) may introduce distortion due to over-accentuation of sidebands. It also precludes the use of a really selective "Q" arrangement.

(ii) Oscillator drift over a period of months will introduce wavelength scale errors and a reduction of sensitivity and image ratios.

(iii) A change of screen, anode, etc., volts may introduce the same trouble as indicated in (i).

Fig. 9 is an example of the sort of thing that happened when the receiver as first designed was switched on from cold.

By exercising care in the design of coils it was possible to make these remain constant to .1 per cent. for temperature changes up to 50 deg. C. and over long periods, without any increase in cost. An inexpensive variable condenser which, when set in any position did not vary more than .1 per cent., was also designed. The chief feature of this was the use of a steatite block in place of the usual paxolin strip for mounting the fixed vanes. The vanes were of .04in. aluminium to avoid microphony. One of the main reasons cheap fixed condensers vary with age is that the pressure of the electrode clamping device does not remain constant. This has been overcome by actually sputtering the electrodes on each side of a mica dielectric and thus obtaining at no great cost maximum variations of less than .1 per cent. Trimmers of high constancy can be made by incorporating most of the capacity in the form described above in the base of the trimmer and only allowing the actual variable portion (which, if of the two-electrode compression type is constant to about .2 per cent.) to constitute only a small proportion of the total capacity.

As this work was carried out before short-wave reception had become as popular as it is now, frequency drift was regarded at that time as one of the difficulties inherently associated with listening on these wavelengths. The work carried out in the design of suitable components for the double superhet, therefore, came in very useful when at a later date a demand arose for a higher standard of frequency stability in all-wave receivers.

Drift due to changes in valve characteristics can be improved by using good tuned coils, low $\frac{L}{C}$ ratios, few reaction turns but closely coupled and the choice of the correct value of grid condenser. The value of the latter for least frequency drift is given by the expression $C_1\left[\frac{k^2}{1-k^2}\right]$ where C_1 is the tuned coil capacity and k the coupling coefficient between grid and anode coils. It can easily be found experimentally as shown in Fig. 8.

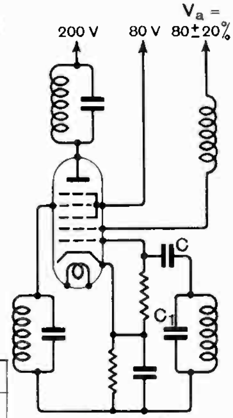
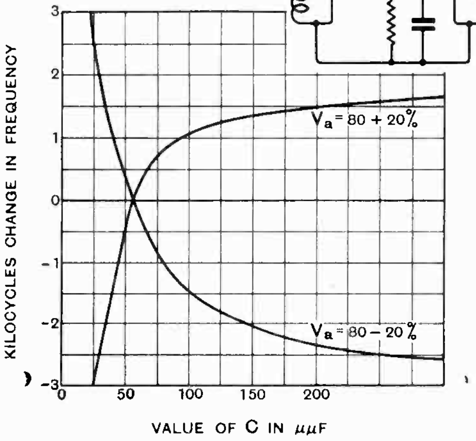


Fig. 8.



With these precautions, the biggest change in frequency measured for the warming up period, ± 12 per cent. change in mains volts or changing valves was 1 kc. or less. Checked over a period of five weeks, the biggest scale error was 3 metres at 340 metres, *i.e.*, ±4 kc/s.

None of the coils need be accurately trimmed except the first and this is best accomplished on the finished receiver by means of an adjustable brass screw which, together with a trimmer across the variable condenser, will enable an exact gang to be carried out at both ends of the waveband.

General Performance

As regards sensitivity and selectivity, the performance was well up to the standard set by a modern 4-valve superhet, the former being of the order of 10 μV at 40 per cent. modulation for ½ watt of output into the speaker.

Whistles caused by images were, on the whole, better than obtained on a conventional superhet using only two signal frequency circuits.

Cross modulation did not cause trouble until very close (*e.g.*, a couple of miles) to a transmitter. In actual practice, a reduction of aerial size effected a cure without appreciable loss of performance on distant stations.

Background noise is not so good as for a receiver including H.F. amplification, but is as good as the average superhet starting with a mixer valve.

Nevertheless, a double superhet has never been produced commercially. Apart from the fact that six valves are required to give the performance normally obtainable from four, one of the chief causes for this is probably the necessity for including rough pre-selection. This immediately detracts from the attractiveness of the scheme as a whole, especially when the pre-selector takes the form of a new and (commercially) untried piece of apparatus. Though a more conventional type of pre-selector could obviously have been used by utilising switching, wave-change switches of three or four years ago were not the compact, economical and reliable units which they are nowadays.

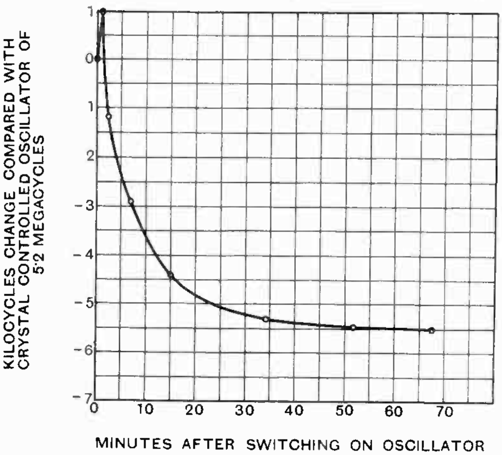


Fig. 9.

In fact, it was in the complete elimination of all switching that most of the *raison d'être* of the double superhet lay.

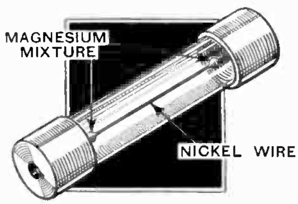
Another development which reduced the advantages of this type of receiver was the increase in popularity of all-wave receivers.

A double superhet would have provided better image ratios at about 20 metres than could have been obtained on a more conventional type of receiver, but this advantage would undoubtedly have been more than outweighed by the increase in signal noise ratio and expense which it would have involved.

In conclusion I should like to acknowledge with thanks the permission of Electric & Musical Industries to publish this work which was carried out in their laboratories at Hayes.

The Industry

ORDINARY fuses are not conspicuously successful as protective devices for broadcast receivers, at any rate when inserted in the power supply leads of mains-operated sets. If the fuse is light enough to afford real protection, it will inevitably be "blown" by the surge which occurs at the moment of switching on. With the object of overcoming this disability, Belling and Lee have introduced the "Mag-Nickel" fuse, which is designed to introduce a lag; the fuse will carry heavy overloads of short duration but will interrupt the circuit when a continuous overload occurs. This object is attained by using as a conductor a nickel wire capable of carrying a 400 per cent. overload; to this are affixed, as here shown, two "blobs" composed of a magnesium mixture which oxidises spontaneously and burns through the wire when its temperature is raised above a certain value. The thermal content of the rather heavy nickel wire is sufficient to absorb momentary surges.



A reduction in the price of the Mullard cathode-ray tube Type E40G3 (3in. screen, 500 volts) has been announced. Formerly priced at £4 15s. 0d., the tube now costs £3 10s. 0d.

Mr. R. P. G. Denman, formerly in charge of the Electrical Engineering section at the Science Museum and well known in radio and aeronautical circles, has joined Mr. E. S. L. Beale in a consulting practice in engineering physics at 129, Ebury Street, London, S.W.1.

The address of Eugen Forbat, agent for Ostar-Ganz universal high-voltage valves, has been changed to Goschen Buildings, 12-13, Henrietta Street, London, W.C.2.

We have received from The British Electric Resistance Co., Ltd., Queensway, Ponders End, Middx., a catalogue giving details of Berco vitreous enamelled resistors, rotary rheostats and potentiometers, adjustable tubular resistances, etc. Toroidal potentiometers and rheostats, 50 and 100 watt rating, are also described.

Energised Loud Speaker Magnets*

By N. W. McLachlan

1. Introduction

IN this article experimental data are given relating to tests on three energised loud speaker magnets designed to fulfil a certain specification. The various parts of the magnetic circuit were not made strictly to the calculated dimensions, since this would have entailed considerable expense in getting special sizes of iron bar and strip rolled. Consequently the nearest stock size to that obtained by calculation was chosen. The first magnet is shown in Fig. 1. It was designed to get a mean flux density of 16,000 lines per square centimetre for a loss of about 30 watts in the field winding, when working off a metal rectifier. The gap was specified to have the dimensions of Fig. 2, but the coil was to have an overhang of $\frac{3}{16}$ inch at each end of the gap, and be able to move $\frac{1}{8}$ inch each way, i.e., a total of $\frac{1}{4}$ inch. This meant that the parallel portion AD (Fig. 1) had to be relatively long. The centre pin is 3 inches in diameter at the base and it is tapered at its upper end to about two inches in diameter in order to fit inside the moving coil, for which it is designed. The flux density about 1 inch from the base of the pin is $5 \times 10^5/45.6 = 11,000$ lines per square centimetre approximately. The density at the base will exceed this in parts, since all the flux does not pass radially from the pin.

It is of interest to notice that the idea of tapering the centre pin and also chamfering the top plate or outer pole dates back to British patent No. 12,141 of 1911, where it was used for telegraphic and telephonic apparatus. In one diagram shown in this patent, a moving coil drives a flat diaphragm in a cylindrical air chamber to which a horn is attached.

2. Experimental Data for Magnet No. 1

The curve showing the relationship between ampere-turns and mean flux-density for the magnet of Fig. 1 is shown in Fig. 3. It is linear up to a density of about 13,000 lines per square centimetre, but gradually curls over at higher densities. This means that up to a density of 13,000 lines per square centimetre, the magnetic reluctance of the iron path is negligible. At higher values of flux density the reluctance of the portion (marked A B C D in Fig. 1) began to increase owing to the high flux density, since this caused a reduction in the permeability of the iron. The permeability curve of the material is plotted in Fig. 4, and when the flux density exceeds about 13,000 lines per square centimetre the permeability falls fairly rapidly.

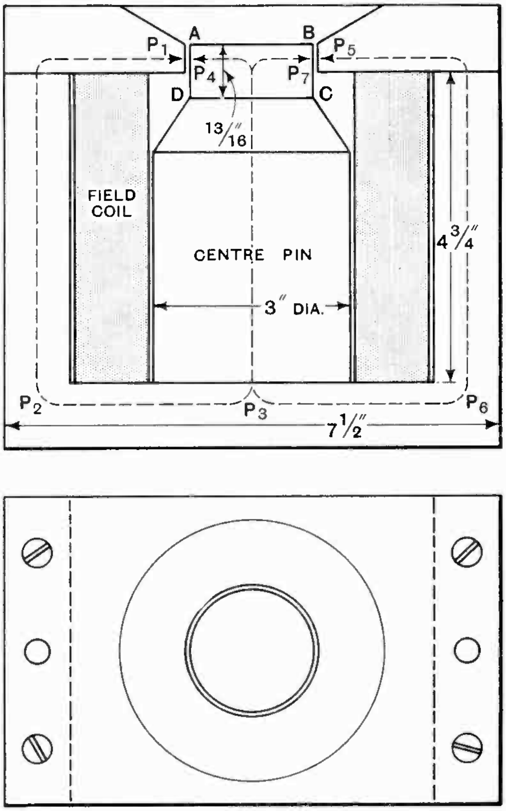


Fig. 1.—*Diagrammatic views of test magnet No. 1.*

With this magnet a gap density of 16,000 lines per square centimetre was obtained using a metal rectifier. the ampere-turns being 3,400 and the loss in the magnetising coil about 30 watts. This low wattage must not be taken as a criterion of high efficiency.

* MS. accepted by the Editor, November, 1936.

In a case which will be cited later, a wattage of nearly 50 was required to obtain the same flux density. The wattage depends upon the dimensions of the coil, a small one necessitating a greater loss than a large one, in order to obtain the same number of ampere-turns.

When the number of ampere-turns was increased from 3,400 to 3,800 the flux density increased but slightly, viz., from 16,000 to 16,700. The disproportionate increase in flux density was due to the iron in the vicinity of the air gap being near magnetic saturation

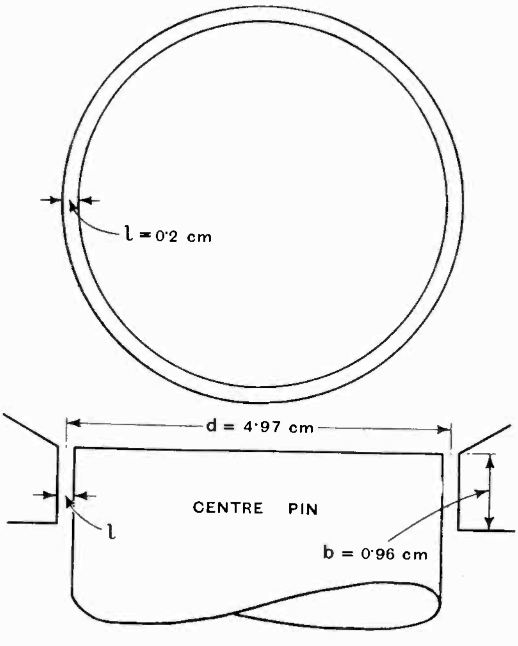


Fig. 2.—*Diagram showing dimensions of air-gap.*

point. The reluctance of the 2 inch cylindrical portion at the upper end of the centre pole was fairly high, owing to the extra length required to permit a large coil amplitude.

There are two ways in which the magnetic reluctance of this upper cylindrical portion can be reduced: (1) decreasing b the axial length of the gap,* thereby reducing the total gap flux, (2) increasing the diameter of the cylinder and, therefore, its cross-sectional

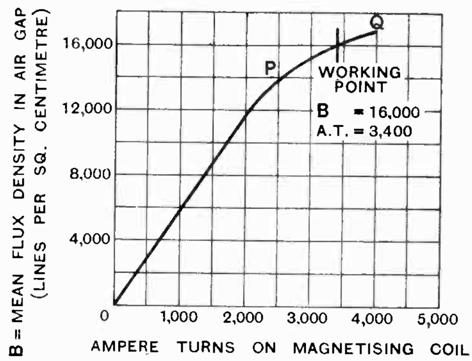


Fig. 3.—*Performance curve of magnet of Fig. 1 showing flux density in air gap and ampere turns on field coil.*

area. The dimensions were fixed primarily in order to accommodate a certain length of moving coil 2 inches in diameter, so that alterations as suggested above could not be effected. If, however, the diameter of the coil is not in question, then for a loud speaker which reproduces frequencies below, say, 500 ~ only, a gap flux density of the order 18,000 lines per square centimetre would be obtained with a moving coil 2.5 inches in diameter. The *total* flux in the air gap would increase correspondingly.

If the diameter of the centre pin at the gap were reduced to accommodate a moving coil 1 inch in diameter, the cross-sectional area would be reduced to $\frac{1}{4}$ its former value. A corresponding increase in the magnetic reluctance of this portion of the magnetic circuit would ensue, and unless the axial length b were reduced appreciably, the flux density in the gap would be well below 16,000 lines per square centimetre. Thus for

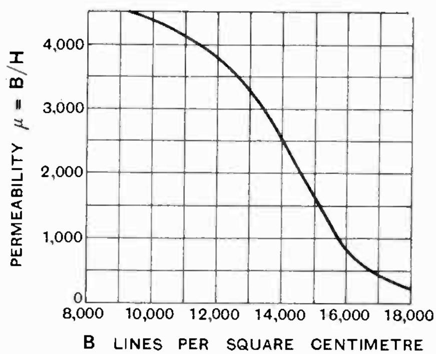


Fig. 4.—*Permeability curve of iron.*

* See Fig. 2.

a given length of moving coil we find that to make the reluctance of the top part of the centre pole as low as possible, the ratio (area of annular air gap/cross-section of top of pin) must not exceed a certain value which is dependent upon economic considerations. In general we may say, therefore, that for a given number of ampere-turns, the smaller the centre pin the lower the gap density, provided the reluctance of the magnetic circuit external to the gap, i.e., the circuit whose

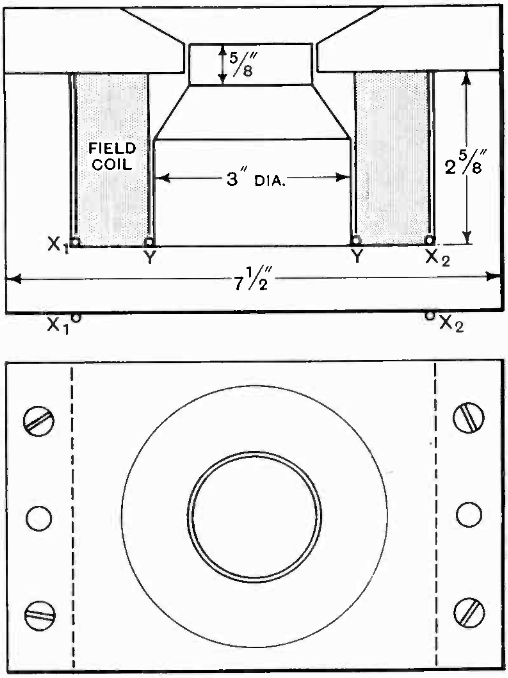


Fig. 5.—*Diagrammatic views of test magnet No. 2.*

mean path consists of $P_1P_2P_3P_4$ and $P_5P_6P_3$ P_7 in parallel as shown in Fig. 1, is negligible.

Measurements made on the magnet of Fig. 1 indicated that the percentage magnetic leakage was approximately the same whatever the flux density, and it was of the same order of magnitude as that obtained from measurements on circular or pot magnets.

3. Experimental Data for Magnet No. 2

The next magnet tested had the dimensions shown in Fig. 5 and its flux density/ampere turns curve is plotted in Fig. 6. For a given number of ampere-turns the mean flux density in the gap just exceeds that obtained with the larger magnet of Fig. 1. This is due to the upper end of the centre pole in the magnet of Fig. 5 being shorter than that of Fig. 1, thereby entailing a reduction in reluctance in the former case. When l, the radial gap length in the magnet of Fig. 5, was reduced slightly (about 5%), the mean flux density was 17,000 lines per square centimetre for 3,400 ampere-turns. The total gap flux was therefore 15.6 × 17,000 = 265,000 lines and the watts lost in the magnetising coil amounted to 55. The flux would, of course, be less after the coil got heated up. The foregoing is satisfactory for working off D.C. mains, but with the type of metal rectifier employed the loss should be reduced to about 35 watts, which gives a flux density of the order 15,000 lines per square centimetre, i.e., a total of 234,000 lines in the gap.

4. Leakage Tests

A series of tests of leakage flux were made on magnet No. 2 of Fig. 5. It was found (1) that the total flux through the base of the centre pin was approximately double that in the air gap: (2) from the base of the centre pin to the bottom end of the 2 inch portion, 25.3 per cent. of flux leaked to the upper plate and to the side limbs: (3) from the ¼ inch of the pin below the gap, 11.7 per

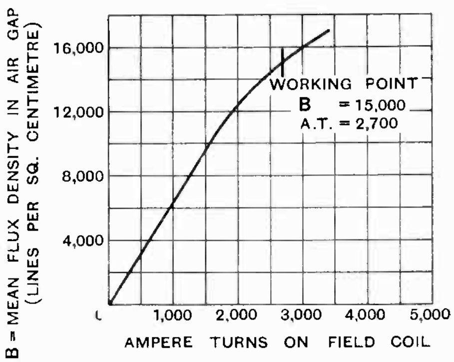


Fig. 6.—*Performance curve for magnet of Fig. 5.*

cent. of flux leaked to the upper plate: (4) outside the upper end of the pin the total leakage to the upper plate was 13 per cent. These three latter items add up to 50 per cent., this being the total leakage of the magnet.

Search coils were wound round the magnet at X_1X_1, X_2X_2 and YY. The two coils at X_1X_1 and X_2X_2 were joined in series and connected in opposition to YY. On reversing the current in the main field coil and taking fluxmeter readings, it was found that practically the whole of the flux passing X_1X_1 and X_2X_2 entered the base of the pin. The flux at X_2X_2 was, however, less than that at X_1X_1 by approximately 5 per cent., which indicated that there was a slight non-uniformity in the magnetic circuit.

5. Experimental Data for Magnet No. 3

In the next experimental magnet shown diagrammatically in Fig. 7 the centre pin is tapered throughout most of its length, and a conical portion is removed from the free end of the pin. The latter removal was for the purpose of determining its influence on the external leakage at the upper end of the

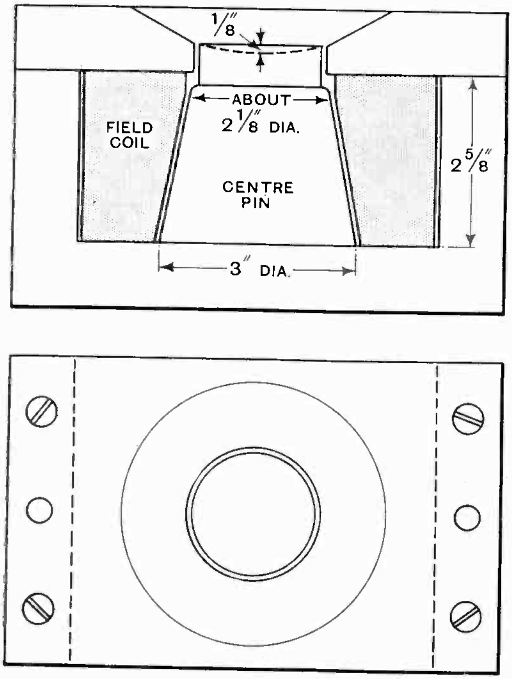


Fig. 7.—*Diagrammatic views of test magnet No. 3.*

centre pole. The field coil for this magnet was tapered inside to fit the magnet, thereby obtaining more turns for given external dimensions than in the case of Fig. 5. The flux density/ampere-turns curve is plotted in Fig. 8. Up to the normal working point of the metal rectifier, there is little difference between the air-gap flux density of this magnet and that of Fig. 5, the ampere-turns on the field coils being about the same in each case. The influence of the conical indentation at the top of the centre pole is to decrease the external leakage, but to

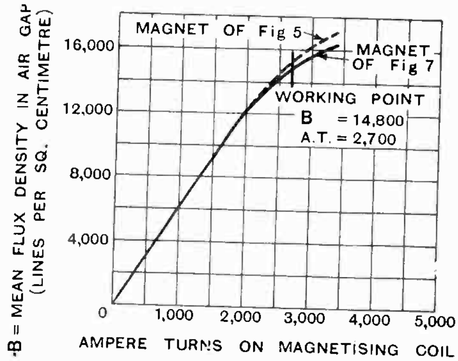


Fig. 8.—*Performance curve for magnet of Fig. 7.*

increase the internal leakage from the 2 inch portion of the centre pin. It also causes a reduction in the gap flux at 3,400 ampere-turns. The leakage figures are respectively 8.5 per cent. and 18.8 per cent., compared with 13 per cent. and 11.7 per cent. for the magnet of Fig. 5.

The length of the air gap used in the above magnets is in the neighbourhood of 2 millimetres or about 80 mils. This length was chosen to allow for (1) the coil formers taking a slightly oval form due to frequent heating and cooling. (2) the possibility of slight non-axial motion of the coil during operation. In other words, a gap of 75 to 80 mils can be regarded as a commercial proposition for a speaker handling large power at low frequencies, where the amplitude is relatively great. By using special coil formers a gap of 65 mils is permissible, provided the coil moves truly axially and remains circular. The flux density with the reduced gap exceeds that with the 80 mil gap, but the difference is of little practical importance.

Audio-Frequency Transformers

By E. T. Wrathall, A.C.G.I., A.M.I.E.E.

(Continued from page 298 of the last issue)

6. Design

At the mean frequency to be transmitted by an A.F. transformer (say 1 000 p.p.s.) the shunt and series loss should be made about equal; the reason for this is as follows. In a practical case of design it will be found that over a large part of the transformer response curve the loss has a minimum value and is almost constant, the loss being determined mainly by the resistance of the windings; this is illustrated in Fig. 16. By making the shunt and series losses equal at some mean frequency, the resistance loss is limited to some conveniently small value thus giving high efficiency over the major part of the characteristic, and it will be found that it is then possible to make the response curve fairly well balanced at each end where the loss begins to increase. It is proposed therefore to give dimensions of cores and spools which enable this to be obtained; then to indicate what range of frequencies may be covered by the use of various types of core, and describe various types of windings and shielding.

Cores: Types and Proportions.

Although there are many varieties and shapes of laminations, only three kinds need be considered here; these are shown in

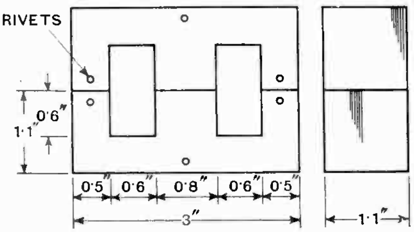


Fig. 10.—*Shell type core, built up from 0.012in. Stalloy laminations, the two halves held by clamps.*

Figs. 10, 11, and 12. The core assemblies of Figs. 10 and 11 are for "shell" type transformers, and that of Fig. 12 is for a "core" type; the latter is more usually called a toroidal type. All the above cores are in most cases suitable for a range of frequencies from 100 p.p.s. to 5 000 p.p.s. if the core material is Stalloy; if nickel steel or other high permeability material is used

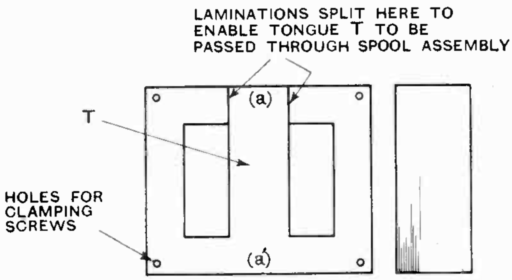


Fig. 11.—*Shell type core, built up from 0.012in. Stalloy laminations, the tongue T being placed alternately to (a) and (a′).*

the frequency range may be extended so that level characteristics from 30 p.p.s. up to 15 000 p.p.s and even higher may be obtained: it is not possible to generalise with any accuracy in this connection because other factors such as type of winding and magnitude of terminating impedances have a direct bearing on the characteristic which can be obtained from a given core.

In order to make the treatment of design as short as possible it will be best to consider only one type of core and winding assembly in detail, and then show how variations of that type, or other types, may profitably be employed. The type of core chosen is that of Fig. 10, using Stalloy; this will be considered with a winding assembly like that shown in Fig. 13 (c) but with only two sections. The core of Fig. 11 is slightly better magnetically than that of Fig. 10; however, if the butt joint in the core of Fig. 10 is carefully made, there is little to choose between the two. The advantage of the core shown in Fig. 11 is, that by placing the tongues alternately at opposite ends of the assembly, the reluctance of the iron circuit is reduced to a minimum in the simplest possible manner: this method of assembly takes longer than that of Fig. 10, and has the disadvantage that the core cannot be slipped in and out of the winding when the transformer is being tested and adjusted, and the reluctance of the core cannot be adjusted by means of spacers as is required sometimes.

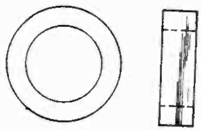


Fig. 12.—*Toroidal type of core.*

Windings.

From the points of view of mechanical strength, insulation, ease of handling, and uniformity of product, it is best to apply shell type windings on a former. Alternatively, separate "pancake" windings may be used. Pancake construction has the advantage that a defective winding may be replaced fairly easily, and the winding self-capacitance will be low; but the windings are more expensive and are not so robust.

Figs. 13 (a), (b) and (c) show the most general constructional variations of a shell type winding assembly for cores such as those of Figs. 10 and 11. The spool may either be a bakelite moulding or be built up from fibre stampings; the type depends on the quantity of transformers to be made. Fig. 13 (a) shows an ordinary shell type winding with a system of complete shielding which reduces the inter-winding and winding to case capacitances to something under 5 $\mu\mu$F; if the end shields are omitted the inter-winding capacitance is of the order of 15 $\mu\mu$F. Shielding is required only in special cases in the ordinary A.F. transformer, but is used much more in carrier frequency transformers. Fig. 13 (b) shows a sandwiched winding assembly, which greatly reduces the leakage factor. Fig. 13 (c) shows an ordinary winding, but sectionalised to reduce the winding self-capacitance; this capacitance for a two section spool is about 60 $\mu\mu$F: for a four section spool the value is about 30 $\mu\mu$F.

With regard to the type of wire used for the windings, it is suggested that enamelled wire be used wherever possible so as to utilise the winding space most economically. A good quality enamelled wire will give every satisfaction. For windings using large gauge wire, and often for toroidal windings, enamelled wire with a single or double silk or cotton covering should be used as more handling is necessary.

As the diagrams show clearly the methods of construction, it is necessary only to summarise the relative merits of shell and toroidal types of transformers; this is done in the following table:—

Relative Merits of Shell and Toroidal Types of Windings

Detail.	Shell Type.	Toroidal Type.
Winding Process.	Requires only a simple machine and windings can be applied quickly; some machines will handle several windings simultaneously.	Requires a special machine; winding process takes longer and only one winding can be done at a time: hence more expensive than shell type.
Winding self-capacitance.		Greater than shell type unless windings carefully sectionalised.
Inter-winding, etc., capacitances		Normally greater than shell type, but can be reduced almost to zero (actually about 2 $\mu\mu$F) by suitable shielding.
Leakage Factor.		Less than shell type for a given method of winding and type of core.
Adjustment of winding to meet special tests.	Very awkward to accomplish, for usually cores have to be removed.	Easily done because the winding completely encloses the core.
Cross-talk.		Ordinarily less than shell type.
Adjustment of Magnetic Circuit.	With a butt joint core, the condition of the magnetic circuit can easily be adjusted to meet special requirements.	Adjustment too awkward to be considered practical except in special cases.

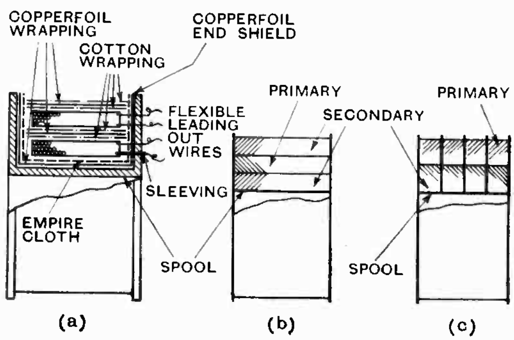


Fig. 13.—*Winding assemblies for shell type transformer. All copper foils soldered to common shield wire.*

Finishing Processes. (Impregnation, Assembly in Cases, and Filling in with compound.)

It is highly desirable that the completed winding assembly should be vacuum impregnated with a suitable bakelite varnish or resinous compound, in order to make the winding impervious to climatic conditions. The complete assembly of core and winding should then be mounted in a suitable iron case for the purposes of mechanical protection, electrical and magnetic screening, to facilitate mounting on a panel, and to give a good appearance. The case should have an earth terminal. It is suggested that the terminal plates should be suitably engraved to indicate clearly the high and low windings, the frequency range, and proper terminating impedances; alternatively, if the terminals are numbered, a transfer diagram may be applied to the case.

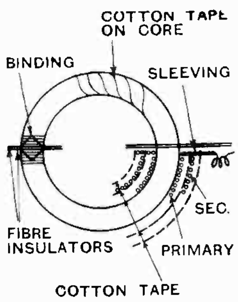


Fig. 14.—*Toroidal winding assembly.*

In some places it has been the practice to fill the cases with a bituminous compound, but it is suggested that except in special cases this is unnecessary.

There is an alternative process to impregnation when it is required to keep the winding self-capacitance to a minimum; the process consists of thoroughly drying the winding assembly and dipping it for a few seconds in a melted bituminous compound: this seals the winding and makes it moisture proof but the compound does not penetrate the winding. This process is especially suitable for carrier frequency transformers.

Methods of Design.

The simplest possible case is one in which the effect of the winding self-capacitance is negligible, where there is no direct current in the windings, where the levels do not cause any amplitude distortion, and where data obtained from measurements at about 900 p.p.s. can be taken to apply over the whole range of frequencies for which the transformer will be used. Such a case is that of a repeating coil (a usual name for a line transformer) to couple two lines, one of 1 800 ohms resistance and the other of 600 ohms resistance as shown in Fig. 15 (a). Let the required characteristic be such that the loss at, and between 100 p.p.s. and 3 500 p.p.s is not greater than 2 db. Fig. 15 (b) gives the equivalent circuit of the equivalent unity ratio transformer. At *low* frequencies Z_{sh} which equals ωL_p (neglecting resistance) becomes small, so the loss in the shunt path becomes large; also, as ωl is small the series impedance $(R + j\omega l)$ is determined by R; R is the combined D.C. resistance of the windings referred to the high side in this case. At *high* frequencies, the magnitude of Z_{sh} becomes so large that the shunt loss becomes negligible; but ωl the leakage reactance becomes large, hence the series loss increases. The effects of these changes on the loss-frequency characteristic are shown in Fig. 16.

The method of design will be to consider a low frequency and find a value of Z_{sh} which will give the required loss, and at that frequency check that the resistance loss due to R is correct; then, at the high frequency end ascertain that the loss caused by the leakage reactance comes within the required limits.

Except in very unusual cases, amplitude distortion is unlikely to occur in any transformer working in a Class A stage because

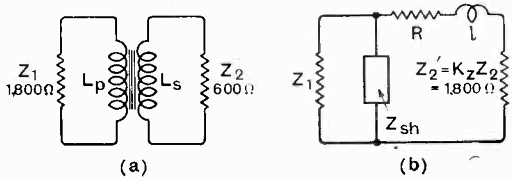


Fig. 15.—*Equivalent unity ratio circuit in connection with design of repeating coil.*

ordinarily the condition of the iron is so far removed from saturation point. Any variation of inductance with applied voltage will cause a very small degree of amplitude distortion because of changes in Z_{sh} of the equivalent circuit, but as in the working range of the transformer Z_{sh} is designed so that the shunt loss shall be small, it will be seen that amplitude distortion is a second order effect. As a matter of interest a curve showing the variation of inductance of a

1 000 turn winding on the core of Fig. 10 will be given in Fig. 32.

Phase distortion, that is, change of phase of harmonics with respect to the fundamental, is usually unimportant; if in special cases this has to be considered, the problem may be approached along similar lines to those adopted in Section 4 in which the effect of a transformer in degrading the impedance of a circuit was worked out. The circuit would be analysed in a similar manner to that illustrated in Figs. 4 (a), (b), (c) and (d), and vector diagrams would probably be the quickest way of finding the relative phases of the fundamental and harmonic voltages.

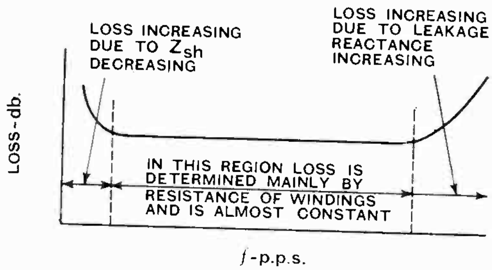


Fig. 16.—*Illustration of causes mainly affecting shape of transformer loss curve.*

Transformer Data.

Inductance of winding of 1 000 turns is 1.3 H measured at 900 p.p.s.; p.d. = 3 volts.

This is often referred to as the inductance per 1 000 turns which tends to indicate that the inductance is proportional to the number of turns; there should be no misunderstanding, though, if always the inductance is taken as proportional to the square of the turns.

Total Winding Area: 0.43 sq. ins.

Leakage as % $\sqrt{K_z}M$.—1.8 for ordinary winding. 0.85 for sandwiched winding. By expressing the leakage in the form % $\sqrt{K_z}M$ is meant: the inductance of a winding measured with the other winding short-circuited expressed as a percentage of the inductance value when the other winding is open.

Length of Mean Turn.—Inner winding, 4.5 inches. Outer winding, 6.3 inches.

Self-capacitance of Secondary Winding.—Two section spool 60 $\mu\mu$F; four section spool, 30 $\mu\mu$F; for ordinary and sandwiched windings.

At 100 *p.p.s.*—The loss must not exceed 2 db. of which 1 db. will be allowed for the series arm R (ωl being negligible) and 1 db. for the shunt arm Z_{sh} of Fig. 15 (b).

Value of L_p.

It is required to find a value of Z_{sh} which will give the above loss. K. S. Johnson in his book *Telephone Transmission Circuits*, gives an exceedingly useful family of curves (Fig. 5 of Chapter IX) which enables the transmission loss of any shunt or series impedance to be found very easily; some of the curves are reproduced in Fig. 17. As the loss due to Z_{sh} is a shunt loss, it is necessary to find the value of $\left|\frac{Z_{sh}}{Z_1} + \frac{Z_{sh}}{Z_2}\right|$, using the nomenclature of the diagram. In the equivalent unity ratio circuit of Fig. 15 (b), $Z_1 = Z_2'$ hence

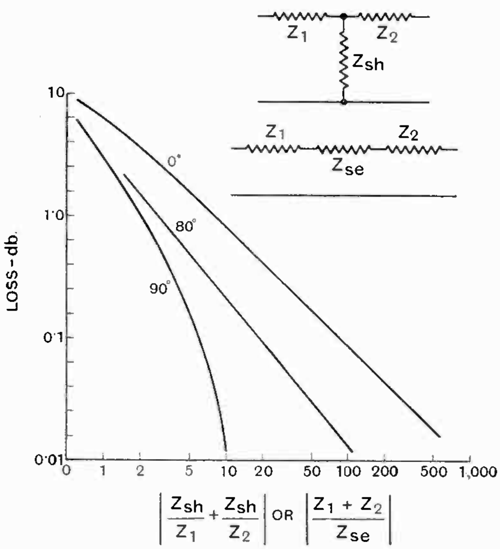


Fig. 17.—*Curves showing loss caused by inserting a shunt impedance Z_{sh} or series impedance Z_{se}, between two impedances Z_1 and Z_2.*

$$\left|\frac{Z_{sh}}{Z_1} + \frac{Z_{sh}}{Z_2}\right| = 2\frac{Z_{sh}}{Z_1}$$

The value of Q for this type of core and winding assembly is 4.5. Fig. 18 shows how Q varies with frequency. Hence the phase angle of Z_{sh} is $\tan^{-1} 4.5$ which is approximately 78°, since the phase angles of Z_1 and Z_2 are 0°. Now, taking the nearest

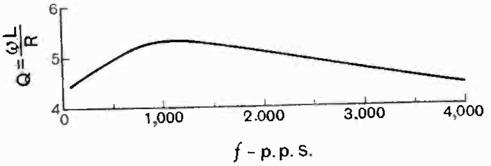


Fig. 18.—*Variation of Q with frequency for winding on core shown in Fig. 10.*

curve, namely that for 80°, against a loss of 1 db.,

$$\left|\frac{Z_{sh}}{Z_1} + \frac{Z_{sh}}{Z_2}\right| \text{ can be read off as } 2.7,$$

$$\text{hence } 2\left|\frac{Z_{sh}}{Z_1}\right| = 2.7 \text{ and } Z_1 = 1\,800 \text{ ohms,}$$

$$\text{hence } Z_{sh} = \frac{2.7 \times 1\,800}{2} = 2\,430 \text{ ohms.}$$

The reactance of $Z_{sh} = 2\,430 \sin 78°$
$= 2\,380$ ohms $= \omega L_p$

$$\therefore L_p = \frac{2\,380}{2\pi \times 100} = 3.78\ H.$$

From the data given, the number of turns required can be found as follows :—

$$\text{Primary turns } T_p = 1\,000\sqrt{\frac{3.78}{1.3}} = 1\,700.$$

As 3.78 H is the minimum value of inductance for a shunt loss of 1 db. it is advisable to increase the number of turns slightly. A 3 % increase makes $T_p = 1\,750$ and $L_p = 4.01\ H$ (L_p increases 6 per cent.). Subsequently when specifying tests for the transformer, L_p may safely be stipulated to be not less than the mean value of 3.78 H and 4.01 H, namely 3.9 H.

Choice of Wire.

The wire for the primary winding can now be chosen. A point to be borne in mind is, that the ratio of D.C. resistance of the primary and secondary windings should approximately equal the impedance ratio. This can be very easily achieved for sandwiched windings and with a little more trouble for ordinary windings too, but in the latter case the importance of the point does not justify the extra work. For sandwiched windings in which the length of mean turn of primary and secondary windings are equal, it can be shown that the above condition holds if the winding areas are made equal. Analysis gives the following formulae for the primary winding area A_p and the secondary winding area A_s, in terms of the total winding area A.

$$A_p = \frac{A}{\frac{1}{\phi} + 1}$$

$$A_s = A - A_p$$

ϕ is a function of the ratios of wire diameter to overall diameter of the primary and secondary windings and approximately equals unity.

For commercially wound coils it is safe to assume that the space required per turn is a square of side equal to the overall diameter of the wire as shown in Fig. 19; on this basis :—

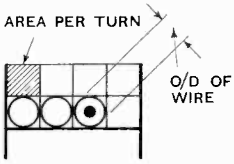


Fig. 19.—*Illustration of space allowed per turn of winding.*

$$\text{Primary winding area} = \frac{0.43}{2} = 0.215 \text{ sq. in.}$$

$$\text{Area per turn (primary)} = \frac{0.215}{1\,750} = 0.0001229 \text{ sq. in.}$$

$$\therefore \text{Outside diameter of wire} = \sqrt{0.0001229} = 0.0111 \text{ in.}$$

Therefore 33 S.W.G. enamelled wire is suitable.

The number of secondary turns T_s can be found as follows :—

$$\text{impedance ratio} = (\text{turns ratio})^2$$

$$\therefore \text{turns ratio} = \sqrt{\frac{1\,800}{600}} = 1.731$$

$$T_s = \frac{1\,750}{1.731} = 1\,011$$

Hence area per turn (secondary)

$$= \frac{0.215}{1\,011} = 0.0002124 \text{ sq. in.}$$

$\therefore$ o/d of wire $= \sqrt{0.0002124} = 0.0146$ in. so 30 S.W.G. enamelled wire will be suitable.

Primary Winding Resistance R_p.

The primary will be made the inner winding.

$R_p = T_p \times$ length of mean turn $\times$ resistance per inch

$$= 1\,750 \times 4.5 \times \frac{0.1035}{12} = 68 \text{ ohms}$$

Secondary Winding Resistance R_s.

$$R_s = 1\,011 \times 6.3 \times \frac{0.06734}{12} = 35.7 \text{ ohms.}$$

The resistance of the secondary winding referred to the high side R'_s is given by

$$R'_s = R_s \times K_z = 35.7 \times 3 = 107.1 \text{ ohms.}$$

Now R of Fig. 15 (b) $= R_p + R'_s$
$= 68 + 107$
$= 175$ ohms.

Series Loss due to $(R + j\omega l)$

At 100 p.p.s. $j\omega l$ is negligible, but it is desirable to demonstrate this.

Leakage inductance $l = 1.8$ per cent. L_p
$= 0.018 \times 4.01$
$= 0.0722\ H$

Leakage reactance $\omega l = 2\pi \times 100 \times 0.0722 = 45.4$ ohms.

Hence the series impedance $(R + j\omega l)$

$$= 181 \left| \tan^{-1} \frac{45.4}{175} \right. = 181 \,|\, 14.5^\circ$$

From the above figures the series loss can be obtained from the curves of Fig. 17 in which Z_{se} is $R + j\omega l$.

Since in the equivalent unity ratio case $Z_1 = Z'_2$

$$\frac{Z_1 + Z_2}{Z_{se}} = \frac{2Z_1}{Z_{se}} = \frac{3\,600}{181} = 19.9.$$

The phase angle is 14.5°.

From $\frac{Z_1 + Z_2}{Z_{se}} = 19.9$ and $\phi = 14.5^\circ$, the series loss can be read off from the curve as 0.4 db.

The curves show that the reactance has hardly any effect at 100 p.p.s. and the series loss could have been obtained sufficiently accurately had the reactance ωl been neglected. Taking the resistance R only,

$$\frac{Z_1 + Z_2}{Z_{se}} = \frac{3\,600}{175} = 20.6 \text{ and } \phi = 0^\circ$$

for these values the curves indicate a loss of 0.415 db.

The total loss at 100 p.p.s. is therefore 1.4 db.; 1.0 db. shunt loss and 0.4 db. series loss: this comes within the specification.

It might be argued that as the series and shunt arms have been considered separately this would introduce appreciable error; but it can be shown by analysis and experiment that this is not so. Considering the two arms separately greatly facilitates the work, and the method is fully justified by results.

Loss at 3 500 p.p.s.

It is necessary to ensure that the loss at 3 500 p.p.s. comes within the specification.

Shunt Loss due to Z_{sh}.

At 3 500 p.p.s. Q of the primary winding is 4.5 (see Diagram 18) hence ϕ is 78°

$$\omega \,.\, L_p = 2\pi \times 3\,500 \times 4.01 = 88\,000 \text{ ohms}$$

$$\therefore |Z_{sh}| = \frac{88\,000}{\sin 78^\circ} = 88\,100 \text{ ohms}$$

$$\therefore Z_{sh} = 88\,100 \,|\, 78^\circ$$

$$\left| \frac{Z_{sh}}{Z_1} + \frac{Z_{sh}}{Z_2} \right| = 2 \left| \frac{Z_{sh}}{Z_1} \right| = \frac{2 \times 88\,100}{1\,800} = 978.$$

Diagram 17 shows that for $\left| \frac{Z_{sh}}{Z_1} + \frac{Z_{sh}}{Z_2} \right| = 978$ and $\phi = 78^\circ$, the shunt loss is practically zero and is quite negligible.

Series Loss due to $R + j\omega l$.

$\omega l = 2\pi \times 3\,500 \times 0.0722 = 1\,586$ ohms.

The phase angle of $R + j\omega l$ is

$$\tan^{-1} \frac{1\,586}{175} = 84^\circ \text{ approximately,}$$

hence $R + j\omega l = 1\,600 \,|\, 84^\circ$.

In this case

$$\frac{Z_1 + Z_2}{Z_{se}} = 2\frac{Z_1}{Z_{se}} = \frac{2 \times 1\,800}{1\,600} = 2.25$$

and $\phi = 84^\circ$

for these values Fig. 17 gives the loss as

1.2 db.; hence the loss at 3 500 p.p.s. is within the specified limit.

If desired, the loss at intermediate frequencies could be determined by the same methods, but it would be found that in all cases the loss would be less than the two figures which have been worked out. Only in special cases would it be necessary to calculate the loss at a sufficient number of intermediate frequencies to enable a complete response curve to be plotted.

Design Summary.

Number of primary turns T_p = 1 750.

Number of secondary turns T_s = 1 011.

Wire for primary, 33 S.W.G. enamelled copper.

Wire for secondary, 30 S.W.G. enamelled copper.

D.C. resistance primary = 68 ohms.

D.C. resistance secondary = 35.7 ohms.

Total loss at 100 p.p.s. = 1.4 db.

Total loss at 3 500 p.p.s. = 1.2 db.

Impedance ratio, 1 800 ohms to 600 ohms.

Primary inductance, 4.01 *H*.

(*To be concluded.*)

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

Distortion in Negative Feedback Amplifiers

To the Editor, The Wireless Engineer

SIR,—In the May issue of *The Wireless Engineer* there appeared on page 259 some lines from Mr. R. W. Sloane about negative feedback, from which it would seem that by negative feedback only the second harmonic is reduced with certainty, whilst the third, etc., may or may not be reduced.

I would point out, that Mr. Sloane treats only the terms of the Taylor series of an amplifier without and with negative feedback, whilst distortion is measured with the terms of Fourier series. Now there exists a narrow relation between the corresponding terms of these two kinds of series, but the higher terms of one contain corrections with respect to those of the other.

The diminution of the terms of the Fourier series of an amplifier by introduction of negative feedback will be treated exactly in next issue of the technical-scientific communications of the Tungsram Laboratories from where it will be seen, that every harmonic, the number of order of which is a prime number (the 2nd, 3rd, 5th, etc.) diminish exactly in the proportion of $1 + \frac{dE}{dv}\beta$ (if we do not take account of the phase distortion, which exists in every amplifier; in taking account of these the sum must be regarded as a vectorial sum). The harmonics with composed number of order (the 4th, 6th, etc.) diminish in somewhat different proportion, but this difference may easily be computed for any real amplifier and will be found to be minimal.

If we compare this result with Mr. Sloane's, we remark that for the second harmonic there is no difference $\left(\text{except the evident misprint} — \frac{d^2E}{dv^2}\right.$ instead of $\left.\frac{dE}{dv}\right)$. If we now consider the two figures which are to be divided with one another according to Mr. Sloane to get the diminution of the 3rd harmonic we remark that omitting the second part of the first figure we get the same quotation as above, i.e., the exact term, so that for the second part undoubtedly difference between Taylor's and Fourier's series is responsible.

JOSEPH FROMMER,
(Research Laboratory, Tungsram Works).
Ujpest, 4,
Nr. Budapest, Hungary.

The Invention of the Telephone

To the Editor, The Wireless Engineer.

SIR,—As one who has made a special study of the early history of the telephone, I read with interest your Editorial in the April edition of *The Wireless Engineer* on the invention of the telephone. Thompson's book seems to have a very limited circulation in this country, and my first knowledge of it came as an incident of my studies at Cambridge University last year.

I think that I was in a position to read Thompson's treatment with discrimination, and I confess that I am unable to follow completely your interpretation of it. Especially from the point which you stress the most, the question whether the contact between the platinum points was of the variable resistance or of the make-and-break variety, with your conclusion in favour of the latter, I would respectfully dissent.

Not, however, that I would support the variable-resistance theory. The fact is that even to-day not enough is known about the action of microphonic loose contacts to classify them in either of the two categories, and certainly any classification of the kind, Reis's among others, was premature seventy years ago. The point of importance is not what he thought he had, but what he really had. That was clearly a microphonic contact, the prototype, however crude, of the modern microphone of the usual type. To try to classify it as either a make-and-break or as a variable resistance seems to me to be quite an irrelevant quibble.

I sometimes think that one should distinguish between invention and scientific discovery. In his error of interpretation Reis showed that he did not comprehend the principle of his device and hence cannot be credited with a scientific discovery. But in invention, at least as interpreted by American patent practice, comprehension is not a necessary element. If Reis devised something that worked in principle, requiring only refinement in detail, as Thompson's work strongly indicates that he had (and Thompson's competence in this field can scarcely be challenged), then he is entitled to acknowledgment of priority in conception and use of the device.

I commend the discrimination in your last paragraph crediting Bell only with the "electro-magnetic telephone transmitter." It is well known, but frequently forgotten under the spell of the implications in the official version of the telephone story, that Bell has no valid claim to either the variable-resistance or the microphonic type of transmitter.

Please accept the compliments of an American friend on the occasion of the Coronation. I am sorry that my very pleasant year in England could not have been extended to include that happy occasion.

L. W. Taylor
Oberlin College, (Professor of Physics).
Ohio.

[With reference to S. P. Thompson's competence in this field we are not alone in thinking that in his enthusiastic and justifiable sympathy for Reis he allowed his heart to run away with his head. In his biography (p. 113) his wife and daughter record that "many thought that Thompson had estimated too highly the work of Reis as a pioneer of telephony." We confess that we began our researches into the subject with a vague idea that Reis had been shabbily treated by posterity, but we failed to discover any real grounds for this idea, and the more we studied Thompson's book, the less were we impressed by his special pleading.

Whatever American patent practice may be we doubt if a man is "entitled to acknowledgment of priority in conception" of something which never entered into his head.—G. W. O. H.]

Bridge for Direct Impedance Measurement.

To the Editor, The Wireless Engineer.

Sir,—I read your Editorial in the May issue of *The Wireless Engineer* with considerable interest, as I was quite unaware that the principles incorporated in the bridges described by me had previously been published.

It seems that this is a minor example of different people thinking of the same thing at about the same time, as actually I first worked out the circuits about the end of 1929, although I did not then elaborate them as at that time the bridges had no application to the work on which I was engaged.

It would appear that neither the Dawes and Hoover bridge nor the Laurent-Ericsson bridge is very well known in this country, as before submitting a description of my bridges to you for publication I had submitted it to two well-known firms manufacturing measuring equipment and one of these had in turn shown it to an important research organisation; in their comments none of these organisations made any suggestion that they had previously come across any such bridge.

London, N.4. A. Serner.

Audio-Frequency Transformers

To the Editor, The Wireless Engineer.

Sir,—In reading over the first instalment of my article on Audio-Frequency Transformers in the June issue of *The Wireless Engineer*, I have found an error as given below.

On page 294, in equation (1) $C_c = Z_m$ should read $Z_c = Z_m$.

I think the error is unlikely to confuse the readers, as it is so obvious, but I tender my regrets for not having noticed it in the proofs.

Little Baddow, E. T. Wrathall.
Essex.

Book Reviews

The Low Voltage Cathode-Ray Tube

By G. Parr. Pp. X + 177; 76 Figs. Chapman and Hall, Ltd., 11, Henrietta Street, London, W.C.2. Price 10s. 6d.

The author is a member of the radio division of the Edison Swan Electric Co. and is therefore closely associated with the commercial development of the cathode-ray tube. The scope of the book will be seen from the chapter headings :—Construction and operation, focusing and performance, Lissajou's figures, linear time bases, other time bases, applications to radio engineering, industrial and other applications, television reproduction, photography. Not the least valuable feature of the book is a very full and classified bibliography, occupying nearly twenty pages—a veritable mine of information. The book is written in a clear straightforward manner, the type and diagrams are very good, and there is just enough mathematics and no more. The book can be recommended to any student of electrical engineering, or indeed to anyone contemplating the application for the first time of a cathode-ray tube to any branch of research.

In enumerating the methods of concentrating the beam the author says (1) by a magnetic field *surrounding* the tube. Surely "surrounding" is the wrong word here; and again a few pages further on "the usual method of deflection by magnetic fields is to fasten a pair of coils *round* the neck of the tube." I wonder if the author would say that a lady wore a pair of earrings round her neck. In Fig. 6 there is an obvious error in the ordinate scale and in discussing the curves on p. 7 an obvious omission of the time taken for the glow to fall to

20 per cent. of its initial value. On p. 14 no reason is given for the statement that "if the accelerator potential is sufficiently high, there is no diminution of sensitivity to zero." The author is not very happy in explaining electrostatic focusing by means of what he calls a "high potential" field; we are told that "the two components of the velocity will be v_x normal to the surface of the electrodes and v_y at right angles to them." On p. 33 "the electrons emitted from the source O normally diverge until they reach the region of curved equipotential lines, where they travel inwards in a direction normal to the curve at the point of intersection"; this is not very clear. On p. 102 is a reference to a Plate IV, Fig. 55; seeing that this fig. occurs on p. 84 between Figs. 46 and 47, a reference to the page would have been helpful. On p. 131 we are told that "the majority of modern television tubes are of 12in. to 15in. diameter, giving pictures of approximately 16 × 12cm., which are adequate for domestic viewing." "Adequate" is an elastic term but it is as well to be satisfied with it if it is all that you can get. It was a brain-wave to turn it into centimetres.

G. W. O. H.

Fundamentals of Vacuum Tubes

By AUSTIN V. EASTMAN, M.S. P. 438 + XV. Published by McGraw-Hill Publishing Co., Ltd., Aldwych House, London, W.C.2. Price 24s.

In the words of the author, this book deals with the laws governing the application of the vacuum tube. It begins with an introductory chapter in which the various types of valve are briefly described and then follows a chapter on electronic emission.

After this preliminary material a long chapter on diodes comes and in it are treated not only the familiar high-vacuum types but also low-voltage rectifiers of the Tungar type, mercury-vapour rectifiers, cold-cathode rectifiers, and mercury-arc rectifiers. The discussion is chiefly confined to high-voltage circuits and 3–, 6–, and 12–phase rectifiers are dealt with in addition to the single-phase types.

Five chapters are devoted to triodes, and in the first of these Class A amplification is dealt with. The derivation of valve constants and the applications of the valves are treated. The next chapter covers gas-filled triodes and the succeeding chapters deal with Class B and C amplification, oscillators, and modulation and demodulation, this last term being used in the American sense of detection. The book concludes with chapters on multi-element tubes, photosensitive cells, and special types of tube.

The ground covered is very large and it is consequently only to be expected that the author should not go very deeply into his subject. In some cases, however, it might have been made clearer that the treatment is not exhaustive and that in practice there are often modifying factors which must be taken into account. A notable example occurs in connection with the linear diode detector, for no mention is made of the importance of maintaining the impedance of the load circuit at as nearly the same value as possible to both D.C. and modulation frequencies. Serious distortion can occur if the impedance at modulation frequency is much lower than the D.C. resistance.

The student should bear in mind, therefore, that the treatment is simplified in many cases and only the major effects are mentioned. Errors are few, but it is surprising to read on page 16 that "secondary emission is seldom made use of now to secure the removal of electrons for useful purposes." Secondary emission is, in fact, becoming increasingly important and is the basis of the secondary-emission multiplier and certain types of photo-cell.

Another rather doubtful statement appears on page 113 where the author says "At this point it is well to note that the static characteristic curves of a vacuum tube accurately portray the *instantaneous* action of the tube under *any* conditions whatsoever, since there is no appreciable lag in the action of the tube at any frequency up to several hundred million;" the italics are his. It is now generally known that at frequencies greater than some 20 Mc/s the time taken by an electron to pass through the electrode system is not negligible. The effect depends largely upon the dimensions of the valve and is the real reason for the use of "Acorn" types at ultra-high frequencies, not the low inter-electrode capacities as stated on page 196, although this is also an advantage. The electron transit time has a very important effect on the performance of a valve, since it can reduce the effective input resistance from megohms at a few megacycles to 5,000 ohms or so at 60 Mc/s.

The superheterodyne is not adequately dealt with in view of its importance in present day receiver design, especially as this type of receiver is much more complicated than it looks.

In spite of these deficiencies, the book covers a wide ground and gives a good general view of the subject. It is not highly mathematical. In view of the stress laid upon high-power rectifiers, amplifiers and oscillators, it is likely to be of more interest to the transmitting than the receiving engineer.

W. T. C.

The Lead Storage Battery.

By H. G. Brown. Pp. 202 and 101 Figs. The Locomotive Publishing Co., Ltd., 3, Amen Corner, London, E.C.4. Price, 5s.

That this is the third edition shows that the book meets a need. To judge from the contents, it is a publication of the D.P. Battery Co., and no attempt is made to disguise the fact. The theory and construction of the lead cell is described very clearly, characteristic charge and discharge curves are given and discussed, the installation, maintenance and testing of stationary batteries are fully explained. Various types of boosters and regulating switches are described. Special attention is devoted to portable cells and their application to traction work. The final chapter deals with emergency lighting equipment. There is a useful summary of instructions for testing water and acid for battery purposes. The book can be recommended to any one interested in storage batteries, although, as its title indicates, it is concerned only with the lead cell.

G. W. O. H.

Abstracts and References

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For the information of new readers it is pointed out that the length of an abstract is generally no indication of the importance of the work concerned. An important paper in English, in a journal likely to be readily accessible, may be dealt with by a square-bracketed addition to the title, while a paper of similar importance in German or Russian may be given a long abstract. In addition to these factors of difficulty of language and accessibility, the nature of the work has, of course, a great influence on the useful length of its abstract.

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PROPAGATION OF WAVES

2437. On Some Effects caused in the Ionosphere by Electric Waves: Part I, *and* Resonance in the Interaction of Radio Waves [Observational Results].—V. A. Bailey. (*Phil. Mag.*, May 1937, Series 7, Vol. 23, No. 157, pp. 929–960: *Nature*, 15th May 1937, Vol. 139, pp. 838–839.)

The theoretical work underlying the conclusions referred to in 840 of March is given in the first paper.

2438. "A Peculiar Phenomenon" [10-Metre Stations received (at Distances 1500–2000 km and over) when listening on 20-Metre Band: Suggested Propagation Phenomenon].—P. L. Bargellini. (*QST*, May 1937, Vol. 21, No. 5, p. 66.)

A letter from Italy. The first obvious assumption is that this sub-harmonic type of reception is due to some radiation from multiplier stages, preceding the final amplifier, reaching the aerial system. "There are, however, the following [three] points making this assumption a wrong or at least an objectionable one. . . ." An Editorial note remarks that this effect has been noticed elsewhere and has hitherto been attributed to radiation from a doubler-final.

2439. "External Cross Modulation" [due to Imperfect, Rectifying Contacts] suggested as True Cause of Luxembourg Effect.—Foster. (*See* 2521.)

2440. On the Possibility of the Long-Distance Reception of Ultra-Short Electromagnetic Waves [in Years of High Solar Activity].—E. Fendler. (*Zeitschr. f. tech. Phys.*, No. 5, Vol. 18, 1937, pp. 119–120.)

From a consideration of data from various sources, commercial and amateur, the writer concludes that in years of maximum solar activity distances of about 400–2000 km will be covered by waves from 9–5 m, on summer days when the low-limit day-waves for transoceanic service, which usually have a long skip distance (2000–3000 km), give excellent audibility both without and within this dead zone. The next maximum will be in about 1939, and already in 1936 the shortest useful day-wave (Berlin/New York) had decreased from 19.6 m to 14.6 m and on occasion had reached 9.0 m.

2441. Ultra-Short-Wave Propagation along the Curved Earth's Surface.—von Handel & Pfister. (*Proc. Inst. Rad. Eng.*, March 1937, Vol. 25, No. 3, Part 1, pp. 346–363.)

English version of the paper dealt with in 3971 of 1936. In two added paragraphs the writers report that attempts, with 3-microsecond pulses over about 120 km, to separate out a refracted ray from the diffracted ray were unsuccessful: they conclude that "only a diffracted ray is present, which at times is more strongly bent by refraction in the lower atmospheric layers. Nevertheless it must be assumed that at very great distances the occasional appearance of short-time field intensities is to be attributed to reflection at a sharply defined layer."

2442. Air-Wave Bending of Ultra-High-Frequency Waves: a Review of Recordings and Observations made on Various Frequencies over 100-Mile Indirect Paths: Part I.—R. A. Hull. (*QST*, May 1937, Vol. 21, No. 5, pp. 16–18 and 76, 78, 80, 82.)

2443. Propagation Tests with Micro-Rays [1935 Tests St. Margaret's Bay/Escalles: Comparison of 18, 20, and 29 cm Waves: Effects of Tides and Condition of Sea: Local Interference (due to People and Ships): Apparatus: New Method of C. W. Reception: etc.].—A. G. Clavier. (*Elec. Communication*, Jan. 1397, Vol. 15, No. 3, pp. 211–219.)

Including the mounting of two completely separate receiving valves (and aerials) on a common electro-optical system, one (for 29 cm reception) behind the paraboloidal reflector, the other (for 20 cm reception) behind the hemispherical mirror: the two dipoles are close together but at right angles to each other. The analysis of the connection between the possible transmitter wavelength and the length of the wire of the oscillating electrode is also given: from the formula derived a chart can be drawn giving the possible wavelengths, for a given length of the electrode wire, as a function of the length of the transmission line leading to the dipole.

2444. Dielectric Constant of Ionised Gases [measured at Ultra-Short Wavelengths].—Imam & Khastgir. (*Phil. Mag.*, May 1937, Series 7, Vol. 23, No. 157, pp. 858–865.)

See 2055 of June. The wave-range is now given as 3.98–5.38 m. The dielectric constant is always less than unity; with chlorine and thallium tubes the reduction in the d.c. increased about proportionally with the increase of discharge current ("thus furnishing experimental evidence of the Eccles-Larmor theory"), but with iodine the change in d.c. was practically independent of the discharge current.

2445. Wireless Echoes from Low Heights.—S. K. Mitra & J. N. Bhar. (*Science & Culture*, Vol. 1, 1936, pp. 782 *et seq*: abstract in *Hochf:tech. u. Elek:akus.*, Jan. 1937, Vol. 49, No. 1, pp. 29–30.)

Continuation of experiments referred to in 2539 of 1935 on echoes from a D region at a height of about 55 km. Echoes from lower heights were also occasionally observed. Reasons are given for concluding that the observations really referred to echoes from a well-defined ionised region; the distance between ground-wave and echo increased with frequency, the echo intensity was relatively large, etc.

2446. The Upper Atmosphere [Mode of Ionisation by Solar Ultra-Violet Light].—M. N. Saha. (*Proc. Nat. Inst. Sci. India*, Vol. 1, 1935, pp. 217–241: abstract in *Hochf:tech. u. Elek:akus.*, Jan. 1937, Vol. 49, No. 1, pp. 30–31.)

The author refers to the work of Chapman (1931 Abstracts, p. 202) on the production of upper-atmospheric ionisation by solar ultra-violet radiation; he finds that one of the fundamental assumptions therein is incorrect, namely that there is any constituent of the atmosphere which has an ionisation potential as low as 9 v and that a wavelength of 1350 Å can produce ionisation there. The present author finds that a much shorter wavelength is required, 1019 Å, corresponding to 12.1 v, the ionisation voltage of O_2. He finds that the available energy would be insufficient to produce the electron concentrations observed, if it is assumed that the radiation has the same spectral distribution as that of a black body. He attempts to justify the view that solar ultra-violet radiation is the cause of upper-atmospheric ionisation by rejecting the assumption of black-body radiation and assuming that there is superposed, on the continuous ultra-violet spectrum, a line spectrum formed by the Lyman series of H_2, the helium resonance line, and perhaps the chief lines of other elements. A detailed discussion of this point of view is given in the original paper.

2447. A Contribution by Radioelectricity to the Study of the Physics of the Globe [Sudden Short Fading on Short Waves coinciding with Violent Increase of Atmospherics on Long Waves and usually with Small Sudden Variation of One Component of Earth's Magnetic Field: preceded (generally by Some Ten Minutes) by Chromospheric Eruption: Provisional Explanations].—R. Jouaust: Dellinger. (*L'Onde Élec.*, April 1937, Vol. 16, No. 184, pp. 211–216.)

These fadings were first reported (May 1935) by Maire of Radio-France. Reference is made to the work of Bureau & Maire (458 of February), Jouaust, Bureau, & Eblé (846 of March), Dellinger (844 of March: but *see* also 1347 and 2905 of 1936), Newton (449 of February and *Journ. of Br. Astron. Assoc.*, Jan. 1937, Vol. 47), Saha (on the necessity for special short-wave radiation, such as the helium resonance ray, to explain Appleton's values of ionisation: *see* 2446, above), and McNish (1281 of April).

2448. Abnormal Attenuation in Short-Wave Propagation: Second Report.—D. Arakawa. (*Rep. of Rad. Res. in Japan*, Dec. 1936, Vol. 6, No. 3, pp. 169–182.)

The phenomena on Feb./May 1936 have already been reported (3976 of 1936). They have often been observed since, and those recorded during June/Nov. 1936 are here described. It was found that abnormal attenuation occurred more often on days coming within the 27th cycle of Feb. 7th & 8th, but no disturbance was recorded on Feb. 14th 1936 or its 27th cycle.

2449. On Short-Period Disturbances in Short-Wave Transmission [Periodic and Non-Periodic Appearances of "Dellinger Effect" in Japan, and Discussion: Propagation of 10 m Waves during This Effect is Much Less Affected].—Ohno, Nakagami, Miya, & Shimizu. (*Rep. of Rad. Res. in Japan*, Dec. 1936, Vol. 6, No. 3, pp. 157–167.)

Covering the work contained in the Japanese papers referred to in 447 and 451 of February. It is concluded that the max. electron density of the F region is generally greater than that of the E region during the Dellinger effect, and that in such cases there is a possibility of maintaining communication by using as high a frequency as possible in order to minimise attenuation through the E layer. Should, however, reverse conditions prevail during the Dellinger effect, only low-frequency waves are likely to be useful. It is also concluded that the high-speed corpuscles which may be regarded as the cause of the abnormal ionisation differ somewhat from those that bend under the influence of the earth's magnetic field during a magnetic storm and produce abnormal ionisation, mainly along the auroral zone. The Dellinger effect seems to be partial to magnetically calm days during periods of sunspot maxima: "magnetic storms are liable to begin more frequently from the time that the Dellinger effect begins to decrease."

2450. CURRENT SUNSPOTS, *and* MAGNETIC DISTURBANCES AND AURORAS [Particulars of Sunspot Groups, Hydrogen Eruptions, and Magnetic Storms occurring 15–30th April 1937: Interruption of Cable Circuits by Earth Currents].—(*Nature*, 1st May 1937, Vol. 139, p. 752: 8th May, pp. 790–791.)

2451. CONCERNING THE PROBABLE MAGNITUDE OF THE NEXT SUNSPOT MAXIMUM [Correlation between Activity at Minimum and Following Maximum for Past Two Centuries: Coming Maximum may not greatly exceed the Moderate Values of Previous Five Cycles: Possibility of Moderate Peak of Magnetic Activity].—A. L. Durkee. (*Phys. Review*, 1st April 1937, Series 2, Vol. 51, No. 7, p. 589.)

2452. OXYGEN IN SOLAR PROMINENCES.—Royds & Narayan. (*Current Science*, Bangalore, April 1937, Vol. 5, No. 10, pp. 531–532.)

2453. DEFLECTION OF A CURRENT IN A GAS BY A MAGNETIC FORCE [Theory including Effect of Free Electron Paths and Collisions: Mean Velocities of Electrons: Equations for Magnetic Deflexion].—J. S. Townsend. (*Phil. Mag.*, May 1937, Series 7, Vol. 23, No. 157, pp. 880–885.) *See* also 1670 of May.

2454. ERRATUM: HEIGHTS OF REFLECTION OF RADIO WAVES IN THE IONOSPHERE [Reasons for Omission of Lorentz Polarisation Term: Modified Numerical Results].—F. H. Murray. (*Phys. Review*, 1st May 1937, Series 2, Vol. 51, No. 9, p. 779.) *See* 2061 of June.

2455. THE IONISATION OF THE UPPER PART OF THE IONOSPHERE [above 200 km: Results of Calculations of Apparent Heights of Reflection for One Curve of Collision-Frequency Variation and Various Ionisations].—Irène Mihul & C. Mihul. (*Comptes Rendus*, 19th April 1937, Vol. 204, No. 16, pp. 1171–1173.)

(P', f) curves showing F_1 and F_2 regions are given which the writers have calculated, using (1) the theory of Jonescu & Mihul (868 of 1936), (2) a given law of variation of collision frequency, and (3) ionisation variations which are shown. The height at which the dielectric constant vanishes for a wavelength 75 m is found to be the same for all the assumed ionisation variations; the variation of the maximum between the curves for F_1 and F_2 regions and the gradual descent of the F_2 curve are discussed in terms of the rates of change of electron density with collision frequency. The writers find that their conclusions are confirmed by observations of long-delay echoes in tropical regions, where conditions are favourable for ionised canals in the upper atmosphere.

2456. IONOSPHERIC MEASUREMENTS DURING THE TOTAL SOLAR ECLIPSE OF JUNE 19TH, 1936; *also* IONOSPHERE STUDIES *and* MEASUREMENT OF THE HEIGHT OF THE IONOSPHERE AT HEIHO, MANCHURIA [both during the Same Eclipse].—Maeda and Isagawa: Minohara and Ito: Nakamura. (*Rep. of Rad. Res. in Japan*, Dec. 1936, Vol. 6, No. 3, pp. 91–113: 115–142: 143–150.)

(i) "A review of the experimental results given in this report will show that, besides points which agree with past results, several new facts have been disclosed." (ii) Among other results, it is concluded that the sporadic E region "originates as the result of a special reflection mechanism due to ionic density and the gradient of the ionic density of a certain value or degree"; that the ionic density of the F_1 region is, in general, proportional to the exposed area of the sun, "which means that the F_1 region is ionised by the ultra-violet rays of the sun, that the electrons function principally as radio waves, and that the decrease in ionisation is due to recombination of positive ions rather than to attachment of the neutral particles"; and that the ionic density of the F_2 region *increased* during the eclipse, partly because of the fall in atmospheric temperature and the resulting contraction. (iii) Reflection from the sporadic E region disappeared entirely before and after the eclipse, with 5100 kc/s; "this fact is a very interesting result compared with those of other measurements"; the F_1 reflection changed to F_2 reflection at the beginning of the eclipse, but the F_2 reflection, which was at first in the condition of magneto-ionic splitting, eventually merged into one region at the time of totality: "we can conclude from this fact that the ionic density of the F_1 region, which diminished during the eclipse and after it was over, returned to ordinary conditions again."

2457. IMPULSE GENERATOR WITH VARIABLE FREQUENCY [the "Gasomagnetron" (producing Ion-Electron Rays) used to generate Pulses of Several Hundred Milliamperes at Tensions up to 10 Kilovolts].—A. J. Usikov. (*Physik. Zeitschr. der Sowjetunion*, No. 4, Vol. 11, 1937, pp. 414–424: in English.)

With the generator described by Ts'en (2082 of 1936) the writer was unable to obtain currents of more than a few milliamperes, and the frequency of the impulses was not variable. With the present generator the current value can reach about 1 ampere, the frequency of the impulses can be varied from 0 to 5 or 10 kc/s without change of amplitude, and their duration from 10^{-3} to 10^{-5} sec. without change of frequency. There is no fundamental difficulty in increasing the current value still further. The following applications are mentioned:—relay with inertia only equal to time of plasma formation; interrupter; d.c./a.c. converter; contactor in a high-voltage circuit with efficiency up to 97%. The "gasomagnetron" used is based on Slutzkin's work (316 of 1936) and consists of an ordinary magnetron filled with a rare gas or mercury vapour.

2458. APPLICATION OF THE THEORY OF PROBABILITY TO THE EFFECT OF FADING.—A. Shukin. (*Tech. Phys. of USSR*, No. 2, Vol. 4, 1937, pp. 91–109: in English.)

In spite of the fact that fading effects are of a completely "accidental" character, so that the classical theory of probability may be applied to them, "there are very few works which consider fading from this point of view [apart from T. L. Eckersley's work, the only papers referred to are Russian]. These works show that even a relatively simplified examination of the effect of fading from the point of view of the theory of probability leads to a number of conclusions which are of great importance in their application to the practice of radio-communications. The present work had the following aims: (1) to show the simplest possible type of method of application of the theory of probability to the analysis of fading, and (2) to draw the most essential conclusions from this application, and to examine the limitations which must be taken into account when applying these conclusions to practice": thus neither the effect of variable absorption nor a change in the number of rays reaching the receiver is taken into account. However, the consequent deviations will (if the gain control is great) only affect the numerical coefficients: "the proportionality of the probability of non-recording to the square of the level is maintained in every case."

2459. NIGHT-TIME PROPAGATION AT BROADCAST FREQUENCIES [based on Questionnaire: Practical Service Limits of Stations].—J. F. Byrne. (*Proc. Inst. Rad. Eng.*, March 1937, Vol. 25, No. 3, Part 1, p. 281: summary only.)

2460. NBC TESTS ON LONG-DISTANCE BROADCAST PROPAGATION OVER LAND.—Guy. (*See* 2561.)

2461. SKIP-DISTANCE CALCULATION: RAPID GRAPHICAL DETERMINATION OF SECANT OF ANGLE OF INCIDENCE [with Alignment Chart].—N. Smith. (*QST*, May 1937, Vol. 21, No. 5, pp. 47–48.)

2462. THE RÔLE OF OZONE IN THE STUDY OF THE UPPER ATMOSPHERE [Laboratory Study of Action of Low Temperatures on Absorption Spectrum: Mean Temperature of Atmospheric Ozone must be $-30°$ C: etc.].—E. Vassy. (*Journ. de Phys. et le Radium*, April 1937, Vol. 8, No. 4, pp. 50–51S.) Another conclusion is that the ozone "can only be created by an ultra-violet radiation longer than 1900 Angstrom units, or by electrons of greater energy than the auroral electrons."

2463. A NEW BAND IN THE SPECTRUM OF THE NITROGEN ARC.—P. Trautteur. (*La Ricerca Scient.*, No. 3/4, Vol. 1, Series 2, 8th Year, 1937, pp. 143–144.)

2464. THE CALCULATION OF THE REFRACTIVE INDICES OF A MIXTURE OF LIQUIDS AT VARIOUS TEMPERATURES.—D. Teodoresco. (*Bull. de Math. et de Phys. de l'Éc. Polytech. Roi Carol II*, Bucarest, Fasc. 19, 20, 21, 1937, pp. 57–59: in French.)

ATMOSPHERICS AND ATMOSPHERIC ELECTRICITY

2465. ATMOSPHERIC DISTURBANCES DUE TO THUNDERCLOUD DISCHARGES [Volley of Discharges preceding Main Lightning Discharge].—F. W. Chapman. (*Nature*, 24th April 1937, Vol. 139, pp. 711–712.)

For previous work *see* 1933 Abstracts, p. 403. The writer has now developed a cathode-ray-oscillographic photographic method which resolves electrical pulses a few microseconds apart by moving the photographic film at right angles to the time-base deflection. Specimen records are given which show a volley of discharges preceding the main lightning discharge. It is presumed that the volley is a type of brush discharge and radiates "a long series of electromagnetic waves of peak value and duration to cause considerable interference in radio receivers." The main discharge is found to consist of a series of steps "separated by an interval of between 30 and 100 μs, their quasi-period corresponding to a wavelength of between 15 and 30 km." Possible connections between these phenomena and observations of other writers are noted.

2466. ATMOSPHERICS AND METEOROLOGY [and the Connection between Short-Wave Atmospherics and Ionospheric-Layer Heights].—Leithäuser & Menzel. (*Funktech. Monatshefte*, April 1937, No. 4, pp. 130–132.) On the work dealt with in 3987 of 1936, together with a plea for concerted amateur observations on ultra-short-wave stations, and an outline of simple cathode-ray-oscillographic methods of working.

2467. DAMAGE BY LIGHTNING TO OVERHEAD COMMUNICATION LINES [and the Calculation of the Strength of the Lightning Stroke: Methods of Decreasing the Damage].—W. Peters. (*E.T.Z.*, 1st & 8th April 1937, Vol. 58, Nos. 13 & 14, pp. 337–340 and 372–375.)

2468. "RAIN STATIC" IN AIRCRAFT RECEPTION.—Rettenmeyer. (*See* 2600.)

2469. EXPULSION PROTECTIVE GAPS.—Rudge & Wade. (*Elec. Engineering*, May 1937, Vol. 56, No. 5, pp. 551–557.)

2470. DISTORTIONS OF SURGES ON SHORT CABLES [Cathode-Ray Oscillographs of Statical Breakdown].—J. L. Jakubowski & A. W. Rankin. (*Arch. f. Elektrot.*, 22nd March 1937, Vol. 31, No. 3, pp. 186–191.)

2471. CAN A SEPARATION OF CHARGES BE PRODUCED IN A MASS BY A PRESSURE GRADIENT AT VERY HIGH PRESSURES? (THE QUESTION OF THE CAUSE OF THE EARTH'S MAGNETIC AND ELECTRIC FIELD) [Theory of Terrestrial and Solar Magnetisation derived from Atomic Physics: Qualitative and Quantitative Explanation of Electrical Field in Atmosphere].—H. Haalck. (*Zeitschr. f. Physik*, No. 1/2, Vol. 105, 1937, pp. 81–87.)

2472. THE NATURE AND ORIGIN OF LARGE IONS IN THE ATMOSPHERE [Connection with Smoke Content].—G. Nadjakoff. (*Comptes Rendus*, 26th April 1937, Vol. 204, No. 17, pp. 1236–1238.)

2473. A TERRESTRIAL ORIGIN FOR COSMIC RAYS [Proposed Mechanism: Vertical Separation of Positive and Negative Ions by Earth's Electrical Gradient: Additional Horizontal Separation by Poleward Air Currents].—M. C. Holmes. (*Journ. Franklin Inst.*, April 1937, Vol. 223, No. 4, pp. 495–500.)

2474. THE CAUSES OF SELF-EXCITATION IN GEIGER-MÜLLER COUNTERS.—Wechsler & Biberhall. (*Physik. Zeitschr. der Sowjetunion*, No. 3, Vol. 11, 1937, pp. 326–343 : in German.)

2475. HIGH-ALTITUDE TEST OF RADIO-EQUIPPED COSMIC-RAY METER.—C. D. Keen. (*Journ. Franklin Inst.*, March 1937, Vol. 223, No. 3, pp. 355–373.)

2476. RADIO METEOROGRAPH SYSTEM [with Transmitting Set and Meteorograph carried by Balloon : Automatic Receiving and Recording Equipment on Ground : Direction-Finders at Ground Station for Tracking Flight].—Nat. Bureau of Standards. (*Journ. Franklin Inst.*, April 1937, Vol. 223, No. 4, pp. 527–529 : preliminary note.)

PROPERTIES OF CIRCUITS

2477. REACTANCE QUADRIPOLES [Matrix Theory of General Design of Circuits with Required Properties: Practical Examples].—H. Piloty. (*E.N.T.*, March 1937, Vol. 14, No. 3, pp. 88–117.)

An exposition and extension of the matrix theory of quadripole design (*see*, for example, Cauer, 1932 Abstracts, p. 537 and back reference ; *also* Bode, 2211/2213 of 1935). The writer starts with the known reactance theory and deals with the impedance and conductance matrices, §I (including their realisation by the partial-fraction method) ; impedance and attenuation functions, §II (with a discussion of residues in the partial-fraction theory and their interpretation in the circuits) ; classification of reactance quadripoles, §III ; development of impedance and attenuation functions for low- and high-pass filters, §IV, and for filters of higher types, §V (with discussions of the various types of frequency transformation). Examples are given (§VI) of typical circuits.

2478. THE DESIGN OF FILTERS AT HIGHER AND HIGHER FREQUENCIES.—C. E. Lane. (*Rad. Engineering*, May 1937, Vol. 17, No. 5, pp. 10–12 and 16.) From the Bell Laboratories. An improved method of shielding filter elements (writer's patent) is mentioned.

2479. DISCUSSION ON "EXPANSION THEOREMS FOR LADDER NETWORKS."—Malti & Warschawski. (*Elec. Engineering*, May 1937, Vol. 56, No. 5, p. 601.) *See* 907 of March.

2480. CORRECTION TO "SOME NOTES ON TUNED-COUPLED CIRCUITS."—Aiken. (*Comm. & Broad. Eng.*, April 1937, Vol. 4, No. 4, p. 21.) *See* 2092 of June.

2481. SPECIAL PROPERTIES OF RESONANT CIRCUITS COUPLED BY LONG LINES [particularly Their Equivalence to a Single Circuit whose $L\omega/R$ is Unity: Analysis of Selectivities of Resonant Circuits coupled by Mutual Inductance and by Long Lines].—G. Fayard & P. Varaldi-Balaman. (*L'Onde Élec.*, April 1937, Vol. 16, No. 184, pp. 226–240.)

"One of the important applications of this study is to free long-wave broadcasting installations and radio-television posts from a part of the linear distortion which generally affects them to a serious degree."

2482. THE CALCULATION OF INPUT, OR SENDING-END, IMPEDANCE OF FEEDERS AND CABLES TERMINATED BY COMPLEX LOADS.—Cafferata. (*See* 2678.)

2483. ON NETWORKS OF CONSTANT RESISTANCE [Constant Impedance at all Frequencies by Series, Parallel, and Bridge-Circuit Compensation : Analysis and Examples].—J. Constantinesco. (*Bull. de Math. et de Phys. de l'Éc. Polytech. Roi Carol II*, Bucarest, Fasc. 19, 20, 21, 1937, pp. 131–144 : in French.)

2484. SOME MATHEMATICAL CONSIDERATIONS ON THE CORRECTION OF DISTORTION.—A. A. Kharkevich. (*Journ. of Tech. Phys.* [in Russian], No. 3, Vol. 7, 1937, pp. 250–256.)

In this paper, which is a continuation of that dealt with in 4001 of 1936, the following methods are suggested for modifying the differential equations representing the system under consideration :—(a) method of altered constants, where the coefficients of the various terms of the equation are modified ; (b) method of division, where an operator is introduced into the right-hand side of the equation and subsequently divided by a similar operator from the left-hand side ; (c) method of subtraction, where terms are introduced into the equation of opposite signs to those terms which it is desired to reduce ; and (d) combination of the above methods. The discussion is illustrated by examples taken from practice.

2485. GENERAL EQUALISER THEORY, TWO-TERMINAL AND CONSTANT-RESISTANCE STRUCTURES [with General Formulae, General Design Formulae, and Charts].—(*Marconi Review*, Jan./Feb. 1937, No. 64, pp. 20–30 : to be contd.)

2486. DISTORTION IN NEGATIVE FEEDBACK AMPLIFIERS [may or may not be Reduced by Feedback].—R. W. Sloane. (*Wireless Engineer*, May 1937, Vol. 14, No. 164, p. 259.) Analysis leading to conclusions similar to those of Feldtkeller (4034 of 1936) : Bartel's graphical method (395 of 1935) is also referred to. *Cf.* also 2095/7 of June.

2487. AUDIO FEEDBACK [Negative Feedback improves Frequency Characteristic, reduces Noise and Amplitude Distortion, and makes Over-all Amplification more Independent of Variations in Valves and Valve Voltages : Analysis and Practical Conclusions].—A. R. Rumble. (*Comm. & Broad. Eng.*, April 1937, Vol. 4, No. 4, pp. 14–16 and 20, 21.)

2488. CHARACTERISTICS OF INVERSE-FEEDBACK CIRCUITS [of the Two Main Types].—L. Martin. (*Rad. Engineering*, May 1937, Vol. 17, No. 5, pp. 13–16.)

2489. PRACTICAL NEGATIVE-FEEDBACK AMPLIFIERS.—Day & Russell. (*See* 2627.)

2490. DISCUSSION ON "TENSOR ANALYSIS OF MULTIELECTRODE-TUBE CIRCUITS."—Boyajian, Bewley, & Kron. (*Elec. Engineering*, May 1937, Vol. 56, No. 5, pp. 614–621.) *See* 911 of March.

2491. VALVE CAPACITIES: THEIR INFLUENCE ON CIRCUIT TECHNIQUE.—Steimel & Zickermann. (*See* 2581.)

2492. AN INVESTIGATION OF THE OPERATION OF AN OVER-DRIVEN VALVE WITH VARIOUS VALUES OF GROUND DRIVE.—Evtyanov. (*See* 2594.)

2493. ON THE FREQUENCY AND STABILITY OF AUTO-OSCILLATIONS.—B. K. Shembel. (*Izvestiya Elektroprom. Slab. Toka*, No. 2, 1937, pp. 3–13.)

A theoretical investigation to clarify certain general conceptions regarding the operation of an auto-oscillating system. Using Lagrange equations of energy balance, free oscillations in a system without losses are considered first, and the results obtained are extended to the operation of an auto-oscillating system deriving its energy from an external source. Methods are indicated for determining the natural frequency of such a system, and various factors affecting it are discussed. A conception is derived of the "stability factor" of the system, which is expressed as a ratio of the reactive and real powers; on the basis of this conception a number of practical suggestions are made. The discussion is illustrated by examples, and results of experiments are given.

2494. THE SQUARE LAW RECTIFICATION OF ELECTRICAL NOISE.—Strafford. (*See* 2530.)

2495. ON THE BEHAVIOUR OF A CIRCUIT WITH A VARIABLE RESISTANCE.—A. B. Sapozhnikov. (*Izvestiya Elektroprom. Slab. Toka*, No. 2, 1937, pp. 27–31.)

In designing a circuit in which a carbon microphone is connected, it is customary to regard the microphone and battery as an a.c. generator. In the present paper a theoretical investigation is made to verify the accuracy of this assumption. Two circuits are considered separately: one in which the secondary of the microphone transformer is connected to the grid filament circuit of a valve, and the other in which the secondary is loaded by a resistance (an external line, for instance). In each case, starting from the fundamental equations, formulae are derived determining the current flowing in the circuit. It appears from this investigation that the assumption under consideration is sufficiently accurate for use as a first approximation.

2496. GRAPHICAL REPRESENTATION OF REAL, WATTLESS, DISTORTIONAL, AND APPARENT POWER, WITH A CONTRIBUTION TO THE PROBLEM OF ALTERNATING CURRENTS OF ARBITRARY WAVE FORM.—Andronescu. (*See* 2705.)

2497. LINES OF MAGNETIC FIELD OF A FILIFORM CIRCUIT, SYMMETRICAL AND PLANE, TWICE BENT.—S. S. Stefanesco. (*Bull. de Math. et de Phys. de l'Éc. Polytech. Roi Carol II*, Bucarest, Fasc. 19, 20, 21, 1937, pp. 124–130: in French.)

TRANSMISSION

2498. THE DYNAMICS OF TRANSVERSELY AND LONGITUDINALLY CONTROLLED ELECTRON BEAMS [General Theory]: PART I.—STATIC AND DYNAMIC RELATIONSHIPS.—H. E. Hollmann and A. Thoma. (*Hochf:tech. u. Elek:akus.*, April 1937, Vol. 49, No. 4, pp. 109–123.)

The foundations of this work have already been referred to in Hollmann's book (784 of February). Here a general theory is developed, based on the fundamental equations of electron motion, which is designed to include all the processes in the production of oscillations by negative resistances, where secondary electrons play no part. The arrangement shown in Fig. 1 is investigated under quite general conditions; the paths of the electrons in an electron beam inclined at an angle to the axis of the tube with deviating plates are calculated. Transverse control of the beam (§ II), as in a cathode-ray tube, is found to require a certain amount of power; there is a finite static resistance between the plates, due to the displacement current arising from the moving electrons. Between the positions of transverse and longitudinal beam control, there is a critical angle giving a position of discontinuity when the electron beam switches from the lower to the upper plate (Figs. 2, 7, 10). The effect of varying the direction and angle of the controlling field relative to the electron beam is summarised in Fig. 12, which shows the current/voltage characteristics for cases including those of an obliquely-controlled retarding-field valve and a magnetron model. The physical cause of the negative resistance in the retarding-field valve is discussed. Push-pull control of the beam by two neighbouring electric fields (§ IVa, Figs. 13, 14) and by multiple fields (Figs. 15, 16) is described; it employs "rising" and "falling" electrons. The energy equilibrium is discussed (§ IVb); the cycloidal paths given by an electric field with a superposed magnetic field are effectively equivalent to the parabolas obtained by oblique entrance of electrons into a retarding electric field (§ IVc). "The conditions are enumerated under which the 'electrostatic retarding valve' can be transformed into the 'magnetic retarding valve' in which the magnetic retarding action is produced by a magnetic field. Thus the Habann generator, with a single electron beam following a suitable path, is identified with the electrostatic retarding valves here investigated." The next part of the paper will deal with the ultra-dynamic properties of the arrangement, when the period of the control voltage is comparable to the electron transit time.

2499. OSCILLATIONS IN VALVES WITH A MAGNETIC FIELD.—Herriger & Hülster. (*Hochf:tech. u. Elek:akus.*, April 1937, Vol. 49, No. 4, pp. 123–132.) Condensed account of work dealt with in 1319 of April.

2500. THE CONNECTION BETWEEN WAVE RANGE AND THE LENGTH OF OSCILLATING-ELECTRODE WIRE IN A MICRO-RAY SYSTEM.—Clavier. (*See* 2443.)

2501. RADIO TECHNIQUE AT ONE METRE [and below: Oscillator Circuits with Quarter-Wave Coaxial Lines: Frequency changed by Added Capacitance or by Spiral Centre Wire: etc.].—P. D. Zottu. (*Proc. Inst. Rad. Eng.*, March 1937, Vol. 25, No. 3, Part 1, pp. 281–282: summary only.)

2502. DESIGN OF A 37 Mc/s MOBILE TRANSMITTER [for Broadcast Pickup Work: 10-Watt Output to Coaxial Feeder to Quarter-Wave Aerial: Combined Plate- and Screen-Grid Modulation (85–90%): 6-Volt Dynamotor: 5–6 Mile Range].—A. W. Shropshire. (*Proc. Inst. Rad. Eng.*, March 1937, Vol. 25, No. 3, Part 1, pp. 277–278: summary only.)

2503. ULTRA-MIDGET EQUIPMENT FOR THE ULTRA-HIGH FREQUENCIES: A COMPLETE TRANSMITTER AND RECEIVER FOR PERSONAL WEAR.—J. Wagenseller. (*QST*, May 1937, Vol. 21, No. 5, pp. 29–30 and 122.)

2504. FREQUENCY-MODULATION NOISE CHARACTERISTICS [Theory and Experimental Work by RCA].—M. G. Crosby. (*Proc. Inst. Rad. Eng.*, April 1937, Vol. 25, No. 4, pp. 472–514.)

For previous work *see* 2962 of 1936. Above the "improvement threshold," the signal/noise ratio is greater than for amplitude modulation by a factor (constant × "deviation ratio") which is slightly greater for impulse than for fluctuation noise ("frequency limiting" effect). Further improvement results from the power gain obtainable in certain types of transmitter by the use of frequency modulation, but this advantage seems to be countered by Doherty's new high-efficiency power amplification (4020 of 1936).

2505. MAKING VISIBLE THE SIDE BANDS OF A MODULATED CARRIER [and the Distinction between Amplitude and Frequency Modulation].—H. J. Zetzmann. (*Funktech. Monatshefte*, April 1937, No. 4, pp. 115–116.) For the writer's patent *see* 2963 of 1936.

2506. CHARACTERISTICS OF AMPLITUDE-MODULATED WAVES [Treatment by "Stroboscopic Vectors" Method: Pure Amplitude Modulation: Combined Phase and Amplitude ("Pseudo-Phase") Modulation: Single Sideband and Suppressed Carrier Transmission: etc.].—E. A. Laport. (*RCA Review*, April 1937, Vol. 1, No. 4, pp. 26–38.)

With regard to suppressed-carrier transmission and the use of a non-synchronous replacement carrier, "the opinion of six moderately critical observers is that 5 cycles deviation is the maximum allowable before the departure from true chromatic scale intervals is noticeable in music."

2507. MODULATION WITH A CONSTANT AVERAGE RATIO OF ANODE SWING TO FEED VOLTAGE.—S. I. Tetelbaum. (*Izvestiya Elektroprom. Slab. Toka*, No. 2, 1937, pp. 32–35.)

A method is proposed for high-efficiency high-power modulation which is a modification of that dealt with in 1744 of 1936. In the present method the coupling between the modulated amplifier and the aerial is varied in accordance with the variation of the depth of the modulation, while the variation of the anode voltage of the modulated amplifier is made independent of the depth of modulation. The modulated amplifier is, therefore, operated at a constant efficiency which can be made equal to that at 100% modulation.

The operating conditions are determined for this type of modulation, and precautions are discussed against the appearance of additional distortion.

2508. A METHOD FOR DUPLEX RADIO-TELEPHONY [Carrier of One Transmitter derived from Incoming Carrier by Multiplication or Division], *and* SIMULTANEOUS DUPLEX RADIO-TELEPHONY.—Borushko & Shchegolev: Marro. (*See* 2779 and 2778.)

2509. 300-WATT MARINE RADIO-TELEGRAPH TRANSMITTER.—I. F. Byrnes. (*RCA Review*, April 1937, Vol. 1, No. 4, pp. 119–124.)

2510. ON SUPPORTING INSULATORS FOR HIGH-POWER SHORT-WAVE TRANSMITTERS.—E. A. Gaylish. (*Izvestiya Elektroprom. Slab. Toka*, No. 1, 1937, pp. 1–8.)

At high frequencies the limiting factor in the design of a supporting insulator may well be overheating due to dielectric losses. A formula is therefore derived determining the rise in temperature in a cylindrical insulator in terms of applied voltage and operating frequency. Curves are plotted on the basis of this formula showing the temperature rise in a "pyrofillit" insulator at a frequency of 17.6 Mc/s for various insulator dimensions and values of applied voltage. The accuracy of these curves is confirmed by a number of experimental points, also shown in the diagrams.

It is pointed out that for frequencies of this order the corrugations of the insulator surface should be designed mainly with a view to increasing heat dissipation, and it is therefore suggested that these should always be arranged to run in a vertical direction. Hollow cylindrical insulators are also considered and their superiority from the point of view of mechanical strength and lower temperature rise is pointed out.

2511. A GENERATOR FOR ALTERNATING CURRENTS OF EXTREMELY LOW FREQUENCY [by Reciprocating Motion of Sliding Contacts].—S. S. Lavrentjev. (*Journ. of Tech. Phys.* [in Russian], No. 2, Vol. 7, 1937, pp. 130–134.) For other methods *see* Saxl, 1934 Abstracts, p. 497, and back references.

RECEPTION

2512. THE SUPER-REGENERATIVE RECEIVER [Correspondence].—P. David: Scroggie. (*Wireless Engineer*, April 1937, Vol. 14, No. 163, pp. 194–195.) Arising from Scroggie's paper (493 of February).

2513. REDUCTION OF SELF-RADIATION IN SUPER-REGENERATIVE RECEIVERS [by Use of Pentode Detector, combined with Reduction of All Types of Coupling between Oscillator and Aerial or Pre-Selector Circuit: Importance of Neutralisation and High Quenching Voltage].—T. Hayasi. (*Rep. of Rad. Res. in Japan*, Dec. 1936, Vol. 6, No. 3, pp. 183–188.)

2514. Super-Regenerative Receiver free from Background Noise [Two Oscillating Audion Circuits separately coupled to Aerial, Quench Frequency applied in Opposite Phase to Each].—(*Funktech. Monatshefte*, April 1937, No. 4, p. 136.) From the Vienna *Radio-Amateur*. The "mush" is reduced to a tenth and the selectivity quadrupled.

2515. Simplified Super-Regeneration [the "Squegger-Quenched" Circuit].—O. J. Russell. (*Television*, May 1937, Vol. 10, No. 111, p. 303.)

2516. New Method of Reception in a Micro-Ray System.—Clavier. (*See* 2443.)

2517. Ultra-Midget Equipment for the Ultra-High Frequencies: a Complete Transmitter and Receiver for Personal Wear.—J. Wagenseller. (*QST*, May 1937, Vol. 21, No. 5, pp. 29–30 and 122.)

2518. 5–15 Metre Reception [Battery-Driven 3-Valve Ultra-Short-Wave Receiver with 3 Ranges by Special Plug-In Coils].—D. W. Heightman. (*Wireless World*, 7th May 1937, Vol. 40, pp. 438–441.)

2519. 10-Metre Long-Distance Signals received when listening on 20-Metre Band: a New "Luxembourg Effect"?—Bargellini. (*See* 2438.)

2520. Frequency-Modulation Noise Characteristics.—Crosby. (*See* 2504.)

2521. A New Form of Interference—"External Cross Modulation" [due to Rectification by Imperfect Contacts: Suggested Real Cause of "Luxembourg Effect": Methods of Elimination: etc.].—D. E. Foster. (*RCA Review*, April 1937, Vol. 1, No. 4, pp. 18–25.)

See also 1759 of May. Examples of such "external cross modulation" have been found in America at distances of over 100 miles, "which are similar to the observations of Luxembourg effect. In general, when the interfering station is at such a distance, it has been found that the interfering station has high power and that there are high-tension lines extending in the direction where the interference was found, so that field intensity of the interfering station was high at those points."

2522. A Noise Reducer for Radio-Telephone Circuits ["Compandor" not successful on Short-Wave Channels: Success of "Expandor" Section, by Itself, leads to Special Form of It as Noise Reducer].—N. C. Norman. (*Bell Lab. Record*, May 1937, Vol. 15, No. 9, pp. 281–285.)

2523. A New Source of Industrial Interference: Incandescent Electric Lamps [almost always "Monowatt" Type, with High-Vacuum and Zig-Zag Filament: Violent Interference on Short and Ultra-Short Wavelengths].—G. Lehmann. (*L'Onde Élec.*, April 1937, Vol. 16, No. 184, pp. 223–225.)

Apparently connected with static changes on the lamp bulb under the action of electron jets from the filament: it disappears on bringing the hand (or a metal mass) near the bulb, reappearing on removal. Further investigation is necessary.

2524. Harmonics, Ripple, and Interference in Rectifiers [including Control by Grid: with Formulae, Tables, and Curves].—H. Jungmichl. (*E.T.Z.*, 22nd April 1937, Vol. 58, No. 16, pp. 417–420.)

2525. Discussion on "Electrical Characteristics of Suspension-Insulator Units."—Dawes & Reiter. (*Elec. Engineering*, May 1937, Vol. 56, No. 5, pp. 628–631.) *See* 962 of March.

2526. Anti-Interference Filters [for Mains-Borne Interference: Survey].—F. R. W. Strafford. (*Wireless World*, 7th & 14th May, 1937, Vol. 40, pp. 454–455 and 468–469.)

2527. Noise Control [Disadvantages of Non-Linear Limiting Devices: Two "Noise-Diode" Methods].—J. E. Dickert. (*Comm. & Broad. Eng.*, April 1937, Vol. 4, No. 4, pp. 7–10.)

2528. Suppressing Noise [in Short-Wave Receivers: Improved Signal/Noise Ratio by Two Signal-Frequency Stages (One Regenerative): Double Diode, for Second Detection and AVC, also gives Static Suppression].—(*World-Radio*, 30th April 1937, Vol. 24, p. 16.) From an article in *Radio*.

2529. Screened-Aerial Losses.—Tyers. (*See* 2566.)

2530. The Square Law Rectification of Electrical Noise [makes R.M.S. Voltage directly proportional to Acceptance Band Width N, where previously proportional to $\sqrt{N}$: Effects of Added Carrier Voltage and of Shifting the Carrier Frequency].—F. R. W. Strafford. (*Wireless Engineer*, May 1937, Vol. 14, No. 164, pp. 242–245.)

An analysis on the assumption of equal amplitudes of the individual frequency components lying within the acceptance band of the receiver.

2531. Distortion in Diode Detector Circuits.—A. W. Barber. (*Rad. Engineering*, April 1937, Vol. 17, No. 4, pp. 7–9.)

2532. Detector Distortion for Cases of Single and Double Sideband Transmission [Analysis].—Jackson & Stuart. (Appendix to paper dealt with in 2597, below.)

2533. Suppressed-Carrier Reception with Non-Synchronous Replacement Carrier: the Maximum Allowable Deviation.—Laport. (*See* 2506.)

2534. A Method of Broadcast Reception free from Fading.—S. Namba & R. Kimura. (*Rep. of Rad. Res. in Japan*, Dec. 1936, Vol. 6, No. 3, pp. 189–198.)

See 2132 of June. Since the sky-wave characteristics of the two receiving aerials differed, "the receiver would not respond to sky waves arriving at a certain angle of incidence when the antennas were operated in opposition to each other. Thus as ground waves were received and sky waves eliminated, fading was prevented. The service area can easily be increased to twice its former value by this means."

2535. STUDY OF LEVEL REGULATORS AND "ANTI-FADING" DEVICES.—Espinasse. (*L'Onde Élec.*, April 1937, Vol. 16, No. 184, pp. 241–246.) Conclusion of the paper referred to in 1752 of May.

2536. NEW BAND-PASS CIRCUIT [using Negative Feedback: for Broadcast Receivers].—(*Wireless World*, 30th April 1937, Vol. 40, pp. 414–415.)

2537. NEW CIRCUITS FOR THE "SINGLE-SPAN" SUPERHET [Regeneration by Electron Coupling, with Fading Compensation: Two-Valve (and Detector) Reflex Circuits: Gramophone Switching: Decrease of Non-Linear Distortion by Aperiodic Pre-Amplification of Signal Frequencies by Reflex Connection: etc.].—H. Boucke. (*Funktech. Monatshefte*, April 1937, No. 4, pp. 123–127.)

2538. AN IMPROVEMENT OF THE ALIGNMENT IN SUPERHETERODYNE RECEIVERS [Four-Point Alignment instead of the Usual Three-Point].—J. Lange. (*Funktech. Monatshefte*, April 1937, No. 4, pp. 113–114.)

2539. SUPERHETERODYNE PADDING CAPACITIES: THE USE OF FIXED PADDING CONDENSERS [of Ordinary Accuracy, to replace Usual Adjustable Types].—W. T. Cocking. (*Wireless Engineer*, May 1937, Vol. 14, No. 164, pp. 246–247.) An economy applicable in many cases. The writer also points out the advantage, on short waves, of padding the signal-frequency circuits instead of the oscillator circuit.

2540. WHY THE TRIODE-HEXODE? [Evolution of Frequency-Changing Arrangements from 1917 to Modern Triode-Hexode Electron-Coupled Frequency Changer].—J. A. Szabadi. (*Wireless World*, 7th & 14th May 1937, Vol. 40, pp. 446–448 and 472–474.)

2541. CORRECTIONS TO "SUPERHETERODYNES WITH SINGLE-KNOB TUNING."—Couppez. (*L'Onde Élec.*, April 1937, Vol. 16, No. 184, p. 270.) *See* 1343 of April.

2542. A GRAPHICAL DESIGN OF AN INTERMEDIATE FREQUENCY TRANSFORMER WITH VARIABLE SELECTIVITY [by Varying Coupling: Theory and Application of Design Method].—C. Baranovsky & A. Jenkins. (*Proc. Inst. Rad. Eng.*, March 1937, Vol. 25, No. 3, Part 1, pp. 340–345.)

2543. AUTOMATIC TUNING, SIMPLIFIED CIRCUITS AND DESIGN PRACTICE [New Discriminator, dispensing with "Side Circuits" and giving 140:1 Correction Ratio: also provides AVC Potentials].—D. E. Foster & S. W. Seeley. (*Proc. Inst. Rad. Eng.*, March 1937, Vol. 25, No. 3, Part 1, pp. 289–313.) The full paper, summaries of which were dealt with in 2148 and 2994 of 1936.

2544. "DISTORTIONLESS" DRIVER [in Class AB (Quiescent Push-Pull) Circuit: Use of Negative Feedback].—W. N. Weeden. (*Wireless World*, 30th April 1937, Vol. 40, pp. 430–431.)

2545. PHASE REVERSAL [in Push-Pull Amplifiers: using Heptode with Appropriate Load Resistances in Anode and Screen Circuits].—C. C. Inglis. (*Wireless World*, 30th April 1937, Vol. 40, pp. 416–417.)

To avoid difficulties (hum, if cathode-heater insulation is not of high order: lack of symmetry) which the writer attributes to the method employed in the *Wireless World* "Quality Amplifiers."

2546. A SIMPLE WAY OF IMPROVING LOW-NOTE REPRODUCTION [Deficiency often due to Too Small a "Cathode Condenser" shunting Grid-Bias Resistance].—K. Nentwig. (*Radio, B., F. für Alle*, May 1937, No. 5, pp. 71–73.) The condenser may be increased, or more effectively the resistance may be replaced by a tuned circuit, whose iron-cored inductance provides the necessary resistance.

2547. WHAT IS THE IDEAL RADIO RECEIVER?—"Decibel" & others. (*World-Radio*, 16th & 23rd April 1937, p. 11: p. 12.)

2548. REFINEMENTS IN A-C, D-C SET CONSTRUCTION.—M. J. Morris. (*Rad. Engineering*, April 1937, Vol. 17, No. 4, pp. 19 and 21.)

2549. CHARACTERISTICS OF AMERICAN BROADCAST RECEIVERS AS RELATED TO THE POWER AND FREQUENCY OF TRANSMITTERS [Permissible Input and Frequency Separation for Freedom from Cross Talk, Heterodyne Beats, and Flutter Effects: Inadequacy of Single-Signal Selectivity Method: etc.].—A. Van Dyck & D. E. Foster. (*Proc. Inst. Rad. Eng.*, April 1937, Vol. 25, No. 4, pp. 387–420.)

2550. AUTOMOBILE RECEIVER DESIGN.—J. C. Smith. (*RCA Review*, April 1937, Vol. 1, No. 4, pp. 94–112.)

2551. INSTALLATION OF RADIO DISTRIBUTION IN THE BEAUJON HOSPITAL, PARIS.—G. Meunier. (*Elec. Communication*, Jan. 1937, Vol. 15, No. 3, pp. 207–210.)

2552. NEW COMPONENTS AT THE LEIPZIG SPRING FAIR.—W. W. Diefenbach. (*Radio, B., F. für Alle*, May 1937, No. 5, pp. 49–51.)

2553. THE OPTIMUM NUMBER OF SCREENING CANS FOR SCREENING THE MAGNETIC FIELD OF COILS.—Herzog. (*See* 2753.)

2554. ASA APPROVES UNDERWRITERS' LABORATORIES TESTS FOR RADIO RECEIVERS [for prevention of Fire and Accident Hazards].—(*Industrial Standardization*, April 1937, Vol. 8, No. 4, pp. 113–116.)

2555. TECHNICAL EDUCATIONAL REQUIREMENTS OF THE MODERN RADIO INDUSTRY [for Service Engineers].—Aufenanger. (*RCA Review*, April 1937, Vol. 1, No. 4, pp. 64–67.)

2556. "RADIO FIELD SERVICE DATA" [Book Review].—Ghirardi. (*Proc. Inst. Rad. Eng.*, April 1937, Vol. 25, No. 4, p. 518.)

2557. 8.5 MILLION BROADCAST LISTENERS IN GERMANY.—(*E.T.Z.*, 15th April 1937, Vol. 58, No. 15, p. 411.)

2558. AUTOMATIC SOS ALARMS [Recently approved by FCC: Mackay Radio and RCA-Radiomarine Types].—(*Electronics*, April 1937, Vol. 10, No. 4, pp. 20–23.)

AERIALS AND AERIAL SYSTEMS

2559. QUANTUM-THEORETICAL CALCULATION OF THE ENERGY EMITTED BY AN AERIAL [and Its Radiation Resistance from Quantity of Energy $h\nu$ emitted by Oscillating Electron in Aerial].—T. V. Jonescu. (*Comptes Rendus*, 5th April 1937, Vol. 204, No. 14, pp. 1061–1063.)

2560. TRANSFORMATIONS USEFUL IN CERTAIN ANTENNA CALCULATIONS [for which Polar Coordinates are required: Transformation Formulae for Antenna above Plane Earth].—W. W. Hansen. (*Journ. of Applied Physics* [formerly *Physics*], April 1937, Vol. 8, No. 4, pp. 282–286.) For previous work see 1785 of May.

2561. NOTES ON BROADCAST ANTENNA DEVELOPMENTS [including Top-Tuned Types (All-Round—WMAQ—and Directive—WPTF) and the New WJZ 640 ft Tower with Uniform Triangular Section and Improved Design of Coaxial Feeder].—R. F. Guy. (*RCA Review*, April 1937, Vol. 1, No. 4, pp. 39–63.)

The new WJZ aerial (*see* also 1786 of May) is based on the results of Gihring & Brown (2274 of 1935) on the bad effects of varying cross section. The paper includes a description of an elaborate set of tests on the effect of the vertical pattern of the transmitting aerial on distant reception: they showed that distant reception depends on radiation confined to angles less than 10° above the surface. No evidence of multiple reflection between ionosphere and earth was found.

2562. SOME TYPICAL BROADCAST ANTENNA INSTALLATIONS [Photographs and Captions only].—(*Comm. & Broad. Eng.*, April 1937, Vol. 4, No. 4, pp. 24–25.)

2563. TOWER AERIAL WITH ADJUSTABLE TOP CAPACITY AND DISTRIBUTED CAPACITY [with Hinged Arms of Adjustable Inclination at Top, carrying Inverted Pyramid of Wires, also Adjustable].—Comp. Gén de TSF. (French Pat. 809 503, pub. 4.3.1937: *Rev. Gén. de l'Élec.*, 24th April 1937, Vol. 41, No. 17, pp. 135–136D.)

2564. LONG-WIRE DIRECTIVE ANTENNAS: DESIGN METHODS FOR "V"S AND RHOMBICS.—R. C. Graham. (*QST*, May 1937, Vol. 21, No. 5, pp. 42–46 and 72, 74, 106.)

2565. THE CALCULATION OF INPUT, OR SENDING-END, IMPEDANCE OF FEEDERS AND CABLES TERMINATED BY COMPLEX LOADS.—Cafferata. (*See* 2678.)

2566. SCREENED-AERIAL LOSSES [and the Need for Matching: Modification of Input Tuned Circuit of Receiver to serve as Line-to-Valve Matching Transformer].—P. D. Tyers. (*Wireless World*, 21st May 1937, Vol. 40, pp. 484–485.)

2567. TWO INTERESTING CASES OF THE DEPOSITION OF SLEET AND ITS REMOVAL BY HEATING THE LINES.—Gervasoni. (*Bull. Assoc. suisse des Élec.*, No. 8, Vol. 28, 1937, pp. 161–164.)

VALVES AND THERMIONICS

2568. A NEW ULTRA-HIGH-FREQUENCY TUBE [Type 1000-UHF, Radiation Cooled (18 Cooling Fins on Anode), 1000 Watts Anode Dissipation].—Eitel-McCullough Company. (*Comm. & Broad. Eng.*, April 1937, Vol. 4, No. 4, pp. 10 and 19.)

2569. THE DYNAMICS OF TRANSVERSELY AND LONGITUDINALLY CONTROLLED ELECTRON BEAMS.—Hollmann & Thoma. (*See* 2498.)

2570. DIMENSIONAL RELATIONS IN THE MOTION OF ELECTRONS IN ALTERNATING FIELDS: II [Extension of Previous Results to Magnetic Fields].—Brüche & Recknagel. (*Zeitschr. f. tech. Phys.*, No. 5, Vol. 18, 1937, pp. 139–140.)

See 3386 of 1936, which referred to electric fields. The writers sum up by a simple example: "Given a system of electric and magnetic alternating fields, through which electrons are moving. It is required to double the frequency ω of the electric field without changing the path of the electrons. What consequences will this change have? From (1) it follows that $\sqrt{e/m}\,.\,U$ must also be doubled. If this quantity is doubled, it follows from (2) that the magnetic field strength must also be doubled if the paths are to remain unchanged. But this field-strength doubling demands, from (3), a doubled frequency of magnetic field.

"What we have thus accomplished is the doubling of the speed at which the whole process is carried out. This increase in speed is dictated by the altered electric frequency. The magnetic field must change in strength and frequency to correspond, if the paths are to remain unchanged. In this fixing and matching of velocity lies the kernel of the dimensional law."

2571. DEFLECTION OF A CURRENT IN A GAS BY A MAGNETIC FORCE.—Townsend. (*See* 2453.)

2572. THE "GASOMAGNETRON" AS IMPULSE GENERATOR, RELAY, ETC.—Usikov. (*See* 2457.)

2573. EXTENSION TO 300 Mc/s OF PREVIOUS MEASUREMENTS OF THE ADMITTANCE OF H.F. AMPLIFYING VALVES.—M. J. O. Strutt & A. van der Ziel. (*E.N.T.*, March 1937, Vol. 14, No. 3, pp. 75–80.)

For previous works *see* 1019 of 1936. The method there used up to 60 Mc/s is here first referred to (diode voltmeter Fig. 1). For valve impedance measurements above 60 Mc/s with the same apparatus, a relative calibration curve only is required. This is obtained by a method already described (p. 390 of paper dealt with in 1931 Abstracts, p. 28), which is applied to the present case by varying the amplitude of the oscillations from the emitter. The ratio of the voltages of any two readings of the diode voltmeter so obtained can be found directly from the ratio of the a.c. currents in the thermocouple.

The design for admittance measurements up to 300 Mc/s is described in § II; the coil dimensions are suitably decreased. Care must be taken to ensure that the emitter oscillates correctly at one frequency only, by tuning-in to a short-wave receiver. Good results down to 2 m were obtained from the emitter circuit of Rohde & Schwarz (1934 Abstracts, p. 509). The emitter for 1–2 m is shown in Fig. 2; an acorn triode was used in a 3-point circuit with very small coil and condenser. Fig. 3 shows the well-screened arrangement for measuring the grid input admittance of acorn valves; Fig. 4 shows the whole apparatus. Some experimental results are given in § III (Figs. 5–8); they show that, when the valves are warm, the input parallel impedance is inversely proportional to the square of the frequency, and the theory of input attenuation by electron transit time, already developed to include terms in the square of the frequency, is sufficient. This is not always true when the valves are cold. Acorn pentodes can be made to give five-fold amplification up to 200 Mc/s. A list of relevant literature from April 1935 until July 1936 is appended.

2574. The Behaviour of Thermionic Valves at High [and Ultra-High] Frequencies.—H. Rothe. (*Telefunken-Röhre*, April 1937, No. 9, pp. 33–65.)

Author's summary:—The electrons which, in a discharge arrangement, fly from the cathode to the anode, induce charges on all the electrodes. If the electron current has an a.c. component, induced alternating currents flow to all electrodes, even to negatively biased control grids. Owing to the finite path-times of the electrons, these alternating currents may contain real components.

The calculations of the alternating currents reaching the anode of a diode and the grid of an amplifying valve, and of the impedance, derived therefrom, of the anode in diodes and the control grid in amplifying valves, are collected and discussed. By measurements of the impedance of diodes and the grid resistances and grid capacities of various types of valve up to frequencies of about 300 Mc/s, the theoretical deductions are checked and confirmed. All valves with ordinary space-charge control are seen to display, up to these frequencies, positive grid conductivity and positive values of ΔC_g.

With characteristics which show a concave shape towards the abscissae, the induced a.c. currents must be inductive. The control grid of such a discharge device must therefore have a negative dynamic capacity variation ΔC_g and a negative ohmic conductivity, which appears even at low frequencies. This was confirmed by measurements on a triode with thorium cathode, whose characteristic (on transition to saturation) shows such a shape [Fig. 14]; and also on valves with "current-distributing" control [2575, below] such as hexodes, space-charge-grid valves, octodes, etc. The control grids of such devices show negative ohmic resistances, which are proportional to $1/\omega^2$ and which make possible the intensive excitation of short-wave oscillations, whose frequency is determined by the natural frequency of the associated circuit.

2575. Current Distribution: Part 4—Current Distribution and Space Charge.—Rothe & Kleen. (*Telefunken-Röhre*, April 1937, No. 9, pp. 90–114.)

For previous work *see* 537 of February. Authors' summary:—If an electron current of great density enters a discharge space limited by two electrodes, the current-distributing process between these electrodes is largely determined by the space charge. This is particularly marked in the case where a virtual cathode is formed between the electrodes. In practice such conditions often exist in space-charge-grid and dual-control valves (hexode, pentagrid-converter, heptode, octode).

The limiting conditions for the existence of a virtual cathode, calculated on certain simplifying assumptions, are given (sections III and VIII). The current-distributing process in cylindrical discharge devices is examined as a function of total current and electrode potentials. As the total current is varied, sudden changes in the current distribution, and hysteresis phenomena, are measured and found to agree qualitatively with what would be expected from simple calculation. The shapes of the current/voltage characteristics and of the modulation characteristics are discussed on the basis of measured characteristics (sections V and VI). The "return-current" characteristics ["by 'return-current' characteristics we mean the relation between current J_1 and voltage U_1 of the input electrode. On the assumption of constant total current the calculated curve for the current returning to the virtual cathode has the form shown in Fig. 10"] possess a dynatron character, an effect which agrees qualitatively with calculation (section VII).

The technical significance of the current-distributing process resulting from space-charge effect is examined for certain practical cases (sections VIII to XI).

2576. Investigations of the Space-Charge Law [Experimental Checking of the Langmuir-Schottky Law: Deductions].—W. Kleen. (*Telefunken-Röhre*, April 1937, No. 9, pp. 66–75.)

The experiments were carried out on a special two-electrode valve designed to avoid the important sources of error, particularly edge-distortion: thus the plane anode A (Fig. 2) is surrounded and backed by a guard-ring and electrode combination, S & S_1, and is parallel to the flat oxide-coated cathode K, of large surface. It was found that the calculated results reproduced very well the values of the space-charge currents for a Maxwellian distribution of electron velocities: occasional discrepancies between calculation and experiment indicated no clear contradiction. But the tests showed that the measured current is markedly greater than that calculated from the simple space-charge equation—by as much as about 50% for voltages of 10 volts. In the arrangement here employed, this difference is largely conditioned by the second term of eqn. 5; that is, by the effect described in section 2c [between potential threshold and anode, the electrons possess a velocity higher than that corresponding to the local potential value: the space-charge density is correspondingly smaller], and to a smaller degree by the influence of x_m [distance of potential threshold from cathode] and U_m [value of potential threshold]. Even when these two factors are allowed for, there is still an appreciable discrepancy. With increasing voltage the absolute value of the discrepancy increases, while the relative value decreases. That this difference is so large is understandable when one considers that the potential threshold acts as a filter which passes only the high-velocity electrons. All electrons, therefore, which reach the anode must have velocities greater by a considerable amount than the values of the local potentials. The consequent decrease of space-charge density must produce a corresponding increase of the space-charge current. . . ." Finally, practically useful approximations are given: thus for the normal working temperature of an oxide cathode, about 1000° K, the percentage p by which the actual space-charge current exceeds that derived from eqn. 11 is roughly $80/\sqrt{U}\%$.

2577. CONDITIONS IN THE ANODE/SCREEN SPACE OF THERMIONIC VALVES [Correspondence].—H. Rothe & W. Kleen: Calpine. (*Wireless Engineer*, April 1937, Vol. 14, No. 163, p. 195.) Arising from Calpine's paper (4062 of 1936) and referring to an exact mathematical treatment of the problem (2167 of June).

2578. THE THREE HALVES POWER LAW OF THE DIODE [New Method of Derivation].—E. B. Moullin: J. Greig. (*Wireless Engineer*, April 1937, Vol. 14, No. 163, p. 193.) For Greig's letter giving his elementary non-mathematical treatment see *ibid.*, June 1937, No. 165, pp. 317–318.

2579. THE EXTERNAL CHARACTERISTIC OF A DIODE RECTIFIER [Analysis of Diode/Load/Smoothing-Condenser Combination: Experimental Confirmation: Dependence of Mean Output Voltage and Ripple on Size of Condenser: Bi-Phase Half-Wave Rectification, including Cascade System: etc.].—E. B. Moullin. (*Journ. I.E.E.*, May, 1937, Vol. 80, No. 485, pp. 553–563.) An appendix discusses the contemporary work of Roberts (3393 of 1936) and of Aldous (691 of February).

2580. MEASUREMENTS ON THE EFFECT OF SPACE CHARGE ON THE INPUT CAPACITY OF AMPLIFYING VALVES [and Comparison with North's Formula].—E. Kettel: North. (*Telefunken-Röhre*, April 1937, No. 9, pp. 15–32.)

For North's formula *see* 1450 of 1936. Measurements of the variation of the input capacity with working conditions show that the formula agrees with the experimental results in form but not as regards the constants. A is not 1/3, but depends on the shape of the characteristic curve; B is not 2.24, differing very greatly from this value in the case of many valves. But such agreement is not to be expected, since the formula (eqn. 2) can only apply to valves following the three-halves law exactly. However, the formula can be extended (eqn. 8) so as to apply to valves with any shape of characteristic. As an example, eqn. 8 is applied to a variable-mu ("exponential") valve. This investigation leads to rules for the design of such valves so that they may have small capacity variations (rules 1–4, p. 31).

2581. VALVE CAPACITIES: THEIR INFLUENCE ON CIRCUIT TECHNIQUE AND THEIR MEASUREMENT: PART I [Definitions of Capacities: Their Influence on Circuits].—K. Steimel & C. Zickermann. (*Telefunken-Röhre*, April 1937, No. 9, pp. 1–14.) A short survey.

2582. DISCUSSION ON "FLUCTUATION NOISE IN VACUUM TUBES WHICH ARE NOT TEMPERATURE-LIMITED."—G. L. Pearson: Williams. (*Journ. I.E.E.*, May 1937, Vol. 80, No. 485, pp. 564–566.)

Pearson discusses Williams's paper (1793 of 1936) and defends his own support of Llewellyn's view of the residual noise at complete space-charge against that of Moullin & Ellis. Williams replies.

2583. MULTIPLE AMPLIFIER [Russian Secondary-Emission Electron Multipliers: Metallic Film on Glass Walls, subdivided by Chemical Method into Slanting Ring Electrodes: Characteristics: Possibility of Grid-Controlled Filamentless Valves for Radio Receivers: etc.].—L. A. Kubetski. (*Proc. Inst. Rad. Eng.*, April 1937, Vol. 25, No. 4, pp. 421–433.) For previous work *see* 243 of January.

2584. SECONDARY EMISSION FROM SOLID BODIES [Summarising Report, with Reference to Technical Applications, Amplifying Valves, Use in Electron Optics, etc.].—R. Kollath. (*Physik. Zeitschr.*, 1st April 1937, Vol. 38, No. 7, pp. 202–224.)

2585. THE CONTROL OF A GAS-FILLED VALVE THROUGH A PHASE-SHIFTING INPUT VALVE.—L. B. Turner. (*See* 2757.)

2586. AN EXPERIMENTAL THERMIONIC TUBE [with Closer and More Precise Spacing than in Taylor & Langmuir's Tube].—Clemens & Phipps. (*Review Scient. Instr.*, April 1937, Vol. 8, No. 4, pp. 133–134.)

2587. DEVELOPMENTS IN VALVE DESIGN IN 1936.—(*Radio, B., F. für Alle*, May 1937, No. 5, Supp. pp. 1–17.) Being the first chapter of the serial *Fortschritte der Funktechnik II*.

2588. DISCUSSION ON "TENSOR ANALYSIS OF MULTIELECTRODE-TUBE CIRCUITS."—Boyajian, Bewley, & Kron. (*Elec. Engineering*, May 1937, Vol. 56, No. 5, pp. 614–621.) *See* 911 of March.

2589. FREQUENCY CHANGERS IN ALL-WAVE RECEIVERS: THE PERFORMANCE OF SOME TYPES.—Strutt: Mullard Company. (*Wireless Engineer*, April 1937, Vol. 14, No. 163, pp. 184–192.)

Cf. 1810 of May. A bibliography of 57 items is included. For a letter from Goldup on a triode-hexode, since developed in the Mullard laboratories, "which avoids most of the effects mentioned."

see *ibid.*, June 1937, No. 165, p. 318; it has a rather high oscillator slope, so that oscillator circuits can be loosely coupled to the valve, thus practically eliminating frequency drift.

2590. THE AUDIO-FREQUENCY CONTROL OF THE SCREEN GRID OF HIGH-FREQUENCY PENTODES.—Neulen & Wehnert. (See 2617.)

2591. METAL VALVE FOR DETECTION, AMPLIFICATION, OR GENERATION OF OSCILLATIONS: HEATER FILAMENT REPLACEABLE WITHOUT AFFECTING VACUUM.—Telefunken. (French Pat. 809 272, pub. 27.2.1937: *Rev. Gén. de l'Élec.*, 24th April 1937, Vol. 41, No. 17, p. 135D.)

2592. NUMBERING TUBES: COMMENTS ON THE SUGGESTED SYSTEM.—(*Rad. Engineering*, April 1937, Vol. 17, No. 4, pp. 22–23.) See 2174 of June.

2593. "THE PHYSICS OF ELECTRON TUBES: SECOND EDITION" [Book Review].—L. R. Koller. (*Electronics*, April 1937, Vol. 10, No. 4, p. 46.)

2594. AN INVESTIGATION OF THE OPERATION OF AN OVER-DRIVEN VALVE WITH VARIOUS VALUES OF GROUND DRIVE.—S. I. Evtyanov. (*Izvestiya Elektroprom. Slab. Toka*, No. 2, 1937, pp. 13–21.)

Continuing the work dealt with in 58 of January, a theoretical discussion is presented of the operation of an over-driven valve. Static and dynamic characteristics are plotted for various values of the drive-voltage, and methods are indicated for determining the operating constants of the valve, such as the depth of the trough of the anode current characteristic, the power output, efficiency, etc. On the basis of this discussion a number of curves are plotted for a 1.5 kw valve manufactured in the U.S.S.R. It appears from these curves that the maximum output is obtained when the valve is over-driven, although the efficiency is somewhat decreased. The theoretical results so obtained are verified experimentally.

2595. CORRECTED DIAGRAM TO THE ARTICLE "TECHNIQUE OF TRANSMITTING VALVES."—Warnecke. (*L'Onde Élec.*, April 1937, Vol. 16, No. 184, p. 269.) See 1817 of May.

2596. X-RAYS IN VACUUM TUBE MANUFACTURE.—W. T. Gibson. (*Elec. Communication*, Jan. 1937, Vol. 15, No. 3, pp. 224–231.)

DIRECTIONAL WIRELESS

2597. SIMULTANEOUS RADIO RANGE AND TELEPHONE TRANSMISSION [on Same Carrier Frequency: Single-Sideband Range Tone (Modulation not exceeding 30%) radiated Directionally from Four Towers and heterodyned by All-Round Carrier from Central Tower, serving also for Weather Broadcasts (Modulation not exceeding 70%): Linear Detection necessary].—W. E. Jackson & D. M. Stuart. (*Proc. Inst. Rad. Eng.*, March 1937, Vol. 25, No. 3, Part 1, pp. 314–326.)

The possibility and difficulties of *double* sideband transmission of the range signals is also discussed.

2598. "RADIO BEACONS" [Book Review].—V. I. Bashenoff & N. A. Myasoedoff. (*Wireless Engineer*, April 1937, Vol. 14, No. 163, p. 174.)

2599. ULTRA-SHORT-WAVE RADIO LANDING BEAM: THE C. LORENZ-A.G. RADIO BEACON GUIDE BEAM SYSTEM.—Elsner & Kramar. (*Elec. Communication*, Jan. 1937, Vol. 15, No. 3, pp. 195–206.)

2600. SOME PROBLEMS OF AVIATION RADIO [including "Rain Static" and Its Elimination by Electrostatically Shielded Loop Aerials: "Z" Markers to provide Positive, instead of Negative, Indication of Position directly over Beacon: etc.].—F. X. Rettenmeyer. (*RCA Review*, April 1937, Vol. 1, No. 4, pp. 113–118.)

2601. "PULSE" DIRECTION-FINDING.—H. Plendl. (*E.T.Z.*, 8th April 1937, Vol. 58, No. 14, pp. 382–383.) From a paper in *Luftfahrt-Forschung*. See also 2186 of June.

2602. RADIO COMPASSES FOR SMALL BOATS.—(*Electronics*, April 1937, Vol. 10, No. 4, pp. 9–11.)

2603. DETECTION OF MOVING OBJECTS [Aircraft, etc.] by Ultra-Short Waves: Use of an Interference Field produced by Two Dipole/Reflector Systems at Slight Angle, fed from Common Transmitter].—Telefunken. (French Pat. 809 612, pub. 8.3.1937: *Rev. Gén. de l'Élec.*, 24th April 1937, Vol. 41, No. 17, p. 136D.)

ACOUSTICS AND AUDIO-FREQUENCIES

2604. ON A FORMULA OF RAYLEIGH FOR VELOCITY POTENTIAL [Applicability to Piston-Baffle Problem].—N. W. McLachlan & A. T. McKay: S. Ballantine. (*Journ. Franklin Inst.*, April 1937, Vol. 223, No. 4, pp. 501–508: Discussion pp. 508–509.)

The formula in question was discussed in a paper referred to in 2656 of 1936 (Ballantine). Here, McLachlan & McKay show mathematically that it is applicable to the case of a *plane* piston and a *plane* baffle. Ballantine argues that the simplification introduced by their planarity "will not occur so conveniently in all piston-baffle problems," and emphasises the advantages of using the general differential equation for velocity potential, rather than Rayleigh's formula for velocity potential, as "a starting point in acoustical investigations connected with vibrating surfaces."

2605. OPERATIONAL FORMS FOR BESSEL AND STRUVE FUNCTIONS.—McLachlan & Meyers. (*Phil. Mag.*, May 1937, Series 7, Vol. 23, No. 157, pp. 918–925.)

2606. REPRODUCTION OF TRANSIENTS BY A HORN LOUDSPEAKER.—N. W. McLachlan. (*Wireless Engineer*, April 1937, Vol. 14, No. 163, pp. 168–174.)

The electrical analogue of the horn loudspeaker: form of applied transient—numerical data (*cf.* 160 of January & 567 of February): sound-pressure wave-form at throat of horn: the equivalent electrical circuit of the loudspeaker (*not* an electrical analogue: obtained by making an addition to the equivalent circuit of the hornless type): horn theory: behaviour of horn to transients (dual action:—introduction of a transient of its own—3053 of 1936—and damping action on diaphragm).

2607. HORN LOUDSPEAKERS: PART I—IMPEDANCE AND DIRECTIONAL CHARACTERISTICS [Conical and Exponential Horns: Relative Effect of Mouth Shape and Dimensions and of Flare: Multi-Horn (Cellular) Loudspeakers: Ring-Shaped Mouths and Their Directional Characteristics: etc.].—H. F. Olson. (*RCA Review*, April 1937, Vol. 1, No. 4, pp. 68–83.) With 12 literature and patent references.

2608. EFFICIENCY OF HORN LOUDSPEAKERS [Derivation of Equation and Some Unexpected Conclusions].—F. Massa. (*Electronics*, April 1937, Vol. 10, No. 4, pp. 30–32.)

The equation was used to compute the curves in a previous paper (1020 of March). Among the conclusions arrived at from the analysis, some of which are contrary to popular belief, are:—the efficiency is independent of the size of wire in the voice coil: it is dependent on the product of the resistivity and the density of the voice-coil conductor, and with proper design will increase as this product is decreased: "however, as actually constructed, some speakers will show an increase in efficiency if this product is increased"—thus if an aluminium coil is less than one-third of the mass of the remainder of the vibrating system, the high-frequency efficiency will be improved by replacing it by a copper coil.

2609. AN INVESTIGATION OF STANDING SOUND WAVES OF LARGE AMPLITUDE.—L. L. Myasnikov. (*Journ. of Tech. Phys.* [in Russian], No. 3, Vol. 7, 1937, pp. 219–224.)

In connection with research on the operation of high-power loudspeakers, a preliminary investigation was made of the distribution of sound pressure in an iron pipe 300 cm long and of 3.3 cm internal diameter, placed in front of the diaphragm of a 250-watt electrodynamic loudspeaker. For experiments with an "infinitely long" pipe an additional flexible pipe, 10 m long, was used. Curves are given showing the distribution of the constant and variable components of the sound pressure in the pipe. The curves were plotted for various outputs and frequencies (from 5 to 10 000 c/s).

2610. THE ACOUSTICAL LABYRINTH [and Its Success in eliminating Loudspeaker "Boom" and giving Better Over-All Response than an Infinite Baffle].—B. J. Olney. (*Electronics*, April 1937, Vol. 10, No. 4, pp. 24–27 and 36.) Based on the work dealt with in 1019 of March.

2611. THE PRODUCTION OF ROCHELLE SALT RESONATORS HAVING A PURE LONGITUDINAL MODE OF VIBRATION, *and* LONGITUDINAL EFFECT IN ROCHELLE SALT.—Stamford: Cady. (*See* 2716 and 2717.)

2612. SIMPLE EQUIPMENT FOR MEASURING THE FREQUENCY CHARACTERISTICS OF LOUDSPEAKERS [using Rotating-Condenser "Wobbler," Rochelle-Salt Microphone, etc.].—H. Strack. (*Funktech. Monatshefte*, April 1937, No. 4, pp. 105–107.)

2613. CONTRIBUTION TO THE INVESTIGATION OF THE CONNECTION BETWEEN THE DUST FIGURES OBSERVED WITH FLEXURAL OSCILLATIONS OF RECTANGULAR AND SQUARE PLATES [Theoretical and Experimental Determination of Nodal Lines].—B. Pavlík. (*Ann. der Physik*, Series 5, No. 7, Vol. 28, 1937, pp. 632–648.) The results are found to differ from those of E. Goldmann (Breslau Dissertation, 1918).

2614. "LAUTSPRECHER- UND VERSTÄRKERANLAGEN."—R. Petillon. (At Patent Office Library, London: Cat. No. 77 382.)

2615. PUBLIC ADDRESS INSTALLATION FOR THE PERFORMANCES OF "LE VRAY MISTÈRE DE LA PASSION" ON THE SQUARE IN FRONT OF NOTRE DAME CATHEDRAL.—G. Meunier. (*Elec. Communication*, Jan. 1937, Vol. 15, No. 3, pp. 251–258.)

2616. ON THE BEHAVIOUR OF A CIRCUIT WITH A VARIABLE RESISTANCE [*e.g.* a Carbon Microphone].—Sapozhnikov. (*See* 2495.)

2617. THE AUDIO-FREQUENCY CONTROL OF THE SCREEN GRID OF HIGH-FREQUENCY PENTODES [*e.g.* by Gramophone Pick-Ups: Analysis and Experimental Confirmation].—F. Neulen & W. Wehnert. (*Telefunken-Röhre*, April 1937, No. 9, pp. 76–89.)

Authors' summary:—The results of the investigation combine to show that modulation by the screen grid of a pentode, which as regards the connection to a pick-up without additional complications [switching, etc.] presents considerable advantages, is perfectly practicable without introducing any appreciable disadvantages. It is true that the drop of modulating voltage at the higher frequencies, due to the loading of the pick-up, is greater than with control by the first grid (when the connection to the latter is through a coupling condenser), but this effect is actually desirable in gramophone reproduction, since it is just the low frequencies which are weakened in the ordinary method of disc recording and thus require greater amplification.

2618. DIRECT RECORDING AND REPRODUCING MATERIALS FOR DISC RECORDING [Five Chemical Groups: Measurements of Frequency Characteristic, Surface Noise, Life, Distortion, etc.].—A. C. Keller. (*Journ. Acoust. Soc. Am.*, April 1937, Vol. 8, No. 4, pp. 234–242.)

2619. ELECTROMECHANICAL LONG-PLAYING GRAMOPHONE ["Tefiphone," using Multiple-Track Endless (and Twisted) Films with Engraved Layer on Both Sides of Celluloid Base: 12½ or 25 Hours for 100 Metres of Film].—(*Funktech. Monatshefte*, April 1937, No. 4, pp. 129–130.)

2620. SOUND-ON-FILM RECORDERS AND REPRODUCERS [using Unperforated 5.8 mm Film: for High-Fidelity 11-Minute Records].—Klangfilm Company. (*Funktech. Monatshefte*, April 1937, No. 4, pp. 128–129.) Not for home use, both instrument and records being too expensive: but will, it is hoped, do valuable pioneer work for the long wanted film-gramophone.

2621. THE OCCURRENCE AND ELIMINATION OF THE "THUNDER" EFFECT IN AMPLITUDE SOUND-ON-FILM RECORDING.—A. Narath. (*Zeitschr. f. tech. Phys.*, No. 5, Vol. 18, 1937, pp. 121–136.)

2622. NEWEST INVENTION IMPROVES HUMAN VOICE ON THE RADIO [Electrical "Voice Editor" for Broadcasting or Recording].—Hays Hammond. (*Sci. News Letter*, 6th March 1937, Vol. 31, p. 152.) Note on a recent U.S. patent.

2623. TRANSPOSITION OF SPEECH SOUNDS [Articulation Test with Nose and Mouth filled with Hydrogen].—E. Bárány. (*Journ. Acoust. Soc. Am.*, April 1937, Vol. 8, No. 4, pp. 217–219.)

2624. THE RECORDING OF THE MUSIC FOR REINHARDT'S PRODUCTION "THE ETERNAL ROAD" [eliminating Orchestra from Stage].—(*Electronics*, April 1937, Vol. 10, No. 4, pp. 28–29 and 75, 76, 77.)

2625. ON SOUND MIXING EQUIPMENT FOR SOUND FILMS [for 4 Different Sources, some of which may be Sound Tracks or Gramophone Records].—A. F. Shorin. (*Izvestiya Elektroprom. Slab. Toka*, No. 1, 1937, pp. 16–22.)

2626. A NEW METHOD OF SOUND RECORDING [Track of Very Fine Iron Powder fixed by Quick-Drying Adhesive].—H. Rademaker. (*Radio, B., F. für Alle*, April 1937, No. 4, pp. 57–59.)

2627. PRACTICAL [Negative-] FEEDBACK AMPLIFIERS [Design Calculations and Performance Curves: Single-Sided and Push-Pull, using 6L6 Beam Power or 6A6 Double Triode Output: Output up to 25 Watts at 1% Distortion].—J. R. Day & J. B. Russell. (*Electronics*, April 1937, Vol. 10, No. 4, pp. 16–19.)

2628. AUDIO FEEDBACK.—Rumble. (*See* 2487.)

2629. PHASE REVERSAL IN PUSH-PULL "QUALITY AMPLIFIERS": USE OF HEPTODE.—Inglis. (*See* 2545.)

2630. ON NEGATIVE RESISTANCE EQUALISERS FOR TELEPHONE TRANSMISSION SYSTEM.—S. P. Chakravarti. (*Phil. Mag.*, May 1937, Series 7, Vol. 23, No. 157, pp. 897–918.)

The experiments described show "the possibility of developing equaliser elements from negative circuit constants to correct the attenuation characteristic of a telephone circuit or an audio-amplifier." Elements with positive and negative circuit constants are combined to form non-reactive impedances of types giving attenuation increasing and decreasing respectively with frequency. Correction of the gain of a transformer-coupled audio-frequency amplifier and the attenuation of a cable circuit is discussed, with measurements of phase-shift as a function of frequency and reference to the stability and advantages of the equaliser.

2631. GENERAL EQUALISER THEORY, TWO-TERMINAL AND CONSTANT-RESISTANCE STRUCTURES [with General Formulae, General Design Formulae, and Charts].—(*Marconi Review*, Jan./Feb. 1937, No. 64, pp. 20–30: to be contd.)

2632. THE CALCULATION OF INPUT, OR SENDING-END, IMPEDANCE OF FEEDERS AND CABLES TERMINATED BY COMPLEX LOADS.—Cafferata. (*See* 2678.)

2633. RESISTANCE-COUPLED A.F. OSCILLATOR [150–10 000 c/s].—T. A. Ledward. (*Wireless World*, 14th May 1937, Vol. 40, pp. 465–466.)

2634. FINITE ACOUSTIC FILTERS.—R. B. Lindsay. (*Journ. Acoust. Soc. Am.*, April 1937, Vol. 8, No. 4, pp. 211–216.) "Most of the previous theoretical work on acoustic filtration has dealt with idealised infinite structures. The present paper is a theoretical study of finite filters such as are used in practice."

2635. SOUND ANALYSIS [and the Five Main Classes of Analyser and Four Groups of Sound: Times taken for Analysis: etc.].—H. H. Hall. (*Journ. Acoust. Soc. Am.*, April 1937, Vol. 8, No. 4, pp. 257–262.)

2636. A NEW NOISE-METER [Type 2A: Portable].—J. M. Barstow. (*Bell Lab. Record*, April 1937, Vol. 15, No. 8, pp. 252–256.) "Agrees better with tests of the effects of noise than does any other apparatus available."

2637. A GENERATOR FOR ALTERNATING CURRENTS OF EXTREMELY LOW FREQUENCY.—Lavrentjev. (*See* 2511.)

2638. A PENTODE-OPERATED FREQUENCY METER OF THE CONDENSER-CHARGING TYPE.—Wheatcroft & Haley. (*See* 2711.)

2639. EXPERIMENTAL REPRESENTATION OF ACOUSTIC TRANSIENTS [showing Their Influence on the Character of Musical Sounds].—V. Aschoff. (*Hochf:tech. u. Elek:akus.*, April 1937, Vol. 49, No. 4, pp. 138–140.)

A circuit is given (Fig. 8) for regulating the duration of the initial transients in electrically produced oscillations and for obtaining oscillograms of the vibrations of strings. It was originally developed for laboratory use with a trautonium, to demonstrate the influence of transients on the character of musical sounds. The principle of the arrangement (Fig. 1) is similar to one already developed by von Békésy (1933 Abstracts, p. 398); the displacement of the grid bias of a regulating valve, in circuit with a generator of "kipp" oscillations and an amplifier containing the "formant" circuits, can be varied. Fig. 2 shows the circuit for controlling switch-on transients, Fig. 4 that for varying the amplitude of existing tones; R_1 is the resistance which varies the transient time-constants. A "physiological transient time" is found which is much smaller than that given by von Békésy (*loc. cit.*). Illustrative oscillograms are given.

2640. The Principles underlying the Tuning of Keyboard Instruments to Equal Temperament.—G. F. H. Harker. (*Journ. Acoust. Soc. Am.*, April 1937, Vol. 8, No. 4, pp. 243–256.)

2641. The Vibrating String considered as an Electrical Transmission Line.—W. E. Kock. (*Journ. Acoust. Soc. Am.*, April 1937, Vol. 8, No. 4, pp. 227–233.)

2642. The Problem of the Striking of Strings by the Hammer of a Pianoforte: I and II, *and* The Energy Spectrum of a String struck by a Pianoforte Hammer.—Rimski-Korsakov. (*Journ. of Tech. Phys.* [in Russian], No. 1, Vol. 7, 1937, pp. 43–74: No. 3, Vol. 7, 1937, pp. 225–241.)

For a paper by Korsakov & Samoilenko on an experimental investigation of hammer-felt, and one by Korsakov on the energy spectrum in plucked stringed instruments, see *ibid.*, No. 2, Vol. 7, 1937, pp. 135–150 and 151–159.

2643. The Onset of Sound on an Organ [Experimental Investigation of Transients of Organ].—Trendelenburg & Thienhaus. (*Journ. Acoust. Soc. Am.*, April 1937, Vol. 8, No. 4, p. 264.) Summary of a paper in *Akustische Zeitschr.* See also 1395 of April.

2644. The Acoustics of Wind Instruments: II.—Struve. (*Journ. of Tech. Phys.* [in Russian], No. 1, Vol. 7, 1937, pp. 75–80.) For I *see* 186 of January.

2645. The Acoustic Frequencies given by a Cylindrical Pipe with a Vibrating Reed [as Function of Length of Pipe].—L. Auger. (*Comptes Rendus*, 19th April 1937, Vol. 204, No. 16, pp. 1169–1171.)

2646. Concerning a Phenomenon of Persistence of Sound Impressions on the Ear: Simultaneous Duplex Radio-Telephony.—Marro. (*See* 2778.)

2647. Analysis of the Action of Alternating Currents on the Auditory Apparatus.—G. Gersuni [Gerschuni]. (*Tech. Phys. of USSR*, No. 2, Vol. 4, 1937, pp. 163–174: in German.)

2648. Deaf Aids manufactured in the USSR.—Scheiwechman. (*Journ. of Tech. Phys.* [in Russian], No. 2, Vol. 7, 1937, pp. 160–162.)

2649. The Aural Detection of the Larvae of Insects in Timber.—F. M. Colebrook. (*Journ. Scient. Instr.*, April 1937, Vol. 14, No. 4, pp. 119–121.)

2650. Standard Acoustical Terminology [issued by American Standards Association].—(*Journ. Franklin Inst.*, April 1937, Vol. 223, No. 4, p. 526: short note only.)

2651. Ventilator Noise and Its Reduction.—S. Alexeev. (*Journ. of Tech. Phys.* [in Russian], No. 3, Vol. 7, 1937, pp. 242–249.)

2652. Smoke Eliminated by Super-Sound Wave [by passing Smoke through Tube containing Standing Supersonic Waves].—H. W. St. Clair. (*Journ. Franklin Inst.*, April 1937, Vol. 223, No. 4, p. 510: note on paper in *Power Plant Engineering*, Vol. 41, No. 3.) *See* also *Sci. News Letter*, 6th March 1937, Vol. 31, pp. 148–149.

2653. Detection and Location of Laminations in Steel Plates, *and* Recent Problems in Supersonics.—Hayes: Bergmann. (*Journ. Acoust. Soc. Am.*, April 1937, Vol. 8, No. 4, pp. 220–226: p. 263.)

2654. Theory of the Diffraction of Light by Supersonic Waves.—Weigle. (*See* 2658.)

PHOTOTELEGRAPHY AND TELEVISION

2655. Cathode-Ray Tube with 6-Micron Tungsten or Molybdenum Screen raised to Incandescence by Spot [Brightness Several Hundred Times that of Fluorescent Screens].—Philips Company. (French Pat. 809 519, pub. 4.3.1937: *Rev. Gén. de l'Élec.*, 24th April 1937, Vol. 41, No. 17, p. 136D.)

2656. On the Thermoluminescence in Certain Minerals [heated to Temperature below Dark Red].—Royer. (*Journ. de Phys. et le Radium*, April 1937, Vol. 8, No. 4, p. 48S.)

2657. Production of White Light by Electrical Luminescence of Xenon.—M. Laporte. (*Comptes Rendus*, 26th April 1937, Vol. 204, No. 17, pp. 1240–1242.) *See* also 1061 of March.

2658. Theory of the Diffraction of Light by Supersonic Waves.—Weigle: Extermann. (*Journ. de Phys. et le Radium*, April 1937, Vol. 8, No. 4, p. 42S.) *See* also 583/584 of February.

2659. Experiment on the Transformation of Infra-Red Rays into Visible Light [Simplified Device].—G. Buthry & G. Sandoz. (*Journ. de Phys. et le Radium*, April 1937, Vol. 8, No. 4, p. 46S.) Prompted by the work dealt with in 1934 Abstracts, p. 331, and 4123 *bis* of 1936.

2660. Russian Secondary-Emission Electron Multipliers, *and* Secondary Emission from Solid Bodies.—Kubetsky: Kollath. (*See* 2583 and 2584.)

2661. The Light Intensity at the Screen in Film Projection.—O. Reeb. (*E.T.Z.*, 22nd April 1937, Vol. 58, No. 16, pp. 430–431: summary only.)

2662. Magnetic Scanning Defects and Their Causes.—I. G. Maloff. (*Television*, May 1937, Vol. 10, No. 111, pp. 268–270.)

2663. The Latest Improvements in Television [including the Barthélémy Procedure for Interlaced Scanning and Its Advantages].—Barthélémy. (*Génie Civil*, 17th April 1937, Vol. 110, No. 16, p. 361.) Summary of a lecture.

2664. Arrangements for the Production of Greatly Enlarged Television Images with an Effect of Relief, using Concave Mirrors or Liquid Lenses.—Toulon. (French Pat. 808 805, pub. 16.2.1937: *Rev. Gén. de l'Élec.*, 24th April 1937, Vol. 41, No. 17, p. 133D.)

2665. The First Acorn-Valve Receiver for Vision Signals.—(*Television*, May 1937, Vol. 10, No. 111, pp. 273–275.)

2666. An Experimental Television Transmitter, *and* An Experimental Television Receiver.—van Mierlo & Gloess: van Mierlo & Pulles. (*Elec. Communication*, Jan. 1937, Vol. 15, No. 3, pp. 232–235: pp. 236–238.) From the laboratories of Le Matériel Téléphonique, Paris.

2667. Field Strength Measurements of the Alexandra Palace Transmissions: Results of a Complete Survey of the Service Area.—(*Television*, May 1937, Vol. 10, No. 111, pp. 265–267.) From the *B.B.C. Annual*, 1937.

2668. Experimental Studio Facilities for Television [at NBC Quarters, Radio City: for RCA Field Tests of Television].—O. B. Hanson. (*RCA Review*, April 1937, Vol. 1, No. 4, pp. 3–17.)

2669. Television Studio Considerations: Part I [" Emphasis " as the Evaluation of Prominence: Seven Rules].—W. C. Eddy. (*Comm. & Broad. Eng.*, April 1937, Vol. 4, No. 4, pp. 12–13 and 27.) The writer is Studio Director, Farnsworth Television, Inc.

2670. America's Biggest Step in Television: " Out of the Laboratory and into the Field."—(*Television*, May 1937, Vol. 10, No. 111, pp. 260–263.)

2671. Institute of Television of Japan: Annual Report, 3rd Issue.—(At Patent Office Library, London: Cat. No. 77411.)

2672. Television Programme Ideas and Criticism.—(*Television*, April & May 1937, Vol. 10, Nos. 110 & 111, pp. 214–215 and 292, 316.)

2673. " Television Cyclopedia " [Book Review].—A. T. Witts. (*Wireless Engineer*, May 1937, Vol. 14, No. 164, p. 241.)

2674. The Development of Television [1875–1894].—Begrich. (*Funktech. Monatshefte*, April 1937, No. 4, Supp. pp. 29–34: to be contd.)

2675. Modern Systems of Multi-Channel Telephony on Cables [including Provision for Television].—A. S. Angwin & R. A. Mack. (*Electrician*, 23rd April 1937, Vol. 118, pp. 543–545.) Summary of an I.E.E. paper.

2676. The Coaxial Cable System [New York/Philadelphia: including Its Use for Television: Necessity for Shifting the Frequency Band Upwards: etc.].—E. I. Green. (*Bell Lab. Record*, May 1937, Vol. 15, No. 9, pp. 274–280.)

2677. Correction of Formula in " The Optimum Cross-Section of the Symmetrical Wide-Band Cable."—F. Kirschstein. (*E.N.T.*, March 1937, Vol. 14, No. 3, p. 118.) *See* 224 of January.

2678. The Calculation of Input, or Sending-End, Impedance of Feeders and Cables terminated by Complex Loads [with help of Chart covering Frequencies from Audio to Ultra-Short-Wave, applicable also to Filters, Delay and Phase-Shift Networks, etc.].—H. Cafferata. (*Marconi Review*, Jan./Feb. 1937, No. 64, pp. 12–19.) Provided the total attenuation of the system is below 3 nepers. Theory and formulae employed will be given in a later paper.

2679. Telephotograph Transmitter and Receiver, *and* Terminal Equipment for Telephotography. — H. Pfannenstiehl: J. A. Coy. (*Bell Lab. Record*, May 1937, Vol. 15, No. 9, pp. 289–292: pp. 293–297.)

2680. Photoelectric Cell with Little or No Loss of Sensitivity through Ageing: Positive Ions Diverted away from Active Parts of Cathode.—Philips Company. (French Pat. 809 247, pub. 26.2.1937: *Rev. Gén. de l'Élec.*, 24th April 1937, Vol. 41, No. 17, p. 135D.)

2681. A Volume Rectification Effect in Illuminated Cuprous-Oxide Crystals.—Groetzinger & Lichtschein. (*Physik. Zeitschr.*, 15th April 1937, Vol. 38, No. 8, pp. 292–298.)

See also 3870 of 1936. The present more detailed description describes the experimental method (§ II, Fig. 1) and gives measured curves for the variation of the volume rectification effect with the applied alternating voltage (Fig. 2) and for the variation with illuminated intensity of the direct voltage due to the Dember effect and the volume rectification effect (Fig. 3). No volume rectification is found when artificial cuprous oxide is illuminated (§ IV). A close connection is found between the occurrence of the crystal photoeffect and the volume rectification effect. The relation to the electron theory of semiconductors is mentioned; it is concluded that " rectification is also caused by the difference in distribution of the electrons within the permitted energy bands at different places in the crystal."

2682. The Spectral Distribution of the Inner Photoeffect in Cuprous Oxide.—A. W. Joffé & A. Th. Joffé. (*Physik. Zeitschr. der Sowjetunion*, No. 3, Vol. 11, 1937, pp. 241–262: in English.)

Among the conclusions reached:—No simple physical meaning to the fundamental maximum of spectral curve of photoconductivity of cuprous oxide at 630 mμ: it is displaced towards shorter wavelengths as the oxide thickness is reduced, and at 9 μ the curve reaches practically the curve of barrier-layer photoeffect, which has a maximum at 540 mμ (*cf.* same writers, 1934 Abstracts, p. 624), so that the latter effect, always considered as completely different, appears to correspond to the inner photoeffect in an extremely thin layer of not more than $1\ \mu$: the photo-conductivity per unit of absorbed energy is independent of wavelength in the visible spectrum, and observed deviations in the ultra-violet and far-red regions are only due to insufficient allowance for strong reflection and to the appearance of a second absorption band, respectively: the connection between the temperature coefficient of conductivity and the limit of photoconductivity is not established for cuprous oxide—"in such semiconductors as cuprous oxide, where the current is carried by 'positive holes,' one must not expect a relation $\omega = U/2$ to hold."

2683. The General Electric Light Sensitive Cell [Selenium on Iron, covered with Semi-Transparent Layers of Metal].—C. W. Hewlett. (*Gen. Elec. Review*, April 1937, Vol. 40, No. 4, p. 212.)

2684. Photo-EMF Cell Characteristics [German "Electrocell" Selenium-on-Iron Self-Generating Cells: Measurement Methods and Curves of Current & Voltage Output in terms of Light Intensity and Wavelength].—R. M. Holmes. (*Electronics*, April 1937, Vol. 10, No. 4, pp. 33 and 56, 58, 60.)

2685. New Double and Differential Selenium-on-Iron Photocells.—Suddeutsches App. Fabrik. (*Electronics*, April 1937, Vol. 10, No. 4, pp. 42 and 44.)

2686. On the Temperature Coefficient of the Selenium Photoelement [Experimental Investigation].—E. K. Puzeiko. (*Journ. of Tech. Phys.* [in Russian], No. 1, Vol. 7, 1937, pp. 10–23.)

2687. Supplement to My Photoelectric and Optical Measurements on Silver, Zinc, and Fuchsin [Optical Behaviour of Silver and Zinc in Range from Infra-Red to Ultra-Violet, 230 mμ].—Hlučka. (*Zeitschr. f. Physik*, No. 9/10, Vol. 104, 1937, pp. 653–657.) *See* 610 of February.

2688. Influence of Luminous Intensity on the Sensitivity of Photoelectric Counters [Measurements with Monochromatic Light].—J. Roulleau. (*Comptes Rendus*, 19th April 1937, Vol. 204, No. 16, pp. 1191–1192.)

MEASUREMENTS AND STANDARDS

2689. The Properties of Chokes, Condensers, and Resistors at Very High Frequencies [Experimental Data at 30–100 Mc/s].—L. Hartshorn & W. H. Ward. (*Journ. Scient. Instr.*, April 1937, Vol. 14, No. 4, pp. 132–135.)

2690. Attenuators and Potential Dividers for Use at Radio-Frequencies [Survey].—N. F. Astbury. (*Journ. Scient. Instr.*, April 1937, Vol. 14, No. 4, pp. 113–118.)

2691. Measurement of Attenuation at High Frequencies [up to 5 Mc/s: Standard Attenuators with Special Low-Phase-Angle Resistances: etc.].—F. R. Dennis. (*Bell Lab. Record*, April 1937, Vol. 15, No. 8, pp. 247–251.)

2692. Resistances free from Stray Fields and with Calculable Time Constants, for Audio and Radio Frequencies [as Substitution Standards for Wagner Bridge].—F. Söchting. (*Elektrot. u. Masch:bau*, 4th April 1937, Vol. 55, No. 14, pp. 161–165.)

The accuracy of a.c. bridge results depends on the accuracy with which the constants of the substitution standard are known. The usual standards (circular loop for values under 1 ohm, stretched parallel wires for higher values) both have considerable inductive and capacitive leakage fields which may lead, actively and passively, to errors: thus with a resistance of 1000 ohms the change of time constant due to capacity to earth may be twice as great as the time constant of the wire pair itself. Screening upsets the calculated time constant: further, it is difficult to construct such resistances of value greater than about 1000 ohms.

The standards here described, in the form of vertically mounted, readily interchangeable units of concentric-cable type (straight lengths of brass or copper tube with a single stretched wire—or spirally wound "resistance cord" for values over 1000 ohms—along the axis) can range from 10 to 10^4 or 10^6 ohms, and their time constants can be determined to within 10^{-9} or 10^{-10} sec. at frequencies from 800 c/s to 1.5 Mc/s. This accuracy is obtained without any auxiliary screening, which however can easily be applied if desired. For low values the stretched wire is replaced by a resistance tube. The high resistances using the wound "resistance cord" cannot be calculated accurately from their geometrical dimensions, but can be determined with the same degree of accuracy as the others by indirect methods.

2693. Alternating-Current Resistance of Rectangular Conductors [Width/Thickness Ratios 1 : 1 to 2400 : 1, Frequencies up to 8 kc/s: Experimental Data confirming Dwight's "Principle of Similitude": Skin Effect Formulae of Rayleigh, Dwight, and Cockcroft].—S. J. Haefner. (*Proc. Inst. Rad. Eng.*, April 1937, Vol. 25, No. 4, pp. 434–447.)

2694. A Modified Potentiometer for measuring Very Small Resistances [Reduction of Troubles due to "Residual E.M.F."].—P. Kapitza & C. J. Milner. (*Journ. Scient. Instr.*, May 1937, Vol. 14, No. 5, pp. 165–166.)

2695. The Temperature Coefficient of Inductance [depends on Four Factors—Thermal Expansion, Skin Effect, Eddy Currents, Self Capacitance: Experimental Confirmation of 3rd (distinct from 2nd) and 4th Factors].—J. Groszkowski. (*Proc. Inst. Rad. Eng.*, April 1937, Vol. 25, No. 4, pp. 448–464.)

Systematic experimental investigation of the writer's theory dealt with in 678 of 1936, with appendices giving the theoretical relations.

2696. Measurement of the Self-Capacity of Iron-Cored Coils [Resonance Methods applicable in spite of Variation of Inductance with Frequency].—M. Reed. (*Wireless Engineer*, May 1937, Vol. 14, No. 164, pp. 252–255.)

2697. An Apparatus using Magnetic Differentiation for the Comparison of Impedances.—F. Neri. (*L'Elettrotec.*, 10th April 1937, Vol. 24, No. 7, pp. 190–196.)

The differential magnetic effect of a twisted twin-wire primary of a transformer can be used to compare two currents, one flowing in each wire. The writer describes the theory and construction of an instrument, based on this principle, which gives extremely accurate measurement of inductances, capacities, and resistances by comparison with a reference standard. The complete apparatus is of multiple-ratio design. For an application to the testing of voltage transformers see *ibid.*, 25th April 1937, pp. 230–234.

2698. Bridge for Direct Impedance Measurement.—G. W. O. H: Laurent: Serner. (*Wireless Engineer*, May 1937, Vol. 14, No. 164, pp. 227–228). Editorial on Serner's paper (1911 of May) and Laurent's previous work leading to the Ericsson Company's bridge.

2699. A 5-Megacycle Impedance Bridge.—C. H. Young. (*Bell Lab. Record*, April 1937, Vol. 15, No. 8, pp. 261–265.)

2700. Extension to 300 Mc/s of Previous Measurements of the Admittance of H.F. Amplifying Valves.—Strutt & van der Ziel. (*See* 2573.)

2701. A New Electro-Magnetic Quotient Meter and Its Use as a Microfarad-Meter.—V. O. Arutyunov. (*Izvestiya Elektroprom. Slab. Toka*, No. 2, 1937, pp. 40–45.)

In one current type of quotient meter (Geyger) the ends of a sickle-shaped armature move inside two fixed coils. The operation of such an instrument is influenced by external magnetic fields and also by the phase displacement of the currents flowing in the coils. In the present paper a description is given of an instrument developed by the author which is claimed to be practically free from the above effects. In this intrument use is made of two armatures, mounted on the same axis and actuated by separate fixed coils working in opposition. The theory of the operation of the instrument is discussed and its use as a microfarad-meter explained. Formulae are also given for estimating the errors due to frequency and temperature variations.

2702. A New Method for recording [or measuring] Minute Changes of Capacitance [Loosely Coupled Circuits, one of which is tuned through Its Resonant Point by the Change of Capacitance, giving the "N-Curve" of Reactance Change].—W. D. Oliphant. (*Journ. Scient. Instr.*, May 1937, Vol. 14, No. 5, pp. 173–177.)

Primarily for recording transient fluid pressures. The use of the "N-curve" by other workers is referred to (*e.g.* Theremin, Brit. Pat. 353 481). In the particular apparatus constructed, a change of 0.01 $\mu\mu$F could be recorded.

2703. The Measurement of the Power Output of an Oscillator operating at Decimetre and Centimetre Waves.—L. A. Dudnik. (*Izvestiya Elektroprom. Slab. Toka*, No. 2, 1937, pp. 36–40.)

In the proposed method use is made of a thermocouple connected to a loop of wire inductively coupled to the output coil of the oscillator. The loop and the coil are spaced a constant distance apart by a metallic rod connected to the loop and carrying an insulator at the other end. The insulated end of the rod touches the coil and thus provides capacitive coupling. The calibration of the instrument by a magnetron oscillator is discussed and a description is given of two models, for measuring power outputs of 0.5 watt and 25 watts respectively.

2704. Discussion on "A Proposed Wattmeter using Multi-Electrode Tubes" [Difficulties in Matching Valves, and a Way Out].—N. H. Roberts: Pierce. (*Proc. Inst. Rad. Eng.*, April 1937, Vol. 25, No. 4, pp. 515–516.)

See Pierce, 2756 of 1936. Roberts uses battery operation to avoid the imperfect-matching difficulty, and reduces the size of the battery required by employing neon-tube coupling (Smith & Hill, 1934 Abstracts, p. 562) in place of direct coupling. He also finds that reducing the potential of the anode-grid to the cathode potential greatly increases the sensitivity.

2705. Graphical Representation of the Real, Wattless, Distortional, and Apparent Power, with a Contribution to the Problem of Alternating Currents of Arbitrary Wave Form.—P. Andronescu. (*Arch. f. Elektrot.*, 22nd March 1937, Vol. 31, pp. 205–210.)

This method employs an auxiliary voltage (eqn. 4) which is combined with the original voltage (eqn. 1) to obtain convenient forms for graphical and vectorial representation. "It is shown how the wattless power of multi-wave currents can be measured," and that by designing the voltage circuit of a power meter as an inductance circuit, the wattless power with a multi-wave voltage on the terminals cannot be measured. It is also shown that "when one of the effective values of the multi-wave currents of two circuits in parallel is perpendicular to the effective value of the voltage on the terminals, all three effective values lie in a plane."

2706. Investigations on the Statical Measurement of Alternating Voltages by the Diode Principle.—O. Macek. (*Hochf:tech. u. Elek:akus.*, April 1937, Vol. 49, No. 4, pp. 133–137.)

The principle of statical measurement of alternating voltage with a diode circuit is discussed (§ 11) :—"an electrometer is connected to the electrodes of a chosen h.f. rectifier. The anode of the rectifier (in many cases the cathode also) forms with the electrometer system a conductor whose potential with respect to earth or to the leads connected to the other electrode is measured. This conductor of capacity C may be called the 'system.' It is charged statically by connecting an alternating voltage to one electrode of the rectifier." The theory of the measurement is worked out; three types of circuit (Fig. 1) are deduced, which differ only in the relative position of the circuit elements. Various known rectifiers are compared (§ III), using sinusoidal h.f. voltage obtained from an emitter by placing near its coil the coil of an absorption wavemeter. A stabilised mains valve voltmeter is used as a standard instrument. Fig. 2 shows the calibration curves of some of the rectifiers investigated, at a frequency of about 10^6 c/s. The emission, insulation resistance, and "barrier" resistance (resistance in the blocking direction) are the chief factors determining the use of a rectifier. Diodes and photocells are found to be most useful; these are separately discussed. Diodes have a linear calibration curve and need only a low-loss condenser connected in parallel to the electrometer; the heating current must however be kept very constant. The use of photocells is indicated in cases when it is not practicable to earth one pole of the voltage to be measured. Some measurements (Table 1) on detectors are given; their rectification improves as the frequency increases.

The sources of error are discussed in § IV; these are resonance, electron transit-time, and leakage. The latter is discussed in detail (Figs. 3–5), with calculations giving limiting conditions for the "leakage constant" of the "system" (eqns. 2, 2a, 3, 3a, 4). It is recommended that the statical method be used for calibrating other methods (*e.g.* valve voltmeter) over a large frequency range.

2707. A NEW MAINS-DRIVEN VALVE VOLTMETER OF HIGH STABILITY [Independence of Mains Fluctuations obtained, without Stabilisers or Bridge Circuits, by use of H.F. Pentode].—E. Mittelmann. (*Elektrot. u. Masch:bau*, 25th April 1937, Vol. 55, No. 17, pp. 197–199.)

2708. VOLTAGE MEASUREMENTS AT VERY HIGH FREQUENCIES, USING A DIODE WITH ADJUSTABLE ELECTRODE DISTANCE.—von Ardenne. (*Wireless Engineer*, May 1937, Vol. 14, No. 164, pp. 248–251.)

The original German paper was dealt with in 269 of January. In the latest type of diode the anode and cathode are side by side, and the elastic glass extension is moved laterally instead of being compressed, giving certain advantages.

2709. CALIBRATING RADIO-FREQUENCY AMMETERS WITH PHOTOCELLS [Fine Incandescent Wire in Vacuum used as Transfer Instrument: Amount of Light proportional to Fifth Power of Current, giving Great Sensitivity].—(*Electronics*, April 1937, Vol. 10, No. 4, pp. 40 and 42: paragraph only.) *Cf.* 2710.

2710. FREQUENCY ERRORS IN RADIO-FREQUENCY AMMETERS [Data for Commonly Used Thermal Ammeters at Frequencies up to 100 Mc/s: obtained by Special Calibrating Lamps working with Photocell Indication (or by Substitution Method, for High-Range Instruments): General Conclusions].—J. D. Wallace & A. H. Moore. (*Proc. Inst. Rad. Eng.*, March 1937, Vol. 25, No. 3, Part 1, pp. 327–339.)

2711. A PENTODE-OPERATED FREQUENCY METER OF THE CONDENSER-CHARGING TYPE [Mains Operated: Three Ranges, up to 15 kc/s].—E. L. E. Wheatcroft & G. Haley. (*Journ. Scient. Instr.*, April 1937, Vol. 14, No. 4, pp. 136–140.)

2712. PIEZOELECTRIC PLATES OF NON-UNIFORM THICKNESS [Theory of Wedge-Shaped Quartz Plates, and Their Application to Band Filters, etc.].—A. Guerbilsky. (*Journ. de Phys. et le Radium*, April 1937, Vol. 8, No. 4, pp. 165–168.) *See* also Guerbilsky & Ménard, 1934 Abstracts, p. 439 and back references. But *cf.* 680 & 1890 of 1936.

2713. A SIMPLIFIED CIRCUIT FOR FREQUENCY SUBSTANDARDS EMPLOYING A NEW TYPE OF LOW-FREQUENCY ZERO-TEMPERATURE-COEFFICIENT QUARTZ CRYSTAL [*CT* and *DT* Cuts].—S. C. Hight & G. W. Willard. (*Proc. Inst. Rad. Eng.*, April 1937, Vol. 25, No. 4, p. 380: summary only.)

The new plates are closely related to the *AT* and *BT* high-frequency plates, and are especially useful in precision apparatus because by slight final adjustment their frequency can be either raised or lowered and their t.c. made either more positive or negative.

2714. VIBRATIONS OF QUARTZ LAMINAE CUT IN DIFFERENT PLANES ROUND THE OPTIC AXIS OF THE CRYSTAL.—N. Tsi-Zé & S. Keng-Yi. (*Comptes Rendus*, 5th April 1937, Vol. 204, No. 14, pp. 1059–1060.)

The writers have studied a series of laminae with various angles of inclination of the normal to the cut plane to the electric axis; for each angle, square laminae of various thicknesses but the same area were cut. Curves are given of the measured vibration frequencies as a function of the angle of departure from the Curie cut (which is perpendicular to the electric axis); three different modes of transverse oscillation are found, in agreement with observations by de Gramont (3540 of 1936).

2715. QUARTZ AND TOURMALIN [Survey, including Apparatus for determining Optic Axis, Author's own Work on Ring-Shaped Quartz Plates and Special Cuts for Zero Temperature Coefficient].—P. Modrak. (*Wireless Engineer*, March & April 1937, Vol. 14, Nos. 162 & 163, pp. 127–134 and 175–183.)

2716. THE PRODUCTION OF ROCHELLE SALT PIEZOELECTRIC RESONATORS HAVING A PURE LONGITUDINAL MODE OF VIBRATION.—N. C. Stamford. (*Proc. Inst. Rad. Eng.*, April 1937, Vol. 25, No. 4, pp. 465–471.)

Beginning with the analysis of the problem (leading to the general conclusion that pure longitudinal vibration can be obtained with specimens having one axis coincident with a crystallographic axis and the other two at 45° to the crystallographic axes, the field being applied parallel to the coincident axis) the writer goes on to describe practical details of growing and grinding the crystals. Since there is no dilatation along the direction of the applied field, contact with the holder does not increase the damping as much as with quartz crystals, and the use of an air gap does not introduce the possibility of increased damping due to resonance of the supersonic air waves in the gap.

2717. LONGITUDINAL EFFECT IN ROCHELLE SALT [Experimental Proof of Theory of Cut giving Polarisation in Direction Parallel to Direction of Compression].—W. G. Cady. (*Phys. Review*, 1st April 1937, Series 2, Vol. 51, No. 7, p. 596 : abstract only.)

2718 THE MAGNETOSTRICTION OF IRON CRYSTALS AT HIGH TEMPERATURES [Temperature Variation of Constants measured with Mechanical-Optical Magnifying Device : Behaviour disagrees with Theoretical Prediction : Connection between Trigonal Magnetostriction and Anisotropy Constants].—H. Takaki. (*Zeitschr. f. Physik*, No. 1/2, Vol. 105, 1937, pp. 92–103.)

2719. THE MEASUREMENT OF INTERNAL FRICTION IN SOME SOLID DIELECTRIC MATERIALS [at Frequencies below 10 c/s, by Torsional Oscillation of Thin Cylindrical Rods and Lateral Vibration of Thin Bars : Friction not of Viscous Character].—A. Gemant & W. Jackson. (*Phil. Mag.*, May 1937, Series 7, Vol. 23, No. 157, pp. 960–983.)

2720. SIMPLIFIED DIELECTRIC LOSS MEASUREMENTS [using Circular Plane Electrodes with Accurately Ground Parallel Surfaces and Micrometer Adjustment, and "Q" Meter].—A. W. Barber. (*Rad. Engineering*, May 1937, Vol. 17, No. 5, pp. 26 and 28.)

2721. THE MEASUREMENT OF DIELECTRIC LOSS AT LOW VOLTAGES AND COMMERCIAL FREQUENCIES [Description and Theory of Special Bridge Method].—G. de Fassi. (*L'Elettrotec.*, 25th April 1937, Vol. 24, No. 8, pp. 234–239.)

2722. ON THE THEORY OF THE MEASUREMENT OF DIELECTRIC CONSTANTS AND ABSORPTION COEFFICIENTS IN THE REGION OF SHORT [and the Longer Ultra-Short] WAVES.—W. I. Romanov. (*Physik. Zeitschr. der Sowjetunion*, No. 4, Vol. 11, 1937, pp. 404–413 : in German.)

The method described in a previous paper (2744 of 1936) is excellent for decimetre waves and up to about 5–6 m wavelengths, but for longer waves such as 5–20 m the dimensions of the apparatus become inconveniently large, especially when the measurements are made on Lecher wires whose length takes in two half-waves. In order to decrease these dimensions, the wires may be bridged by a condenser C_1 (Fig. 1). By application of the fundamental propagation equations the writer derives expressions for the dielectric constant of the material filling the condenser and for the loss angle (tan θ) in this. These expressions are derived without taking into account the influence of the apparatus enclosing the dielectric, and can therefore only apply when this influence can be neglected. This, to a first approximation, is the case when the wavelength in use is many times greater than the dimensions of the enclosing apparatus. The expressions are given for the two separate cases where resonance is obtained by adjusting the length of the wires (eqns. 14, 24, 25) and where it is obtained by varying the capacity of the test condenser C_1 (eqn. 29).

2723. RESEARCHES ON THE ANOMALOUS DISPERSION OF POLAR LIQUIDS : METHODS AND APPLICATIONS.—Abadie. (*L'Onde Élec.*, April 1937, Vol. 16, No. 184, pp. 247–268.)

Conclusion of the paper dealt with in 1901 of May. Regarding the results on normal propyl alcohol, "the value we have thus obtained is very close to that given by the kinetic theory ; but in spite of this agreement no conclusions can be drawn, without other information, as to the validity of Debye's theory (which concerns the gaseous state) when applied to pure liquids. We have not obtained, for the shortest wavelengths used, the negative dielectric constants indicated by Potapenko, nor the high coefficients of absorption found by that worker and Seeberger. We have shown that the formulae used by Potapenko were erroneous, and have explained why Seeberger's results appear doubtful to us."

2724. THE TEMPERATURE VARIATION OF THE DIPOLE CONDUCTIVITY OF ALCOHOLS [with Measurements of Dielectric Constant and H.F. Conductivity : Connection with Debye's Theory].—W. Hackel. (*Physik. Zeitschr.*, 15th March 1937, Vol. 38, No. 6, pp. 195–199.)

2725. THE DIELECTRIC CONSTANTS OF CYCLOHEXANE AND BENZENE [measured as Functions of Temperature].—J. Hadamard. (*Comptes Rendus*, 26th April 1937, Vol. 204, No. 17, pp. 1234–1235.)

2726. THE PHENOMENON OF POSITIVE ELECTRIC SATURATION [in Dilute Solutions of Nitrobenzene : Explanation on Debye's Theory].—A. Piekara. (*Comptes Rendus*, 12th April 1937, Vol. 204, No. 15, pp. 1106–1108.) *See* also 653 of February.

2727. ELECTRIC AND MAGNETIC DIMENSIONS [Correspondence].—Skancke : G. W. O. H. (*Wireless Engineer*, April 1937, Vol. 14, No. 163, pp. 192–193.) *See* 1098 of March.

SUBSIDIARY APPARATUS AND MATERIALS

2728. THE SCATTERING OF CATHODE RAYS OF MEDIUM VELOCITY [between 20 & 80 kv] IN GASES [at Pressures below 1 mm : Measurements of Variation of Ray Intensity with Gas Pressure, Ray Velocity, Nature of Gas : Quantitative Nature of Scattering Process : "Diffusion Cross-Section" of Gas Molecules : Single and Multiple Scattering].—Becker & Kipphan. (*Ann. der Physik*, Series 5, No. 6, Vol. 28, 1937, pp. 465–506.)

2729. DIMENSIONAL RELATIONS IN THE MOTION OF ELECTRONS IN ALTERNATING FIELDS.—Brüche & Recknagel. (*See* 2570.)

2730. THE DYNAMICS OF TRANSVERSELY AND LONGITUDINALLY CONTROLLED ELECTRON BEAMS.—Hollmann & Thoma. (*See* 2569.)

2731. DEFLECTION OF A CURRENT IN A GAS BY A MAGNETIC FORCE.—Townsend. (*See* 2453.)

2732. A CATHODE-RAY-OSCILLOGRAPHIC AND PHOTOGRAPHIC METHOD WHICH RESOLVES PULSES A FEW MICROSECONDS APART.—Chapman. (*See* 2465.)

2733. NEW APPLICATIONS OF CATHODE-RAY OSCILLOGRAPHS [Tracing Plate-Current/Plate-Voltage Curves of Valves and Rectifiers: etc.].—Mayer. (*Gen. Elec. Review*, April 1937, Vol. 40, No. 4, pp. 203–205.)

2734. "THE LOW-VOLTAGE CATHODE-RAY TUBE AND ITS APPLICATIONS" [Book Review].—Parr. (*Television*, May 1937, Vol. 10, No. 111, p. 270.)

2735. ON THE USE OF BRAUN TUBES AS OSCILLOGRAPHS.—I. P. Polevoy. (*Journ. of Tech. Phys.* [in Russian], No. 1, Vol. 7, 1937, pp. 81–83.)

Various factors affecting the photography of oscillograms on the screen of a cathode-ray tube are discussed, and empirical formulae are given determining the necessary exposures for oscillograms of periodic and non-periodic processes.

2736. A VERSATILE OSCILLOSCOPE USING THE 913.—Gordon. (*QST*, May 1937, Vol. 21, No. 5, pp. 31–34 and 118.) Including linear sweep, amplifier and sine-wave audio-oscillator; adaptable to amateur and servicing requirements.

2737. "KIPP" OSCILLATIONS FOR TIME BASES OF CATHODE-RAY OSCILLOGRAPHS [Survey].—Klein. (*Funktech. Monatshefte*, April 1937, No. 4, pp. 107–113.)

2738. POTENTIAL AND LUMINESCENCE OF INSULATED WILLEMITE CATHODE-RAY SCREENS [Experimental Data for Two Phosphors and Various Ranges of Electron Energies: Law of Luminosity Variation with Screen Potential: Evaporation of Thorium Atoms on to Screen gives Enhanced Secondary Emission at High Voltages and Best Solution to Problem of High Screen Luminosity].—Nottingham. (*Phys. Review*, 1st April 1937, Series 2, Vol. 51, No. 7, p. 591.)

2739. INFLUENCE OF THE VISCOSITY AND NATURE OF THE SOLVENT ON THE DEGREE OF POLARISATION OF THE LIGHT OF FLUORESCENCE.—Pringsheim & Vogels. (*Journ. de Phys. et le Radium*, April 1937, Vol. 8, No. 4, pp. 121–124.)

2740. VAPOUR-COOLED ELECTRODES [avoiding Dangers of Water-Cooling for High-Voltage Apparatus].—Schmitt. (*Review Scient. Instr.*, April 1937, Vol. 8, No. 4, p. 131.)

2741. TWO AIDS IN HIGH-VACUUM TECHNIQUE: 1—A LEAK-PROOF VALVE, AND 2—A LEAK-PROOF JOINT [Cement-Free].—Rose. (*Review Scient. Instr.*, April 1937, Vol. 8, No. 4, p. 130.)

2742. A VACUUM GAUGE FOR LEAK HUNTING.—Kuper. (*Review Scient. Instr.*, April 1937, Vol. 8, No. 4, pp. 131–132.)

2743. THE THREE HALVES POWER LAW OF THE DIODE, *and* THE EXTERNAL CHARACTERISTIC OF A DIODE RECTIFIER.—Moullin. (*See* 2578 and 2579.)

2744. THE APPLICATION OF A THYRATRON FOR AUTOMATIC REGULATION.—Vartel'ski. (*Izvestiya Elektroprom. Slab. Toka*, No. 2, 1937, pp. 46–57.)

A general discussion of the operation of a thyratron and of the various methods for continuous variation of its anode current—by varying the grid voltage, phase displacement between the grid and anode voltages, etc.

2745. DEPENDENCE OF THYRATRON CHARACTERISTICS ON ELECTRODE SPACING AND DESIGN [Experimental Investigation using Tube with Movable Anode].—Fairbrother. (*Wireless Engineer*, April 1937, Vol. 14, No. 163, pp. 196–198.) From the BT-H laboratories.

2746. THE OVERTONES ON THE D.C. SIDE IN CURRENT RECTIFIERS [Calculations].—Jungmichl & Steckmann. (*Arch. f. Elektrot.*, 22nd March 1937, Vol. 31, No. 3, pp. 191–196.)

2747. HARMONICS, RIPPLE, AND INTERFERENCE IN RECTIFIERS [including Control by Grid: with Formulae, Tables, and Curves].—Jungmichl. (*E.T.Z.*, 22nd April 1937, Vol. 58, No. 16, pp. 417–420.)

2748. APPLICATIONS OF DRY-PLATE RECTIFIERS TO CARRIER-CURRENT TELEPHONY AND TELEGRAPHY [as Blocking Switches, by Control of Their Resistance to Carrier Currents by Adjustment of Superposed Control Current].—Pagès. (*Bull. de la Soc. franç. des Élec.*, May 1937, Vol. 7, No. 77, pp. 521–532.)

2749. DISCHARGE OF A CONDENSER ACROSS A GAS-FILLED TUBE: THE RESULTING "MAGNETIC PERCUSSION."—Laporte. (*Journ. de Phys. et le Radium*, April 1937, Vol. 8, No. 4, pp. 51–52S.) For previous work *see* 2389/2390 of 1936.

2750. THE MAGNETOSTRICTION OF IRON CRYSTALS AT HIGH TEMPERATURES.—Takaki. (*See* 2718.)

2751. ARTIFICIAL RESIN IN THE CONSTRUCTION OF MAGNETS [Tromalit (Mixture of Powdered Oerstit and Artificial Resin) for Specially Shaped Magnets for Loudspeakers, Small Meters, etc.].—Winkler. (*Elektrot. u. Masch:bau*, 15th April 1937, Vol. 58, No. 15, p. 403.) In an article on the Leipzig Fair.

2752. AN EXPERIMENTAL INVESTIGATION OF THE THEORY OF EDDY CURRENTS IN LAMINATED CORES OF RECTANGULAR SECTION [Complete Verification of J. J. Thomson's Theory, by Use of Non-Magnetic Material].—Reed. (*Journ. I.E.E.*, May 1937, Vol. 80, No. 485, pp. 567–578.) Appendices deal with eddy currents in an elliptical core and with an investigation of Peterson & Wrathall's equations (1970 of 1936).

2753. THE OPTIMUM NUMBER OF SCREENING CANS FOR SCREENING THE MAGNETIC FIELD OF COILS.—W. Herzog. (*E.N.T.*, March 1937, Vol. 14, No. 3, pp. 81–88.)

Calculations (§ I) are given for the screening effect of a metal can round a cylindrical coil as a function of frequency, conductivity of the metal used, and the thickness of the can. The circuits effectively controlling the screening are shown in Fig. 1. The "screening action" *S* is given by eqn. 1; complete screening is found to be attained when circuits I and III (Fig. 1) are in antiphase. This condition can be realised in practice to any required degree of approximation. Fig. 2 shows the arrangement of coils for measuring *S*; the coupling between them was measured by a coupling meter for magnetic coupling; the results (Table 1) confirmed the theory. The vector diagram for variation of the "transparency" of the screens with the reciprocal of their loss angle is discussed in § II (Fig. 3); the screen is found to cause, in addition to the decrease in field strength, a phase displacement of the current in the non-screened coil from that in the screened coil. § III deals with multiple screening; calculations are made of the optimum number of cans for a given screening, with the condition that the total thickness shall be a minimum. Fig. 5 illustrates the theoretical relationship between the screening action, the "quality number" (a measure for the economy in material), and the reciprocal loss angle as a function of the optimum number of cans. It is found that the best cans for screening are those whose reciprocal loss angle has the value 1.98; using these, any desirable degree of screening can be attained with the appropriate number of cans. The number of cans should be calculated for the lowest frequency of the band to be used.

Measurements given in § IV (Figs. 6,7) show that the requirements can be well fulfilled without considering the reaction, which complicates the calculations considerably. Fig. 8 gives a comparison of a closely coupled double can with a single can made of the same amount of material. The frequency for which three is the optimum number of cans is also worked out, with a discussion of the economy in material thereby attained.

2754. RESISTANCES FREE FROM STRAY FIELDS AND WITH CALCULABLE TIME CONSTANTS.—Söchting. (*See* 2692.)

2755. THE PROPERTIES OF CHOKES, CONDENSERS, AND RESISTORS AT VERY HIGH FREQUENCIES.—Hartshorn & Ward. (*See* 2689.)

2756. THE TEMPERATURE COEFFICIENT OF INDUCTANCE.—Groszkowski. (*See* 2695.)

2757. THE CONTROL OF A GAS-FILLED VALVE THROUGH A PHASE-SHIFTING INPUT VALVE: A VERSATILE MAINS-OPERATED RELAY-AMPLIFIER OF THIS KIND [giving up to 30 Watts Output of Unidirectional Pulses at Mains Frequency: operates on Slow-Change Signals or (through Rectifier) on Audio or Wireless Signals].—Turner. (*Wireless Engineer*, May 1937, Vol. 14, No. 164, pp. 229–241.)

2758. A VALVE AMPLIFIER FOR THE MEASUREMENT OF SMALL CHARGES [10^{-4} to 10^{-5} E.S.U. upwards: Triode Bridge Circuit].—Chalmers & Pasquill. (*Journ. Scient. Instr.*, April 1937, Vol. 14, No. 4, pp. 127–131.) Based on that of Wynn-Williams, with the addition of a second stage of amplification using a second bridge circuit.

2759. A SIMPLE DIFFERENTIAL AMPLIFIER [with Gain of about 160, independent of Frequency up to 20 kc/s: Two High-Mu Pentodes].—Schmitt. (*Review Scient. Instr.*, April 1937, Vol. 8, No. 4, pp. 126–127.)

2760. REGULATED PLATE SUPPLY [Regulated Rectifier Unit giving 100 mA at 130–180 V and 50 mA at 250 V, constant to within 0.25% regardless of Load or Supply-Voltage Changes].—Trucksess. (*Bell Lab. Record*, May 1937, Vol. 15, No. 9, pp. 298–301.)

2761. THE STRIKING OF GLOW-DISCHARGE VOLTAGE-DIVIDER STABILISING TUBES [Ignition ensured when connected to Permanent Load and Voltage is switched on: by connecting Small Choke Coil between Tube and Load: Calculation].—Avramescu. (*E.T.Z.*, 1st April 1937, Vol. 58, No. 13, pp. 343–345.)

A footnote mentions that the writer has just heard that tubes are now being made which have a very small striking voltage for one gap.

2762. A VOLTAGE STABILISER CIRCUIT [giving Elimination of Fluctuations in Output Voltage due to Cathode-Emission Changes, by operating Control Grid at Positive Potential].—Ashworth & Mouzon. (*Review Scient. Instr.*, April 1937, Vol. 8, No. 4, pp. 127–129.) Evans's circuit (1188 of 1935) corrects for this type of fluctuation but gives a transient attributed to a thermal lag in the cathode.

2763. THE PRODUCTION OF CONSTANT D.C. POTENTIALS FOR TUBE-COUNTER APPARATUS AND PEAK COUNTERS [by use of Corona-Discharge Stabilisers].—Schopper. (*Zeitschr. f. tech. Phys.*, No. 5, Vol. 18, 1937, pp. 117–119.)

The writer has modified the spark-gap and corona-tube combination used by Medicus (1933 Abstracts, p. 638) by replacing the spark-gap generator by a mains-driven transformer and rectifier arrangement (using two old, de-socketed triodes as rectifiers, connected in series) and stabilising the 3000-volt output with a corona-tube made from a tube counter with a filling of carefully dried air. With six alternative tubes of different pressures, stabilised voltages between 750 and 1800 volts can be obtained.

2764. THE DESIGN AND WORKING OF A VIBRATOR D.C./A.C. CONVERTOR FOR BROADCAST RECEIVERS.—Pollak & Spreither. (*Funktech. Monatshefte*, April 1937, No. 4, pp. 132–135.)

2765. IMPULSE GENERATOR WITH VARIABLE FREQUENCY [applicable also as Relay, Interrupter, D.C./A.C. Convertor, etc.].—Usikov. (*See* 2457.)

2766. The High-Voltage Impulse Generator.—Solomonov. (*Journ. of Tech. Phys.* [in Russian], No. 1, Vol. 7, 1937, pp. 84–97.)

The operation of a high-voltage impulse generator of the order of 10 000 000 volts, used for testing purposes, is analysed with the aid of equivalent electrical circuits. The fundamental principles of its design are established.

2767. The Conductivity of Solid Dielectrics at High Field Strengths *and* The Nature of the Electrical Conductivity of Solid Dielectrics in Strong Electric Fields: II—Mica at High Field Strengths.—Quittner: Pruschinina-Granowskaja. (*Physik. Zeitschr. der Sowjetunion*, No. 4, Vol. 11, 1937, pp. 359–368: pp. 369–389: both in German.)

Authors' summaries:—(i) As is now finally established, the previously observed increase in the conductivity of solid dielectrics at high field strengths is not an illusion due to counter-potentials or inhomogeneities, but is a universal property of the solid insulating body. These deviations from Ohm's law appear to be produced always by ions, in the case of amorphous bodies, but in crystals generally by electrons.

(ii) The character of the conductivity of mica in strong fields was investigated at high and low temperatures. It was shown that the additional conductivity appearing in strong fields possesses an electronic character at all temperatures. At low temperatures the conductivity in strong fields is predominantly by electrons. At high temperatures it is of a mixed nature. The conductivity by ions is bipolar and is caused by the ions of aluminium and oxygen. The transport numbers are functions of the temperature. The analysis of the dependence of electronic conduction on field strength value shows that with mica in weak fields and at low temperatures ionic conductivity is present.

2768. The Measurement of Internal Friction in Some Solid Dielectric Materials, *and* Papers on Dielectric Loss Measurement.—Gemant & Jackson: Barber: de Fassi. (*See* 2719/2721.)

2769. Dielectric Paper and Its Application to Capacitors.—Bailey. (*Rad. Engineering*, May 1937, Vol. 17, No. 5, pp. 17–18 and 35, 36.)

2770. The Dielectric Constant of Titanium Dioxide at Low Temperatures [Measurements on Dry TiO_2 Powder between 0° and − 180° show No Anomalous Variation with Temperature such as That given by Rochelle Salt: No Grounds for Assumption of Dipoles].—Büttner & Engl. (*Zeitschr. f. tech. Phys.*, No. 5, Vol. 18, 1937, pp. 113–117.)

2771. Materials made from Hardenable Synthetic Resins, *and* from Non-Hardenable Synthetic Resins.—Zebrowski: Raalf. (*E.T.Z.*, 6th May 1937, Vol. 58, No. 18, pp. 469–471: pp. 471–473.)

2772. Low-Loss Dielectrics at High Frequencies [including Laminated Materials: Effect of Smooth and Waterproofed Edges: etc.].—Landt. (*Proc. Inst. Rad. Eng.*, April 1937, Vol. 25, No. 4, p. 379: summary only.)

2773. Insulators for High-Power Short-Wave Transmitters.—Gaylish. (*See* 2510.)

2774. Conditioning Insulating Materials for Test.—Burns. (*Bell Tel. System Tech. Pub.*, Monograph B-986: 14 pp.)

2775. "Elektrotechnik und Witterung" [Electrotechnics and Atmospheric Phenomena: Book Review].—Retzow. (*Rev. Gén. de l'Élec.*, 3rd April 1937, Vol. 41, No. 14, p. 418.) Including the influence of humidity and temperature on the action of the air on conductors and insulating materials.

2776. Breakdown of the Layered Oil/Air Dielectric under Impulsive and Alternating Voltage [Measurements: Observations].—Weber. (*Arch. f. Elektrot.*, 22nd March 1937, Vol. 31, No. 3, pp. 197–204.)

2777. Copper-Beryllium Alloys of High Electric Conductivity and Great Hardness [for Current-Carrying Springs, Contacts, etc.].—Hessenbruch. (*Zeitschr. V.D.I.*, 10th April 1937, Vol. 81, No. 15, pp. 439–440.)

STATIONS, DESIGN AND OPERATION

2778. Concerning a Phenomenon of Persistence of Sound Impressions on the Ear: Simultaneous Duplex Radio-Telephony [including Intelligibility Tests for Various Interrupting Frequencies, and Apparatus used for Ultra-Short-Wave Communication Tests].—M. Marro. (*Rev. Gén. de l'Élec.*, 24th April 1937, Vol. 41, No. 17, pp. 527–530.)

Further development of the work dealt with in 1249 of March and back references. Successful tests on a 4.5 m link have been carried out on an island in the Mediterranean (La Maddelena).

2779. A Method for Duplex Radio-Telephony.—Borushko & Shchegolev. (*Izvestiya Elektroprom. Slab. Toka*, No. 2, 1937, pp. 22–31.)

Simultaneous transmission and reception are discussed for the case when the transmitter and associated receiver are located in close proximity or even use the same aerial. It is shown that in considering the methods for protecting the receiver against pick-up from the transmitter, it is necessary to take into account wide ranges of frequencies due to the presence of harmonics in both the incoming and local carriers and to the interaction between these. Arrangements can, however, be made to avoid this interference if the incoming and local carrier frequencies bear a certain fixed ratio to each other. It is difficult, however, to meet this requirement, since it imposes very strict limitations on the frequency stability of the transmitters. It is therefore suggested that the carrier frequency of one of the transmitters should be derived by division or multiplication from the incoming frequency of the other transmitter. In this way the necessary ratio between the two operating frequencies would be maintained independently of frequency variations. The method proposed has been tried experimentally in the U.S.S.R. and proved to be entirely satisfactory.

2780. AN EXPERIMENT IN COMMON-FREQUENCY BROADCASTING.—Kayano. (*Rep. of Rad. Res. in Japan*, Dec. 1936, Vol. 6, No. 3, pp. 151–155.)

Tests on transmissions carefully synchronised by the new system devised by the writer (Fig. 2) led to the conclusions that the ultimate permissible ratio if the two field strengths is 1 : 2; that, in practice, the region in which the signal quality is distorted by wave interference is not very extensive; and that in almost the entire service area distortion can easily be avoided by a suitable treatment of the receiving aerial.

2781. WAVE PROPAGATION OF THE SWISS BROADCASTING STATIONS [with Field-Strength Charts of Beromünster & Sottens, Vertical Radiation Diagram of the Former (showing Dependence on Height of Aeroplane): etc.]. —Gerber & Werthmüller. (*Hochf:tech. u. Elek:akus.*, Jan. 1937, Vol. 49, No. 1, pp. 31–33: long summary only.)

2782. THE NEW BROADCASTING STATION "MARSEILLE-PROVENCE" AT RÉALTOR.—D'Auriac. (*Ann. des Postes, T. et T.*, April 1937, Vol. 26, No. 4, pp. 277–321.)

2783. CHARACTERISTICS OF AMERICAN BROADCAST RECEIVERS AS RELATED TO THE POWER AND FREQUENCY OF TRANSMITTERS.—Van Dyck & Foster. (*See* 2549.)

2784. THE CORONATION BROADCAST: TECHNICAL ARRANGEMENTS.—(*World-Radio*, 7th May 1937, Vol. 24, pp. 10–16.)

2785. BROADCAST OF PRESIDENT ROOSEVELT'S SECOND INAUGURATION.—McElrath. (*RCA Review*, April 1937, Vol. 1, No. 4, pp. 84–93.)

2786. THE OXFORD UNIVERSITY ARCTIC EXPEDITION, 1935–36, TO NORTH EAST LAND: A REPORT ON THE RADIO COMMUNICATIONS.—(*Wireless Engineer*, May 1937, Vol. 14, No. 164, pp. 256–258.)

2787. POLICE WIRELESS [on the 141.84–147.8 m Band: Description of Headquarters and Mobile Transmitters and Receivers, Aerials, etc.).—Burroughes. (*Marconi Review*, Jan./Feb. 1937, No. 64, pp. 1–11.)

2788. POLICE RADIO COMMUNICATION.—White & Denstaedt. (*Elec. Engineering*, May 1937, Vol. 56, No. 5, pp. 532–544.)

GENERAL PHYSICAL ARTICLES

2789. THE LORENTZ TRANSFORMATIONS IN THE NEW QUANTUM ELECTRODYNAMICS.—Infeld. (*Proc. Roy. Soc.*, Series A, 15th Jan. 1937, Vol. 158, No. 894, pp. 368–371.)

2790. GENERALISATION OF THE LORENTZ TRANSFORMATION.—Destouches. (*Journ. de Phys. et le Radium*, April 1937, Vol. 8, No. 4, pp. 145–152.)

2791. ON THE NEW FIELD THEORY: II—QUANTUM THEORY OF FIELD AND CHARGES.—Pryce. (*Proc. Roy. Soc.*, Series A, 1st April 1937, Vol. 159, No. 898, pp. 355–382.)

2792. DISCUSSION ON "POYNTING'S THEOREM IN ELECTROTECHNICS."—Darrieus. (*Bull. Soc. franç. des Élec.*, March 1937, Vol. 7, No. 75, pp. 276–280.) *See* 745 of February.

2793. THE DISPERSION OF LIGHT IN ELECTRIC FIELDS ACCORDING TO THE THEORY OF THE POSITRON.—Kemmer. (*Helvet. Phys. Acta*, Fasc. 2, Vol. 10, 1937, pp. 112–122: in German.)

2794. A CRITICISM OF THE [Jordan] NEUTRINO THEOREM OF LIGHT.—Fock: Jordan. (*Physik. Zeitschr. der Sowjetunion*, No. 1, Vol. 11, 1937, pp. 1–8: in German.)

2795. THE MAGNETIC MOMENT OF THE PROTON.—Lasarev & Schubnikov. (*Physik. Zeitschr. der Sowjetunion*, No. 4, Vol. 11, 1937, pp. 445–457: in German.)

2796. MEASUREMENT OF THE VELOCITY OF LIGHT [with Beam modulated at High Frequencies: Modulation detected by Photocell: Difference in Path Length measured for Minimum Voltage in Photocell].—Anderson. (*Phys. Review*, 1st April 1937, Series 2, Vol. 51, No. 7, p. 596: abstract only.)

2797. ABSOLUTE DEFINITION OF THE BOLTZMANN CONSTANT: OF THE STEFAN CONSTANT.—Laboccetta. (*La Ricerca Scient.*, No. 1/2 and 3/4, Vol. 1, Series 2, 8th Year, 1937, pp. 58–59: pp. 148–150.)

2798. "TABLES ANNUELLES DE CONSTANTES ET DONNÉES NUMÉRIQUES DE CHIMIE, PHYSIQUE, BIOLOGIE, ET TECHNOLOGIE" [Book Review]. —(*Physik. Zeitschr. der Sowjetunion*, No. 2, Vol. 11, 1937, pp. 239–240: in German.)

MISCELLANEOUS

2799. OPERATIONAL FORMS FOR BESSEL AND STRUVE FUNCTIONS, *and* OPERATIONAL REPRESENTATION OF THE PARABOLIC CYLINDER FUNCTIONS: II [with Evaluation of Infinite Integrals involving the Function].—McLachlan & Meyers: Varma. (*Phil. Mag.*, May 1937, Series 7, Vol. 23, No. 157, pp. 918–925: pp. 926–928.) For I of Varma's paper *see* 3653 of 1936.

2800. THE DETERMINATION OF PARAMETRIC FUNCTIONS [Functions between One Dependent and Two Independent Variables] BY THE HELP OF ELECTRICAL MEASURING ARRANGEMENTS.—Lieneweg. (*E.T.Z.*, 15th April 1937, Vol. 58, No. 15, p. 406: summary only.)

2801. On the Numerical Resolutions of Systems of Two Equations with Two Unknowns [by Extension of "Method of Proportional Parts"].—Viola. (*La Ricerca Scient.*, No. 1/2, Vol. 1, Series 2, 8th Year, 1937, pp. 42–52.)

2802. Conformal Transformation with the Aid of an Electrical Tank.—Bradfield, Hooker, & Southwell. (*Proc. Roy. Soc.*, Series A, 1st April 1937, Vol. 159, No. 898, pp. 315–346.)

2803. On the Representation of Non-Linear Motions by Series of Damped Time Exponentials [with Examples of Solutions of First and Second Order Differential Equations].—Frazer. (*Phil. Mag.*, May 1937, Series 7, Vol. 23, No. 157, pp. 866–879.)

2804. "Statistical Mechanics: Second Edition" [Book Review].—Fowler. (*Review Scient. Instr.*, April 1937, Vol. 8, No. 4, p. 101.)

2805. Vector Addition Charts [for Evaluation of Impedances, Total Harmonic Distortion, etc.].—(*Comm. & Broad. Eng.*, April 1937, Vol. 4, No. 4, pp. 21–23.)

2806. Electrical Communication in 1936.—(*Elec. Communication*, Jan. 1937, Vol. 15, No. 3, pp. 177–194.)

2807. Discussions on "Recent Developments in Telegraph Transmission, and Their Application to the British Telegraph Services."—Harris, Jolley, & Morrell. (*Journ. I.E.E.*, May 1937, Vol. 80, No. 485, pp. 549–552.) *See* 2036 of May.

2808. Work of the N.P.L. in 1936.—(*Electrician*, 23rd April 1937, Vol. 118, pp. 549–550.) From the 1936 Report.

2809. "B.B.C. Annual 1937" [Book Review].—(*Wireless Engineer*, May 1937, Vol. 14, No. 164, p. 255.)

2810. The Radioelectricity Section of the École Supérieure d'Électricité [at Malakoff, Seine].—Bédoura & Curchod. (*Rev. Gén. de l'Élec.*, 24th April 1937, Vol. 41, No. 17, pp. 531–539.)

2811. Electronics Engineers' Library [List of Suitable Books].—(*Electronics*, April 1937, Vol. 10, No. 4, pp. 37–38.)

2812. "De l'Anglais au Francais en Électrotechnique" [Lexicon: Book Review].—Dupuis. (*Rev. Gén. de l'Élec.*, 1st May 1937, Vol. 41, No. 18, p. 546.)

2813. French Importations and Exportations of Electrical Material in 1936.—Reyval. (*Rev. Gén. de l'Élec.*, 1st May 1937, Vol. 41, No. 18, pp. 567–575.)

2814. The Fourth Exhibition of Detached Components and Accessories for Wireless.—(*L'Onde Élec.*, April 1937, Vol. 16, No. 184, pp. 217–222.)

2815. The Examination and Recording of the Human Electrocardiogram by means of the Cathode-Ray Oscillograph [including "Mush"-Neutralising Devices, etc.].—Robertson. (*Electrician*, 16th April 1937, Vol. 118, pp. 517–518.) Summary of I.E.E. paper.

2816. The Phonostethograph: New Apparatus for Amplifying and Recording Heart Beats.—Henriques. (*Electrician*, 2nd April 1937, Vol. 118, p. 456: summary only.)

2817. Wheat Storage and Ultra-Short Waves [Max. Temperature Rise produced by 5 m Waves: Russian Results].—Tarutin. (*Electronics*, April 1937, Vol. 10, No. 4, p. 53.)

2818. The Ionisation of Air by Electrified Dielectrics [Interpretation of Inversion of Current produced by Dielectric discharging in Ionisation Chamber requires Assumption of Ionised Air].—Perrier. (*Comptes Rendus*, 19th April 1937, Vol. 204, No. 16, pp. 1174–1175.) *See* also 3241 of 1936 and 790 of February.

2819. Detection of Moving Objects [Aircraft, etc.] by Ultra-Short Waves.—Telefunken. (*See* 2603.)

2820. A New Method for Recording Minute Changes of Capacitance [for Fluid Pressure Recorder].—Oliphant. (*See* 2702.)

2821. Two Practical Capacity-Operated Relays.—Shephard. (*Electronics*, April 1937, Vol. 10, No. 4, pp. 35 and 40.)

2822. Teletouch Corporation [and Its Various Products, especially Capacity-Sensitive Devices for Protection and Advertising, Light-Ray Apparatus (Photocell and Lamp together), D.C. Converter for Synchronous Clocks (using Commutator Ripple), etc.].—Theremin. (*Electronics*, Feb. 1937, Vol. 10, No. 2, pp. 26–28.)

See also *ibid.*, pp. 36 and 38. The basic patent of the capacity-sensitive system is the compensation against *slow* changes by a thermal-inertia device.

2823. Recent Improvements in Vibrometers and Accelerometers.—Koch & Zeller. (*Génie Civil*, 6th Feb. 1937, Vol. 110, pp. 140–142.) From the paper referred to in 802 of February.

2824. Half-Cycle Spot-Welder Control [using Simple Cold-Cathode Tubes: "Strobotron" and "Band-Igniter Arc Tube"].—Gray & Nottingham. (*Review Scient. Instr.*, Feb. 1937, Vol. 8, No. 2, pp. 65–68.) For the "Strobotron" *see* 3564 of 1936. The second tube is a simple pool-type mercury-arc tube.

2825. Resistance Welding improved by Thyratron Control.—Hutchins. (*Gen. Elec. Review*, March 1937, Vol. 40, No. 3, pp. 116–124.)

2826. A Watch-Rate Recorder.—Hibbard. (*Bell Lab. Record*, Feb. 1937, Vol. 15, No. 6, pp. 202–206.)

2827. THE DVL DYNAMIC EXTENSOMETER [for Aircraft Engine Crankshaft and Propeller Tests, etc.].—(*Zeitschr. V.D.I.*, 24th April 1937, Vol. 81, No. 17, pp. 472–473.) Very small and light electro-magnet device: variations in the relative positions of the parts of a differential coil, in an a.c. bridge connection, are used to modulate a carrier wave.

2828. ON METHODS OF ELECTRICAL CONTROL [of Lengths, Angular Displacements, Accelerations, Pressures, Viscosity, Colour, Quality of Welded Compounds, Speeds of Rotation, etc: Survey].—Temnikov. (*Automatics & Telemechanics* [in Russian], No. 5, 1936, pp. 65–81.)

2829. "DIE TECHNIK SELBSTTÄTIGER STEUERUNGEN UND ANLAGEN" [Automatic Controls: Book Review].—Meiners. (*Elektrot. u. Masch:bau*, 4th April 1937, Vol. 55, No. 14, p. 172.)

2830. "ELECTRON TUBES IN INDUSTRY: SECOND EDITION" [Book Review].—Henney. (*Electronics*, April 1937, Vol. 10, No. 4, p. 46.)

2831. THE POST OFFICE SPEAKING CLOCK.—Speight & Gill. (*Journ. I.E.E.*, May 1937, Vol. 80, No. 485, pp. 493–510: Discussion pp. 510–516.) For a previous paper *see* 1640 of April.

2832. DETECTION AND LOCATION OF LAMINATIONS IN STEEL PLATES [by Sand Patterns at Acoustic Frequencies].—Hayes. (*Journ. Acoust. Soc. Am.*, April 1937, Vol. 8, No. 4, pp. 220–226.)

2833. SPECTROSCOPY IN INDUSTRY [including Control of Lead Sheathing for Cables].—Fowler. (*Journ. Scient. Instr.*, May 1937, Vol. 14, No. 5, pp. 153–161.)

2834. A PHOTOELECTRIC METHOD FOR THE MEASUREMENT OF THE OPTICAL CONSTANTS OF METALS.—Bor. (*Nature*, 24th April 1937, Vol. 139, pp. 716–717.)

2835. THE PHOTOELECTRIC MEASUREMENT OF TIME AND SPEED [especially of Motor Cars].—Melzer. (*Elektrot. u. Masch:bau*, 11th April 1937, Vol. 55, No. 15, pp. 173–176.)

2836. PHOTOTUBE TEMPERATURE CONTROL [in Valve-Stem Heat Treatment, Sparking-Plug Assembly, Annealing, etc: Latest Technique].—Powers. (*Electronics*, April 1937, Vol. 10, No. 4, pp. 12–15.)

2837. THE ELECTRON-BEAM SECTROMETER: A LINE-OPERATED VACUUM-TUBE TITROMETER FOR POTENTIOMETRIC TITRATIONS WITH CATHODE-RAY TUBE REPLACEMENT OF THE MICROAMMETER [using the 6E5 "Magic Eye" Visual Tuning Indicator].—Smith & Sullivan. (*Journ. Soc. Chem. Industry*, March 1937, Vol. 56, pp. 104–108T.) On the instrument referred to in 816 of February.

2838. THE PHOTO-RELAY [Construction and Application of the Chlorine-Hydrogen Cell].—Chilowski. (*Recherches et Inventions*, March 1937, Vol. 17, pp. 62–67.) *See* also 436 of January and 2839, below.

2839. THE CHILOWSKI-TUBEST "PHOTO-RELAY" AND ITS APPLICATION TO THE AUTOMATIC CONTROL OF MOTOR-CAR SIDE LAMPS, ETC.—Reyval: Chilowski. (*Rev. Gén. de l'Élec.*, 3rd April 1937, Vol. 41, No. 14, pp. 442–445.) *See* also 2838, above.

2840. THE PORTABLE PHOTOELECTRIC DAYLIGHT-FACTOR METER.—Barnard. (*Proc. Phys. Soc.*, 1st March 1937, Vol. 49, Part 2, No. 271, p. 194: demonstration.)

2841. ELABORATE HORSE-RACE TIMER USES FIVE PHOTO TUBES ["Multiple-Eye" Camera Equipment].—Powers: Gardner. (*Electronics*, April 1937, Vol. 10, No. 4, p. 34.) For an examination of the accuracy of "camera finishes" *see* Gardner, *Journ. of Res. of Nat. Bur. of Stds.*, April 1937, Vol. 18, No. 4, pp. 467–474.

2842. THE METHODS USED IN THE STATE DEPARTMENT FOR WEIGHTS AND MEASURES FOR PRECISION MEASUREMENTS ON INCANDESCENT LAMPS BY MEANS OF SELENIUM BARRIER-LAYER PHOTOCELLS.—Buchmüller & Konig. (*Bull. Assoc. suisse des Élec.*, No. 5, Vol. 28, 1937, pp. 89–99: in German.)

2843. A NEW COLOUR-SEPARATOR [Two-Photocell Equipment comparing Percentage of Two Basic Colours].—Richter. (*Electronics*, March 1937, Vol. 10, No. 3, pp. 28–29.)

2844. GLASS COLOUR FILTERS FOR SPECIAL APPLICATIONS [*e.g.* Correction of Photocell Response Characteristic: Method of Calculation of Thickness].—Gage. (*Journ. Opt. Soc. Am.*, April 1937, Vol. 27, No. 4, pp. 159–164.)

2845. A NEW SELENIUM BARRIER-LAYER FILTER-PHOTOCELL [agreeing with International Eye-Sensitivity Curve].—Fogle. (*E.T.Z.*, 15th April 1937, Vol. 58, No. 15, p. 408: summary only.)

2846. A DEPENDABLE SELENIUM-CELL CIRCUIT [for Light-Beam Relay Equipments].—Praetorious. (*Electronics*, April 1937, Vol. 10, No. 4, p. 42.)

2847. THE AMPLIFICATION OF GALVANOMETER DEFLECTIONS.—Taylor. (*Review Scient. Instr.*, April 1937, Vol. 8, No. 4, pp. 124–125.) A simple and successful method using two caesium photocells.

2848. PHOTOCELL SORTS LETTERS FOR BRITISH POST OFFICE [and controls Stamp Perforation for U.S. Post Office].—(*Electronics*, April 1937, Vol. 10, No. 4, p. 34.)

2849. RECENT DEVELOPMENTS IN THE PHOTOCELL CHECKING OF ELECTRICITY METERS.—Nölke. (*Bull. Assoc. suisse des Élec.*, No. 7, Vol. 28, 1937, pp. 149–150: summary only, in German.)

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. A selection of abstracts from patents issued in the U.S.A. is also included, and these bear a seven-figure serial number.

AERIALS AND AERIAL SYSTEMS

460 570.—Long and short wave aerial, with four divergent collectors and a transmission-line down-lead.

Marconi's W.T. Co. (assignees of V. D. Landon and J. D. Reid). Convention date (U.S.A.) 28th April, 1934.

460 830.—Short-wave aerial unit, particularly suitable for receiving television.

The British Thomson-Houston Co. Convention date (U.S.A.) 7th September, 1935.

462 911.—Coupling arrangement for matching the impedance of a dipole aerial to that of a concentric feed-line.

E. C. Cork and J. L. Pawsey. Application date 17th September, 1935.

TRANSMISSION CIRCUITS AND APPARATUS

461 204.—Relay system for increasing the effective range of ultra-short waves.

O. Poschle; A. Dietrich; and P. Habig. Convention date (Austria) 17th October, 1934.

464 768.—Modulating by absorption in a low-powered wireless transmitter.

K. Schuchter. Convention date (Austria) 12th September, 1935.

RECEPTION CIRCUITS AND APPARATUS

458 798.—Tuning control and muting arrangements for a receiver of combined sound and picture signals.

Marconi's W.T. Co. (assignees of R. S. Holmes). Convention date (U.S.A.) 28th June, 1934.

458 801.—Push-pull input circuit from a dipole aerial designed to minimize interference " pick-up."

Kolster-Brandes and C. W. Earp. Application date 28th June, 1935.

459 070.—Superheterodyne receiver for combined sound and picture signals in which a common amplifier is used for both beat frequencies.

The British Thomson-Houston Co.; T. H. Kinman; and D. S. Watson. Application date 26th June, 1935.

459 658.—Tuning a wireless receiver by an initial manual movement followed by an automatic " fine " adjustment.

The British Thomson-Houston Co. Convention date (France) 7th June, 1934.

460 055.—Automatic tuning arrangement for a wireless receiver, in which the controlling potentials are derived from two parallel streams in an auxiliary valve.

E. K. Cole and G. Bradfield. Application date 3rd October, 1935.

460 179.—Coupling arrangements for wireless receivers of the homodyne type.

Marconi's W.T. Co. and G. M. Wright. Application date 22nd July, 1935.

460 198.—Automatic volume control system for a combined television and sound receiver.

L. R. Merdler and Baird Television. Application date 22nd July, 1935.

460 408.—Superhet receiver utilizing a diode as the first detector, for giving high selectivity without re-radiation.

N. V. Philips Lamp Co. Convention date (Germany) 19th August, 1935.

460 675.—Automatic volume control system for combined sound and picture receivers.

The General Electric Co. and D. C. Espley. Application date 27th November, 1935.

461 092.—Construction of wireless receiver and chassis to facilitate servicing.

E. K. Cole and H. C. Taylor. Application date 2nd October, 1935.

461 282.—Frequency-changing circuit for a superhet receiver in which the input grid of the valve is kept at a potential node with respect to other grids of the same valve.

J. H. O. Harries. Application date 15th August, 1935.

461 360.—Automatically varying the selectivity of a wireless receiver by means of a valve, the grid of which is made more negative as the carrier strength increases.

The General Electric Co. and J. J. E. Aspin. Application date 1st October, 1935.

462 328.—Receiver in which the tuning control indicates whether or not the incoming carrier is correctly related to the band-pass characteristic of the tuned input circuits.

Marconi's W.T. Co. and R. F. O'Neill. Application date 7th September, 1935.

DIRECTIONAL WIRELESS

458 820.—Radio direction-finder comprising two substantially-vertical and electrically-unconnected dipole aerials, one of which is movable.

L. L-K. Honeyball. Application date 22nd June, 1935.

462 464.—Wireless directional system for facilitating the " blind landing " of aircraft in fog.

A. H. Cooper. Application date 7th September, 1935.

TELEVISION AND PHOTOTELEGRAPHY

458 878.—Means for maintaining the electrical centre of a television picture coincident with the position of the undeflected beam in a cathode-ray tube receiver.

The General Electric Co.; R. J. Dippy; and D. C. Espley. Application date 25th October, 1935.

458 883.—Producing synchronising signals by means of apertures cut in a scanning disc of the Nipkow type.

The General Electric Co. and D. C. Espley. Application date 22nd November, 1935.

458 923.—Setting and adjusting the reflecting surfaces of a rotating mirror-drum as used for television scanning.

J. Bell and W. S. Worthington. Application date 8th April, 1936.

459 177.—Television system in which scanning is effected in groups of parallel strips, the inclination of which varies from group to group.

J. L. Baird and Baird Television. Application date 4th July, 1935.

459 422.—Preventing curvature distortion of the saw-toothed oscillations used for scanning.

Radio-Akt. D. S. Loewe. Convention date (Germany) 29th March, 1935.

459 506.—Producing square-peaked impulses from a sine-wave input for use in scanning.

J. C. Wilson and Baird Television. Application date 5th July, 1935.

459 610.—Push-pull time-base circuits for television receivers.

The General Electric Co. and D. C. Espley. Application date 20th November, 1935.

459 853.—Compensating for the distortion of very low frequency and D.C. signal components in television.

E. L. C. White. Application date 12th July, 1935.

460 197.—Interlaced scanning system utilising a mirror screw which is given a real or apparent displacement between successive traversals.

J. L. Baird and Baird Television. Application date 22nd July, 1935.

460 445.—Cathode-ray television receiver in which a diode inside the glass envelope is used to rectify the A.C. mains supply.

Baird Television and C. Szegho. Application dates 27th July, 1935, and 26th May, 1936.

460 721.—Method of keeping step with slow changes in the background illumination of a televized picture.

G. W. Walton. Application date 7th August, 1935.

461 646.—Increasing the sensitivity of the photo-electric screen used in a television camera of the Iconoscope type.

Marconi's W.T. Co. (assignees of A. V. Bedford and R. D. Kell). Convention date (U.S.A.) 31st August, 1934.

462 110.—Means for eliminating spurious signals in a cathode-ray television transmitter.

E. L. C. White. Application date 24th June, 1935.

462 550.—Television transmission system in which the picture is focused upon a photo-electric "mosaic" of cells in a cathode-ray tube.

H. Miller. Application date 10th September, 1935.

462 684.—Minimising the stray fields from the magnetic deflecting-system of an image-dissector or Iconoscope tube used as a television transmitter.

A. H. Gilbert; L. R. Merdler; and Baird Television. Application date 12th September, 1935.

SUBSIDIARY APPARATUS AND MATERIALS

459 041.—Arrangement for varying the electron content of a cathode-ray stream in accordance with its rate of deflection.

R. A. W. Watt. Application date 26th March, 1935.

459 171.—Polarising-prism comprising three-bi-refringent elements, symmetrically arranged, to increase the separation of the ordinary and extra-ordinary rays in a light valve.

P. V. Reveley and Baird Television. Application date 3rd July, 1935.

460 507.—Valve-holder for a seven or nine pin valve designed to minimise the risk of contact or leakage between adjacent sockets.

A. F. Bulgin and A. F. Bulgin and Co. Application date 21st August, 1936.

460 579.—Photo-electric cell in which the electrons are accelerated or intensified before being focused upon a fluorescent screen.

C. Szegho; T. M. C. Lance; and Baird Television. Application date 29th July, 1935.

460 994.—Moving-coil loud-speaker with a domed corrugated member of different cross-section along different radial lines extending outwards from the moving coil.

Jensen Radio Manufacturing Co. Convention date (U.S.A.) 4th June, 1934.

461 434.—Photo-electric cell in which light produced by the impact of electrons against a fluorescent screen is used to liberate more electrons from a photo-sensitive electrode.

D. M. Johnstone and Baird Television. Application date 16th August, 1935.

462 488.—Rectifier circuit for supplying high D.C. voltages to the electrodes of a cathode-ray television receiver.

The General Electric Co. and D. C. Espley. Application date 27th November, 1935.

462 579.—Rectifier of the dry-contact type arranged to have a low and exactly-reproducible self-capacity.

N. V. Philips Co. Convention date (Germany) 29th July, 1935.

MISCELLANEOUS

460 297.—Multivibrator circuit utilised to indicate the approach or entry of a body into a protected zone.

A. C. Alexandra. Application date 25th July, 1935.

460 479.—Fluorescent screen for a cathode-ray tube, comprising a mixture of a manganese compound with zinc borate and zinc sulphide.

Farnsworth Television Inc. Convention date (U.S.A.) 13th March, 1935.