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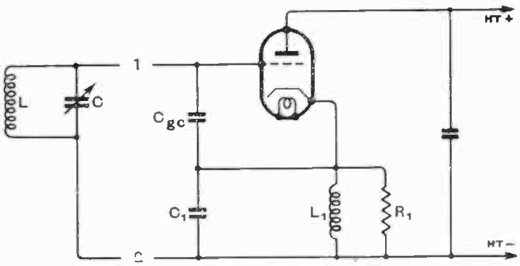
The Effect of Reaction on Tuning

ALTHOUGH at one time very widely used, reaction is not common nowadays, but there are signs that it is staging a comeback. It is being increasingly used in inexpensive receivers of the so-called communication type. These receivers are superheterodynes and reaction is used at radio-frequency, largely to increase the selectivity and so reduce second-channel interference, and at intermediate frequency, to increase the adjacent channel selectivity. This permits a reduction in the number of tuned circuits and so of the cost.

Reacting circuits are rarely designed; they are usually arrived at by a process of trial and error based upon experience. This does not mean that the final result is unsatisfactory, but it does mean that the work of the designer is unnecessarily great, and he is unable to give theoretical reasons for his final choice.

The important properties which a regenerative circuit should possess are two. On varying the amount of regeneration the tuning of the circuit to which it is applied should not alter. On increasing reaction to the oscillation point, the valve should slide gently into oscillation without backlash or ploppiness. This second requirement is much less important than it used to be, because in modern receivers critical reaction is not used; instead of depending largely upon reaction for sensitivity, it is now used in a more moderate degree to increase selectivity.

The smoothness of reaction depends largely upon the valve characteristics and its steady applied voltages. The effect of reaction on the tuning is often more important and is easier to investigate, for as long as the valve is not oscillating only linear quantities are involved.



One of the simplest arrangements is based on the Colpitt's oscillator, and it is particularly convenient since no reaction coil is needed nor any tapping on the tuning coil. It can be drawn in the form shown in the figure, and it has been shown by Williams and Chester[1] that the input impedance between terminals 1 and 2 can be represented by a resistance R_{in} in parallel with a capacitance C_{in}. Their equations are reducible to the forms:—

$$R_{in} = R\frac{(1 + C_1/C_{gc})^2 + (1 + gR)^2/\omega^2 C_{gc}{}^2 R^2}{1 - gRC_1/C_{gc}} \quad \ldots \quad \ldots \quad (1)$$

$$C_{in} = C_1\frac{(1 + gR)/\omega^2 C_1 C_{gc} R^2 + 1 + C_1/C_{gc}}{(1 + gR)^2/\omega^2 C_{gc}{}^2 R^2 + (1 + C_1/C_{gc})^2} \quad \ldots \quad \ldots \quad (2)$$

[1] *The Wireless Engineer*, May, 1939.

where $g = \mu/R_a$, $R = R_1R_a/(R_1 + R_a)$, and μ and R_a are respectively the amplification factor and anode A.C. resistance of the valve. L_1 is assumed to have a high enough reactance compared with that of C_1 for it to be ignored.

Provided that $gRC_1/C_{gc} > 1$, the input resistance is negative and regenerative effects are provided on the circuit LC. Self-oscillation occurs when R_{in} is less than the dynamic resistance of the tuned circuit.

Examination of (2) shows that C_{in} depends on all quantities and so must vary whichever one is varied as a regeneration control. When

$$(1 + gR)/\omega^2C_1C_{gc}R^2 \ll (1 + C_1/C_{gc}) \text{ and}$$
$$(1 + gR)^2/\omega^2C_{gc}{}^2R^2 \ll (1 + C_1/C_{gc})^2$$
$$C_{in} \approx C_1/(1 + C_1/C_{gc}) \qquad .. \quad (3)$$

It is clear that neither C_1 nor C_{gc} must be used as a control of regeneration, but as neigher g nor R occurs in (3) either of these can be varied without affecting C_{in}.

At the other extreme, when

$$(1 + gR)/\omega^2C_1C_{gc}R^2 \gg (1 + C_1/C_{gc}) \text{ and}$$
$$(1 + gR)^2/\omega^2C_{gc}{}^2R^2 \gg (1 + C_1/C_{gc})^2$$
$$C_{in} \approx C_{gc}/(1 + gR) \qquad .. \qquad .. \quad (4)$$

In this case it is clear that C_{in} is very dependent on both g and R, but is independent of C_1. The proper regeneration control is thus a variable condenser for C_1.

Voltage Control

It has long been the practice to control reaction in short-wave equipment by varying the voltage applied to one of the electrodes of the valve, in other words by varying g and/or R, because it has been found experimentally that this affects the tuning of the input circuit least. Equation (3) shows that this course is the right one, for it is at very high frequencies that the assumptions made in deriving (3) are most nearly accurate. On the other hand, this method of control is clearly the wrong one when the conditions for equation (4) apply; that is, at the lower radio frequencies. This is a somewhat unexpected result and illustrates the value of an analysis.

As an example, take the case of a valve with $g = 2$ mA/v, $R_a = 10{,}000\Omega$, and $C_{gc} = 10$ $\mu\mu$F. If $R_1 = 50{,}000\Omega$ and C_1 is variable between the limits of 10 $\mu\mu$F and 100 $\mu\mu$F, then at a frequency of 465 kc/s R_{in} varies from $-2.8\ M\Omega$ to $-0.27\ M\Omega$ and C_{in} from 0.57 $\mu\mu$F to 0.76 $\mu\mu$F. When C_1 is 200 $\mu\mu$F, R_{in} becomes $-0.2\ M\Omega$ and C_{in} is 1.26 $\mu\mu$F.

High-Frequency Operation

With modern I.F. transformers a dynamic resistance of more than 0.2 $M\Omega$ is readily obtainable with a tuning capacity C of the order of 70 $\mu\mu$F. Full regenerative effects can thus be obtained with a change of capacity of less than 0.69 $\mu\mu$F. Varying C_1 from 10 $\mu\mu$F to 200 $\mu\mu$F will under these conditions alter the resonance frequency of the input circuit by about 1.5 kc/s. With a little care in design, this figure could no doubt be reduced appreciably.

At high frequencies, say, 30 Mc/s, C_1 and C_{gc} should be fixed, and as the minimum input resistance occurs when they are equal, let us assume them to be each 10 $\mu\mu$F. C_{in} then tends to the fixed value of 5 $\mu\mu$F. Taking $\mu = 20$ as a fixed value and varying R_a we have for $R_a = 10^4\Omega$, $C_{in} = 3.9$ $\mu\mu$F and $R_{in} = -2{,}800\Omega$. Both C_{in} and R_{in} increase with R_a and at $R_a = 50{,}000\Omega$, C_{in} becomes 4.96 $\mu\mu$F and R_{in} is $-11{,}300\Omega$. At $R_a = 100{,}000\Omega$, C_{in} is 4.99 $\mu\mu$F and R_{in} is $-23{,}600\Omega$.

The values chosen are not necessarily the most suitable; indeed it would probably be advisable to reduce C_{gc} and increase C_1. The examples do show, however, that by the proper choice of the reaction control it is possible to make the changes of input capacitance very small indeed, and that the proper choice of the control depends largely upon the operating frequency, a rather unexpected result.

It should be pointed out that in practice an alteration in the values of the voltages applied to the valve may appreciably alter the value of C_{gc}. This is not taken into account in the equations, and it would consequently seem better to make the reaction control at high frequencies a variable resistance R_1 than to vary g or R_a by altering the electrode potentials of the valve.

W. T. C.

A.V.C. Characteristics and Distortion*

Graphical Analysis of Valve Operating Conditions

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(Communication from the Research Staffs of the M.O. Valve Co., Ltd., and of The General Electric Co., Ltd., at the Research Laboratories, Wembley, England)

SUMMARY.—A graphical method of deducing the A.V.C. characteristic of a radio receiver from a knowledge of the valve characteristics is described. Each amplifying stage is studied separately and the value of aerial input voltage at which each stage distorts may be clearly observed. Several typical valves are examined and the best operating condition of each is deduced.

Introduction

ALMOST every modern radio receiver employs some form of automatic volume control, i.e. the gain of the receiver is arranged to be reduced when the aerial signal voltage increases. As the reduction in gain is usually effected by increasing the value of negative bias applied to the grids of the amplifying valves, it is necessary that the anode current-grid voltage characteristics of the valves should be curved, and distortion is therefore introduced in the valves.

The amount of distortion generated in any valve, at any value of grid bias, can be determined either graphically or experimentally [1], but before the overall distortion from a number of valves in an amplifying chain can be determined, it is necessary to know the value of the grid bias applied to every valve

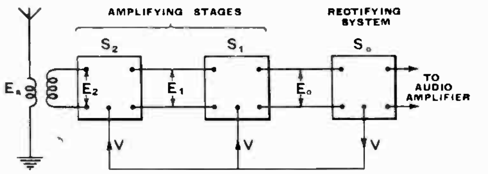

Fig. 1.—*Schematic diagram of a typical receiver.*

at all values of the input voltage. It may also be necessary to apply only a fraction of the available A.V.C. controlling voltage to one or more of the valves in order to reduce the amount of distortion, and it has hitherto been difficult to forecast what this fraction should be.

A method of visualising the above conditions for any number of valves in an amplifying chain is given in this article.

Method of Deducing the A.V.C. Characteristic of a Receiver

The most common type of broadcast receiver in present use employs either two or three pre-detector amplifying stages, and it is immaterial, in studying the A.V.C. performance, whether these are R.F., frequency changing or I.F. stages. The bias, controlling the gain of each stage, is derived from a rectifier system at the output end of the chain, and by far the most popular arrangement is a simple system employing two diodes. One of the diodes is used for demodulating the signal, and the other provides the controlling bias to be applied to the amplifying valves. In the general case it is often necessary to apply only a fraction of the available controlling bias to the various stages, but in order to facilitate explanation, the case where the full A.V.C. voltage is applied to all the amplifying valves will be considered first. A schematic diagram of such a receiver is shown in Fig. 1. S_1 and S_2 represent the amplifying stages, and S_0 the rectifier stage which provides the controlling bias V. Let the R.M.S. input signal voltages to the various stages for a given value of the aerial input E_a be denoted by E_0, E_1 and E_2.

The easiest way to understand the application of the method is to consider the behaviour of the receiver, starting with the rectifying stage and progressing along the chain, stage by stage, until the aerial circuit is reached.

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The behaviour of the rectifying stage S_0 can be expressed readily by a curve such as AB, shown in Fig. 2. This curve shows the relationship between the D.C. bias V and the applied voltage E_0 for a typical diode operated with no initial bias. It is usual to arrange the rectifier circuit so that no controlling voltage is obtained until the input

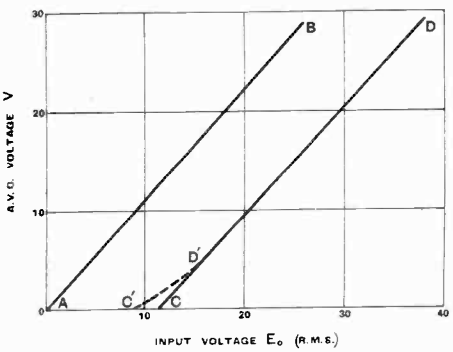

Fig. 2.—*Relation between input voltage and bias produced for a typical diode.*

E_0 reaches some predetermined value. A corresponding curve for such an arrangement is shown at CD in Fig. 2. When this delayed action it obtained by using a simple diode biased negatively, the relationship between the input voltage and the A.V.C. bias produced will be modified by the modulation of the signal. The extent of this modification for a modulation depth of 30 per cent. is shown by the dotted curve $C'D'$.

(a). Case of full A.V.C. to all the valves.

The next step in the determination of the A.V.C. action involves the addition of the rectifier curves to characteristics of the stage S_1, and this becomes more convenient if the rectifier curves are replotted with the input E_0 drawn on a logarithmic scale as shown by the curve EF in Fig. 3, which corresponds to the curve $C'D'D$ of Fig. 2. Now E_0, the input to the rectifier, is also the output from the stage S_1, so that, for any fixed value of the input E_1 to this stage, a second curve GH can be plotted on Fig. 3 showing the way in which E_0 varies with the applied controlling bias V. When the two stages S_0 and S_1 operate together, the output E_0 and the bias V must satisfy the two conditions given by the curves EF and GH. The intersection of these two curves (point P) satisfies both conditions, and therefore completely determines the operating conditions of stages S_0 and S_1 for the particular value of input E_1 under consideration.

If now a different value of E_1 is considered, another curve $G'H'$ can be drawn for the stage S_1, and this will intersect the curve EF at the point P'. The point P' will similarly completely determine the operating conditions of the stages with this new value of input. Hence, if a family of curves of the type GH is drawn, the operating conditions of the stages S_0 and S_1 for a range of the input E_1 are completely determined by the intersections of this family with the curve EF. It is then possible to draw a curve showing the relationship between E_1 and V for the two stages S_0 and S_1, and this is shown at KL in Fig. 4.

A little consideration will show that this new curve KL of Fig. 4 bears the same relationship to stage S_2 as did the rectifier characteristic EF of Fig. 3 to the stage S_1.

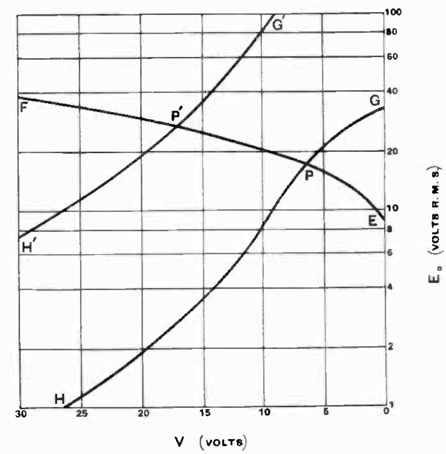

Fig. 3.—*Variation of output against bias with a constant input for stage S_1.*

That is, the process described for the stage S_1 can be repeated for the stage S_2 by adding to Fig. 4 a family of curves of output E_1 against applied control bias V for various values of the input E_2. The intersection of this family of curves with KL will then give the operating condition of the stage S_2, when it is followed by the stages S_1 and S_0, and shows the relationship between E_2 and V.

If S_1 and S_2 are the only amplifying stages, then the A.V.C. characteristic of the receiver can be deduced from the relationship between E_2 and V. The input E_2 is proportional to the aerial signal E_a ($E2/E_a$ is the aerial circuit gain), and the output E_0 is related to V by the curve EF of Fig. 3. A relationship between E_0 and E_a can therefore be obtained. In all normal arrangements the L.F. output from the receiver is proportional to the output E_0 so that the relationship between E_0

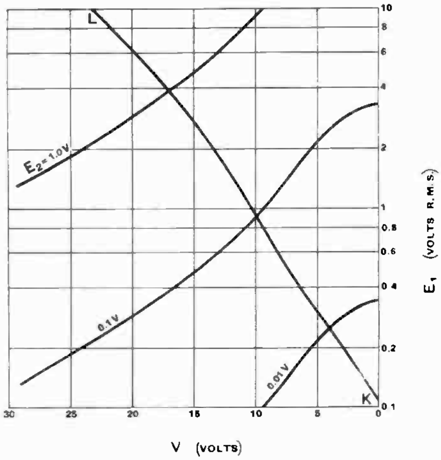

Fig. 4.—*Variation of output against bias for stage S_2.*

and E_a is, in effect, the A.V.C. characteristic of the receiver.

So far a receiver having only two amplifying stages has been considered, but the method is applicable to any number of stages. With three amplifying stages, the relationship already obtained between E_2 and V is superimposed on a family of output against bias curves for the stage S_3; a relationship is then obtained between the input E_3 to the stage S_3 and the A.V.C. bias V. The transformation of this into the A.V.C. characteristic is then exactly similar to that described above.

(*b*) *Case where a fraction of the A.V.C. voltage is applied to some valves.*

In certain cases it is undesirable to apply the full A.V.C. voltage to one or more of the amplifying stages, and the method can be readily adapted to such a case. For example, if only a fraction "f" of the available A.V.C. voltage is applied to the stage S_1 its controlling bias will no longer be V, but will be some new value V_1 where $V_1 = fV$. It is necessary, therefore, to superimpose a curve of E_0 against V_1 (i.e. E_0 against fV) on the family of output against bias curves for the stage S_1 instead of E_0 against V. The relation between E_1 and V_1 can then be obtained as before and hence the relation between E_1 and V for use with the previous stage.

Considerations of Distortion

When a modulated signal is applied to the grid of an R.F. amplifying valve, distortion of the modulation envelope occurs owing to the necessarily curved characteristic of the valve. The amount of distortion will increase with increased signal input and the limit to the amplitude of the signal which can be applied before L.F. distortion is observed is known as the signal handling capacity of the valve.

If the signal handling capacity for each valve in the receiver is known, then the contribution of each valve to the distortion of the receiver can be determined. In order to do this it is most convenient to consider the last amplifying stage first. In most receivers this last stage will be an I.F.

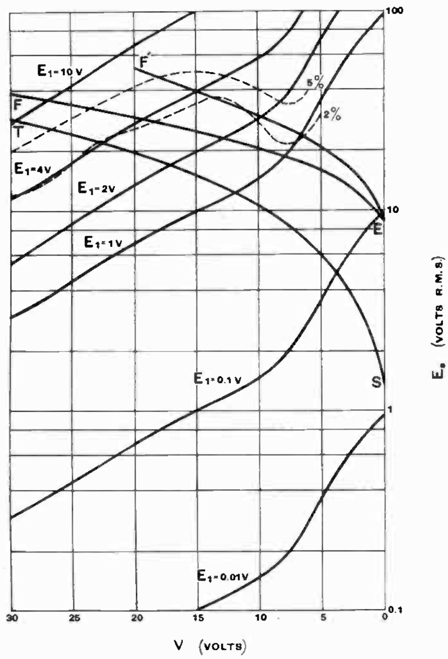

Fig. 5.—*Output-bias and distortion characteristics of an experimental I.F. valve.*

valve, and Fig. 5 shows the output—bias characteristics with various values of input for an experimental valve. The signal handling capacity of the valve was measured for 2 per cent. and 5 per cent. 2nd harmonic L.F. distortion with 30 per cent. modulation depth, and the figures obtained are plotted on Fig. 5 by taking the constant input lines as reference. The corresponding curves are shown dotted. If the operating point of the valve lies below the dotted curve corresponding to 2 per cent. L.F. distortion, then the distortion obtained will be less than this figure.

Some appropriate curves have been added to Fig. 5 to show how the valve would operate when it was followed by the usual delayed diode system for providing the A.V.C. bias. The curve *ST* corresponds to full A.V.C. applied to the valve, and a delay of 2 volts applied to the diode; curve *EF* corresponds to full A.V.C. and 15 volts delay, while ½ A.V.C. and 15 volts delay gives the curve *EF′*. The intersections of these curves with the constant input curves gives the operating points of the valve in each case.

It will be seen that with 2 volts delay and full A.V.C. (curve *ST*) 2 per cent. distortion occurs at a bias of about 23 volts; with 15 volts delay and full A.V.C. 2 per cent. distortion occurs at about 18.5 volts bias. The curve *EF′* illustrates an interesting case of variation of distortion with input. In this case the distortion increases with input, reaching a maximum of about 3 per cent. at 8 volts bias, then decreasing to just under 2 per cent. at 12 volts bias, and finally increasing in the usual way.

The curves connecting the input E_1 with the A.V.C. bias V, determined from Fig. 5, are shown by the curves *PQ* and *PR* in Fig. 6: *PQ* corresponds to 15 volts delay and full A.V.C. to the stage S_1, and *PR* to 15 volts delay and half A.V.C. The value of the input E_1 at which distortion occurs is marked on each of these curves, and the dotted portion of the curve represents a region where the distortion is more than 2 per cent.

The performance of the preceding stage S_2 can be determined by superimposing a family of output—bias curves for S_2 on the curves *PQ* and *PR*, as shown in Fig. 6. As in the case of the stage S_1 the signal handling capacity curves for 2 per cent. and 5 per cent. L.F. distortion are drawn for the stage S_2.

It will be seen from Fig. 6 that, at an input of 5 volts to the stage S_2, nearly 5 per

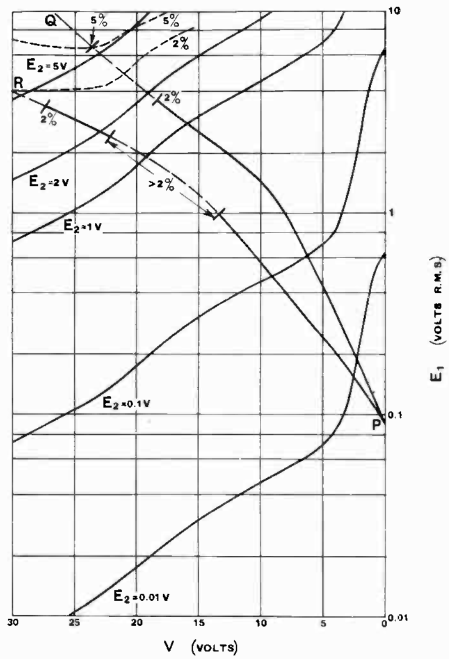

Fig. 6.—*Output-bias and distortion characteristics of a frequency changer valve. PQ corresponds to full A.V.C. on stage S_1. PR corresponds to half A.V.C. on stage S_1.*

cent. distortion occurs in both stages when full A.V.C. is applied to S_1, whereas with half A.V.C. to this stage the distortion is slightly less than 2 per cent. in S_2 and slightly greater than 2 per cent. in S_1. That is, for this value of input the distortion in both stages is appreciably reduced by applying half A.V.C. to the stage S_1. However, due to the trough in the distortion characteristic of stage S_1, slightly more distortion is obtained at an input of 1.0 volt.

In a normal receiver the aerial circuit gain on the medium wave band is of the order of 5, so that an input E_2 of 5 volts corresponds to an aerial signal input of 1 volt, and a receiver is generally considered satisfactory if it can handle this input without appreciable distortion.

The case examined above illustrates the importance of choosing the operating conditions of each stage so that a minimum amount of distortion is produced in the whole amplifier, and shows how the method assists in determining the most satisfactory condition.

The A.V.C. curve calculated from Fig. 6 with full A.V.C. to the stage S_1 (curve PQ) is shown by the full line in Fig. 7, while experimental results obtained in a receiver employing the above valves are shown by the points in circles. There is a slight discrepancy between the results at the low values of input which is due to regeneration in the receiver, and at high values of the input the L.F. output is greater than that calculated. The reason for the latter difference is that when a valve is being operated under such conditions that distortion of the modulated envelope occurs, there is a corresponding rise in the percentage modulation in its output, together with a rise of the carrier. The small amount of carrier rise occurring is offset by the A.V.C. action, since an increase of bias is obtained, but the increase in the modulation depth results in a corresponding direct increase in the audio output. It is possible to make an estimate of this rise in output, since the rise of percentage modulation is related to the distortion of the modulation envelope. For example, with 2 per cent. 2nd harmonic distortion of the output from a 30 per cent. modulated carrier, the modulation rise is 0.8 db., and for 5 per cent. distortion the rise is 2.1 db. The rise in output, estimated in this way, has been indicated by the dotted part of the curve.

The inputs at which the valves give 2 per cent. and 5 per cent. distortion are indicated on Fig. 7. A curve of distortion measured experimentally on the receiver is also shown. The distortion factor meter used for these measurements gave the results in terms of the R.M.A. distortion factor, in which the harmonics are weighted according to their order. It will be observed that at inputs just below 0.1 volt there is a slight maximum in the measured distortion. This is due to slight distortion occurring in the I.F. valve as a consequence of the trough in the distortion contour at a bias of about 8 volts. At higher inputs (from 0.4 volt upwards) the distortion rises as would be expected.

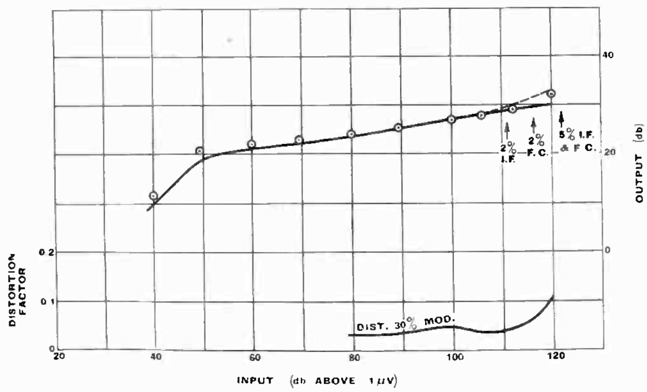

Fig. 7. — *A.V.C. and distortion characteristic of receiver using stages S_1 and S_2 as shown in Figs. 5 and 6. (Full A.V.C. to both stages.)*

Choice of Delay Voltage

It is well known that if the delay voltage is increased, the A.V.C. action will commence at a higher value of input, but that a flatter A.V.C. characteristic is obtained[2]. However, the delay voltage cannot be increased indefinitely as distortion will be introduced in the various amplifying stages. The effect of this in the last I.F. stage can be seen in Fig. 5, where the curves ST and EF are the diode characteristics corresponding to 2 volts and 15 volts delay. More distortion will be obtained at a bias of about 8 volts with 15 volts delay than with 2 volts delay, the amount of distortion increasing as the delay voltage is increased.

The possibility of a high value of delay voltage giving rise to distortion in a preceding stage is not as great, but in certain cases (e.g., in a valve having a sharp "knee" in its characteristic as shown in Fig. 11) it can give rise to appreciable distortion.

Examination of Some Practical Cases

(*a*) *KTW61 Valve in the Last I.F. Stage.*

The method described above demonstrates which valve in an amplifying chain gives rise to distortion, and over which part of the grid bias range that distortion occurs.

Once this fact is known, the gain-bias characteristic can be so designed that very little distortion occurs over the whole operating range when used in a normal receiver.

Fig. 8 shows the output-bias characteristics of a KTW61 valve, the design of which

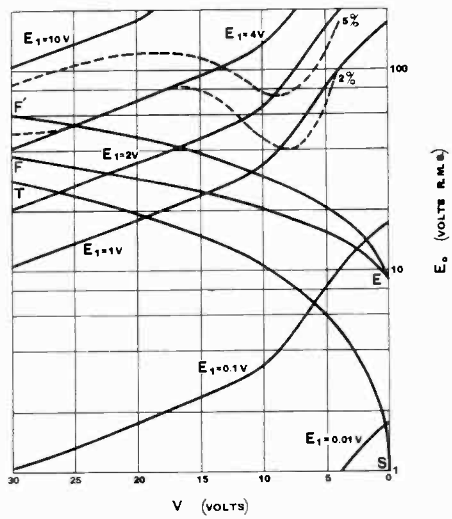

Fig. 8.—*Output-bias and distortion characteristics of a KTW61 type valve in the last I.F. stage. Curve ST corresponds to 2 volts delay on the diode and full A.V.C. to the I.F. valve, EF to 15 volts delay and full A.V.C. and EF′ to 15 volts delay and half A.V.C.*

has been based on the above considerations. The anode load of the valve assumed in obtaining these curves is 60,000 ohms, which gives a stage gain to the A.V.C. diode at minimum bias of 170. The scale of bias on the curves refers to the applied A.V.C. bias, and it is assumed that a cathode resistance is used so that the correct minimum bias is obtained when the applied bias is zero. The screen voltage is obtained from a 250 volt H.T. supply through a dropping resistor. Signal handling capacity curves for 2 per cent. and 5 per cent. distortion at 30 per cent. modulation depth are shown dotted. These figures are based on the distortion that occurs due to curvature of the anode current against grid-voltage characteristic of the valve, and do not take into account any distortion due to the curvature in the anode current-anode voltage characteristics. In practice the effect of this second source of distortion is an overall reduction, so that the valve would actually give less distortion than would be expected from the curves of Fig. 8, except at very low bias values where the distortion in the anode circuit is of greater importance than that in the grid circuit. However, the input signal under these conditions is, in general, small, so that negligible distortion is generated.

The diode curves for various normal operating conditions have been added to Fig. 8, and it will be observed that with full A.V.C. the distortion is less than 2 per cent. up to a bias of greater than 30 volts, while with half A.V.C. and 15 volts delay 2 per cent. distortion is obtained at a bias of 25 volts, i.e., at an A.V.C. voltage of 50. When the valve is operated under the above conditions (conditions which hold in the I.F. stage of most receivers) it can be used in conjunction with almost any preceding valve, without giving rise to distortion.

(*b*) *The X65 Frequency Changer Valve.*

The case in which the KTW61 valve is preceded by an X65 type frequency changer is shown in Fig. 9. In this figure a family of output—bias curves for the X65 valve operated with a screen potentiometer of normal value, is shown, together with the signal handling capacity curves for 2 per cent. and 5 per cent. distortion. A curve connecting the output of this valve (input to the KTW61) with the A.V.C. bias for 15 volts delay and full A.V.C. to the KTW61 is superimposed on the family. No distortion is obtained from the KTW61 with a bias of up to 30 volts, while 2 per cent. distortion occurs in the X65 with an input of 6.3 volts to it (i.e. at a bias of 30 volts). If the X65 valve was the first valve in the receiver, this input would correspond to an aerial input signal of 1.26 volts with the average aerial circuit gain of 5.

(*c*) *KTW61 as R.F. Valve.*

The choice of the gain of an R.F. stage which precedes a frequency changing valve is influenced by considerations of noise and whistles. If a gain of 10 is obtained from the R.F. valve at minimum bias, then any noise appearing after the first valve is unimportant and no appreciable increase in the signal to noise ratio is obtained if the R.F. stage gain is increased beyond this. In order to keep the whistles generated in the frequency changer as low as possible it is desirable to limit the gain preceding the valve, and experience has indicated that with the usual value of aerial circuit gain the R.F. stage gain must not exceed 10. On the medium wave band a gain of this order gives adequate sensitivity in the usual type of receiver.

Fig. 10 shows a family of output—bias curves for a KTW61 valve whose anode load is adjusted so that the gain is 10 at the minimum bias. Here, as in the case of the I.F. stage, the screen voltage is obtained from a 250 volt H.T. supply by means of a dropping resistor. The operating point of the valve, when it is followed by an X65 frequency changer and a KTW61 I.F. valve, is determined by superimposing the curve of input to the X65 against A.V.C. bias derived from Fig. 9. At an input to the R.F. valve of 5 volts the only distortion occurring in the amplifying stages is just over 2 per cent. in the R.F. valve itself.

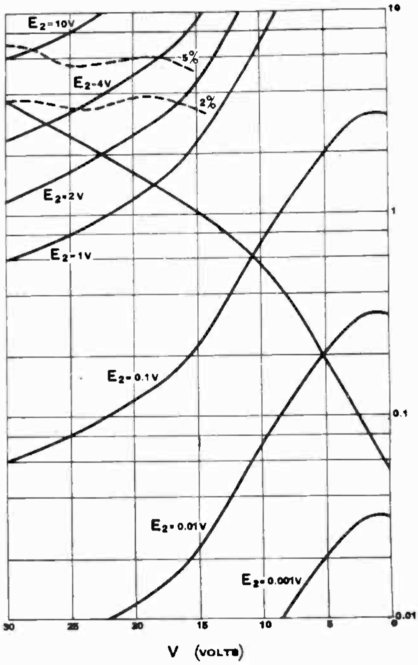

Fig. 9.—*Output-bias and distortion characteristics of an X65 frequency changer valve.*

It will be seen from Fig. 10 that the input to the R.F. valve could be increased to about 11 volts (i.e., at an A.V.C. bias of 30 volts) before 2 per cent. distortion is encountered in the X65. With other combinations of valves the distortion in the frequency changer or I.F. valve might be

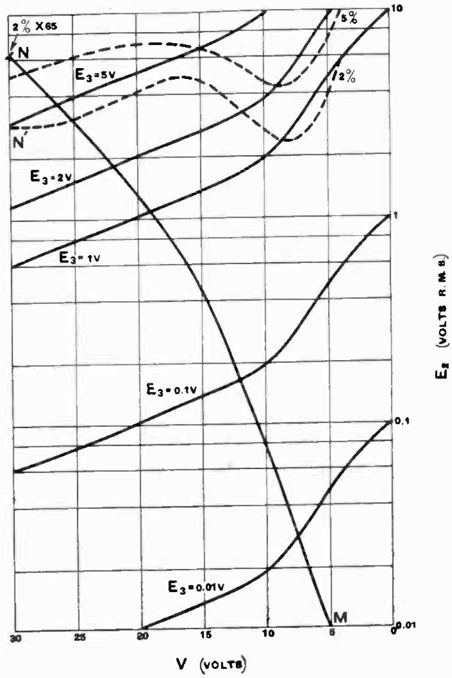

Fig. 10.—*Output-bias and distortion characteristics of a KTW61 valve in the R.F. stage of a superheterodyne receiver.*

encountered with much smaller inputs. For example, if distortion was encountered from these valves at an A.V.C. bias of 22 volts the overall distortion of the receiver could be reduced by increasing the control of the R.F. valve, and this can be done by supplying the screen voltage from a potentiometer.

With the particular combination of valves discussed the distortion at 5 volts input to the R.F. valve could be slightly reduced if the curve *MN* was moved so that it passed through the point *N′*, as the signal handling capacity of the R.F. valve is larger at the higher value of bias. This could be done by applying about half of the A.V.C. to the I.F. valve but there would be a slight sacrifice in the flatness of the A.V.C. characteristic, with this modification.

(*d*) *Effect of a Sharp " Knee " in the Characteristic of a Valve.*

It is desirable that the gain—bias characteristic of a valve should not have a sharp " knee " at a high value of bias if the receiver is to operate without distortion. In order to illustrate the kind of difficulties which are likely to be encountered in such a case, the output-bias characteristics of an experimental frequency changer valve are shown in Fig. 11. The " knee " in the characteristic of this valve occurs at an A.V.C. bias of about 9 volts with a consequent sharp dip in the signal handling capacity at this bias. The curves *AB* and *AC* show how the valve would behave in conjunction with a KTW61 I.F. valve operated with full and half A.V.C. respectively. With full A.V.C. to the KTW61 (curve *AB*) distortion is encountered in the frequency changer at an input of about 0.5 volt, while with half A.V.C. to the KTW61 the input can be increased up to about 6 volts before 2 per cent. distortion appears. It therefore follows that if the distortion of a receiver is reduced by applying only a fraction of the A.V.C. to one valve, it does not necessarily mean that the distortion was being generated in that particular valve.

Although comparative freedom from distortion with such a valve can be obtained, if the operating conditions in the receiver are chosen with sufficient care, the following difficulties arise which make such a characteristic undesirable.

(i) The position of the " knee " will, in practice, vary from valve to valve, and in order to cater for this variation it would be necessary to arrange the operating line *AC* (by suitable choice of A.V.C. fraction to the I.F. valve) to fall further away from the distortion region than is shown in Fig. 11. This would involve a sacrifice in A.V.C. performance.

(ii) When a receiver is slightly detuned, the gain of each stage to the desired signal is reduced, and a greater input will have to be applied to the I.F. valve to genearte the same A.V.C. voltage. The effect on the operating condition of the frequency changer will be to move the curve *AC* of Fig. 11 in a vertical direction relative to the constant input curves, with the result that serious distortion would be encountered with input signals to the frequency changer of more than 0.5 volt. This might make the tuning of the receiver unpleasant.

(iii) From the point of view of avoiding spurious responses in a superheterodyne receiver, it is necessary to keep the curvature of the control characteristic as small as possible. A valve of the type shown in Fig. 11 is therefore likely to be troublesome, especially when it is operating in the region of the " knee."

(*e*) *Effect on Signal Handling Capacity of Operating a Valve with a Screen Dropping Resistor.*

When the screen voltage of a valve is derived via a dropping resistor from the H.T. line, the application of the A.V.C. bias will cause the screen voltage to rise. It is generally known that less distortion is obtained under this condition than when the screen voltage is obtained from a potentiometer. The above method of examining the performance of a valve shows up this difference very clearly. In order to make a just comparison of the performance in the two cases, it is necessary to adjust the control obtained in each case to be the same; i.e.

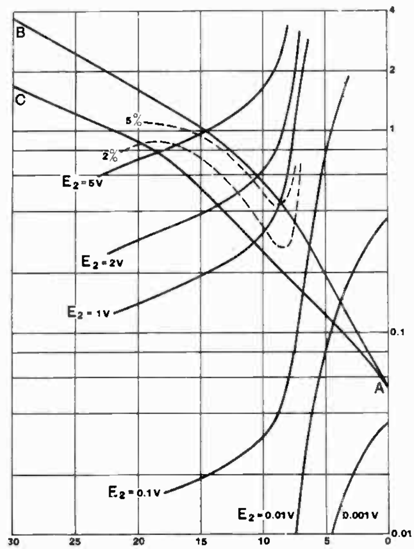

Fig. 11.—*Output-bias and distortion characteristics of an experimental frequency changer valve. AB corresponds to full A.V.C. on the KTW61 I.F. valve, and AC to half A.V.C.*

approximately the same relationship between input to the valve and the total A.V.C. bias must be obtained. If full A.V.C. is applied to the valve with a fully rising screen voltage,

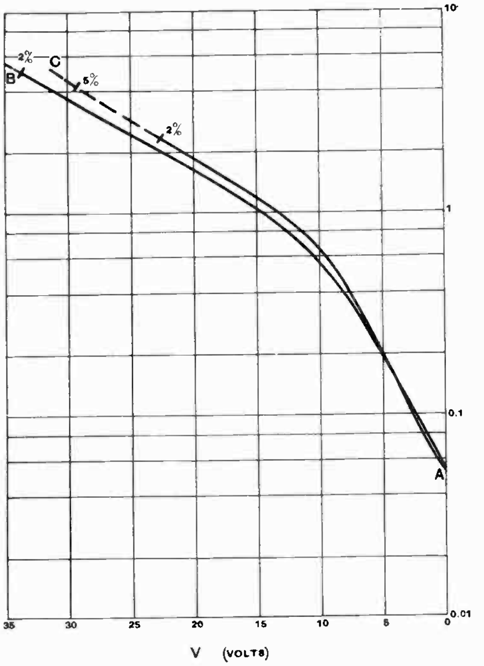

Fig. 12.—*Relationship between input to KTW61 I.F. valve and A.V.C. bias. AB—fully rising screen voltage and full A.V.C. AC—fixed screen voltage and 1/3 A.V.C.*

then it is necessary to apply a fraction of the A.V.C. in the fixed screen case in order to obtain the same control. Curve AB in Fig. 12 shows the relationship between input and A.V.C. bias for a KTW61 type valve in the last I.F. stage operated with a fully rising screen voltage, while curve AC shows a similar relationship for the same valve operated with fixed screen voltage and one-third of the A.V.C. voltage. It will be observed that in the fully rising screen case an input of 5.0 volts can be handled for 2 per cent. distortion, whereas in the fixed screen voltage case the corresponding input is 2.4 volts. This difference will correspond to a still larger difference in the input to a preceding valve; this can be seen by superimposing Fig. 12 on Fig. 9.

The authors desire to tender their acknowledgment to the General Electric Company and the Marconiphone Company, on whose behalf the work was done which led to this publication.

APPENDIX

For each valve in the receiver it is necessary to obtain a family of output—bias curves for various constant inputs. In the region of importance, these curves will all be parallel, on logarithmic paper, to a curve of gain against bias. One method of drawing the family of curves required is to trace the gain against bias curve on to another similar sheet of paper, the curves for various inputs being obtained by sliding the sheets of paper relatively in a vertical direction.

The signal handling capacity of a valve is usually expressed in terms of the input which can be handled for a given distortion criterion at any given value of bias. The easiest way of plotting this characteristic is shown in Fig. 13. "ABC" is the curve of output against bias for an input of 10 volts. If the signal handling capacity at a bias of − 15 volts is 2 volts, this can be plotted by placing a scale (consisting of a cycle of the same log. paper) "BD," so that the "10" mark falls on point "B" of the curve "ABC." The signal handling curve at this bias will pass through "E" and the whole curve "FEG" can be drawn by a repetition of the process. Such a method can also be used to draw the family of parallel output—bias curves.

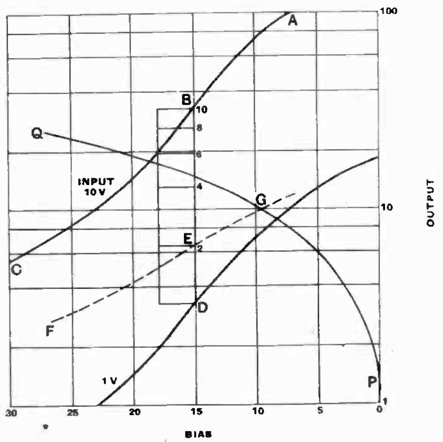

Fig. 13.—*Illustration of method of plotting distortion characteristic.*

In all cases the working point of the valve is given by intersection of the constant input curves with another curve represented for illustration at "PQ." In order to determine the input at which distortion occurs, it is necessary to know the input corresponding to the point "G." This can be found by placing the scale "BD" along the vertical line through "G" with the "10" mark on the curve "ABC." The required input can then be read off.

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Output Stage Distortion

Some Measurements on Different Types of Receivers

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[Concluded from page 390 of the August issue]

Pentode Output Valve

The pentode output valve, as is known, enables a larger portion of the anode voltage to be swung out than is possible with a triode (without giving rise to grid current). The function of the 3rd grid in a pentode is to prevent the passage of secondary electrons from anode to the screen-grid. The older types of output pentodes had a 3rd grid which not only radically suppressed these secondary electrons but also caused a substantial portion of the primary electrons to reverse their direction at low anode voltages and thus prevented these electrons from reaching the anode. In the $I_a - V_a$ diagram this phenomenon is manifested by the fact that the anode current increases slowly with the anode voltage at low values of the latter.

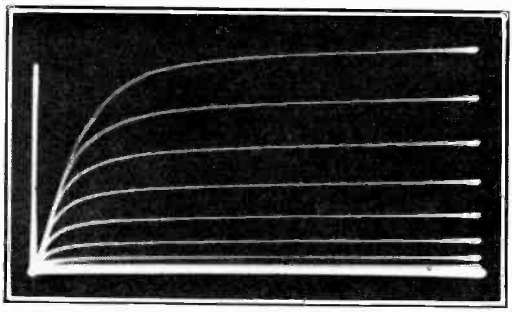

Fig. 10.—*Oscillogram of $I_a - V_a$ curves for an old type output pentode.*

This can be clearly seen in Fig. 10, which gives an oscillogram of the $I_a - V_a$ diagram for an old type pentode. The length of the horizontal axis of this and following diagrams is equal to twice the normal D.C. anode voltage unless otherwise stated. Since a better knowledge has been obtained of field-strength distribution and space-charge effect in the region between the screen-grid and the anode, the shape of the 3rd grid in some modern output pentodes has been considerably improved. The 3rd grid has been dimensioned in such a manner that secondary emission effects are just suppressed or are only admitted to a slight extent at very low anode voltages and

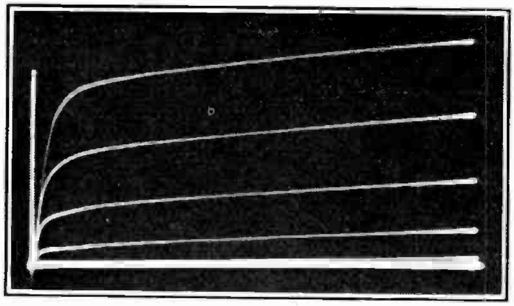

Fig. 11.—*Oscillogram of $I_a - V_a$ curves for a new type output pentode.*

currents. Fig. 11 gives the $I_a - V_a$ diagram for a more modern pentode on the same scale as Fig. 10. Comparison of these two figures shows that in the modern pentode the anode current initially increases very rapidly with the anode voltage. The tangent of the angle between the line for $V_{g1} = 0$ volt (the uppermost curve) and the vertical axis in Fig. 11 is about one half to one third of the value in Fig. 10. This improvement is expressed in the distortion curve by a lower distortion at maximum modulation of anode voltage and by a smaller amount of 3rd harmonics. Whereas older types pentodes gave about 15 per cent. distortion at maximum modulation of anode voltage, distortion in a modern pentode with an improved 3rd grid is about 10 per cent. A further advantage of the modern output pentode is that the difference in screen-grid current at quiescence and at full swing is much less than in the old type. This is important in cases where a series resistance is included in the screen-grid supply to ensure sufficient smoothing of the supply voltage.

Besides having a differently shaped 3rd grid, the vast majority of modern pentodes have a very high slope, which is an important asset to the sensitivity of the receiver.

The Mullard Pen A4 has been taken as a typical example of the pentode output stage. The principal data for this valve are :

Anode voltage = 250 ; slope = 9.5 mA/V ; grid voltage = 250 ; internal resistance = 50,000 ohms ; optimum load resistance = 7,000 ohms ; cathode resistance = 145 ohms ; max. anode dissipation = 9 watts ; anode current = 36 mA.

Sensitivity for 50 milliwatts is 0.33 volt, i.e., 10 times better than for the triode output valve AD1. The $I_a - V_a$ characteristics show only a slight deviation from those given in Fig. 11.

As compared with that of the triode output valve the higher internal resistance (R_i) is very evident. A direct consequence of this is that the current through the speaker coil as a function of frequency is practically constant when there is a constant A.C. voltage on the grid of the pentode output valve. It is well known that a constant current of varying frequencies through the coil of a moving-coil speaker approximates a level acoustic output more closely than a constant voltage of varying frequencies. Now, if the internal resistance is low compared with the speaker impedance as is the case with a triode output valve, this is practically tantamount to a constant voltage at the speaker terminals. Since the speaker impedance increases at higher frequencies, these frequencies will be too faintly reproduced. As the high modulation frequencies in the H.F. and I.F. sections are already weakened to meet the demands of selectivity, an additional weakening of these notes in the output stage is in no way beneficial to the quality of reproduction.

This difficulty does not arise when we use an output stage of high internal resistance, as for instance the pentode. In the region in which speaker resonance occurs (generally between 40 and 100 c/s), a constant current through the speaker coil would result in too powerful reproduction of this resonance frequency. But through the influence of the primary self-inductance of the output transformer, the speaker resonance will not cause over-powerful reproduction of these notes even when a pentode is used.

Owing to the high slope of most modern output pentodes, we may use a triode for the preamplifier without interfering with sensitivity requirements. Fig. 12 gives the distortion curve for the combination TDD4 + Pen A4. Comparing this with Fig. 7, we at once notice that the distortion curve for the Pen A4 is at a much higher level than for the combination SP4B + AD1. Contrary to what is commonly supposed, this is not due to the pentode having a much stronger 3rd harmonic than the triode. With the combination TDD4 + Pen A4, the curve for D3 is approximately at the same level as with the combination SP4B + AD1. Owing, however, to the much greater sensitivity of the pentode output valve, the A.C. voltages occurring on the grid of the preamplifier valve are so small that practically no distortion occurs in this valve. The 2nd harmonic of the pentode output valve is therefore no longer neutralised, with the result that the combination TDD4 + Pen A4 has considerably more 2nd harmonics than the combination with the triode AD1.

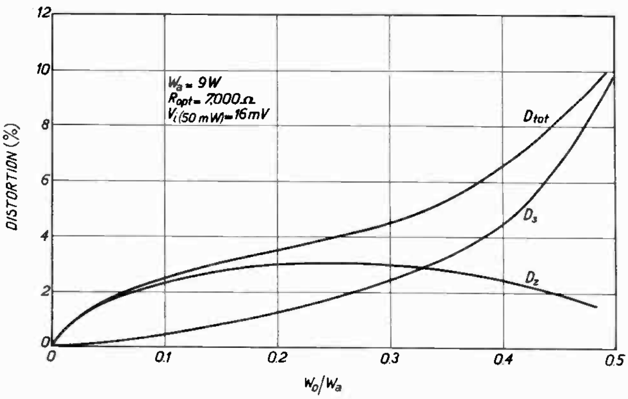

Fig. 12.—*Distortion curves for the combination TDD4 + Pen A4 without feed-back.*

It will further be noticed that the field of operation of the Pen A4 is in a very much safer position as regards grid current than that of the triode. The commencement of the grid current region in the triode is located at $\frac{W_0}{W_a} = 0.3$, while in a well-designed pentode grid current starts at about $\frac{W_0}{W_a} =$ 0.5. This is an important advantage from

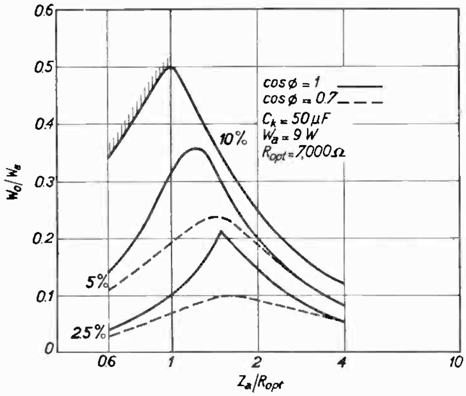

Fig. 13.—*Output at* 10 *per cent.,* 5 *per cent. and* 2.5 *per cent. distortion as a function of the load impedance when* $\cos \phi = 1$ *and when* $\cos \phi = 0.7$, *for the combination TDD4 + Pen A4 without feed-back.*

the point of view of overloading in the receiver. Whereas, when using a triode output valve, quality suddenly becomes very bad on passing the point $\frac{W_0}{W_a} = 0.32$, distortion in the Pen A4 when above $\frac{W_0}{W_a} = 0.32$ increases gradually from the permissible value of 5 per cent. to a value of 10 per cent. when $\frac{W_0}{W_a} =$ approx. 0.5, and not until then does distortion become very objectionable on account of grid current and limitation of the A.C. anode voltage. At the same volume adjustment the pentode thus gives a larger margin than the triode.

The dependence of output upon the value and phase angle of the load is illustrated in Fig. 13. Output at 2.5 per cent. and at 5 per cent. distortion is plotted in this figure as a function of the quotient of the load impedance and the optimum load resistance. In this instance, and again later when dealing with the beam-power valve, we have taken as optimum load resistance the value recommended by the factory which is generally equal to the quotient of the D.C. anode voltage and the D.C. anode current. The curves for $\cos \phi = 0.7$ are shown in the same figure by dotted lines. Comparing these with the corresponding curves for the triode combination (Fig. 9), it will be noticed in the case of the pentode that when $\frac{Z_a}{R_{opt}}$ is greater than 1, output is not limited abruptly by the occurrence of grid current, but in a gradual manner by the distortion factor itself. With pentodes, distortion in this region is chiefly determined by the A.C. anode voltage and is more or less independent of the value of the load resistance. This is clearly illustrated by the full-line curves in Fig. 14, which give the amplitude of the A.C. anode voltage for the fundamental frequency as a function of $\frac{Z_a}{R_{opt}}$.

Fig. 13 further shows that for load impedances greater than the optimum load resistance, the output at 2.5 per cent. distortion is smaller for the pentode than for the triode, and furthermore that a phase angle of the load impedance over prac-

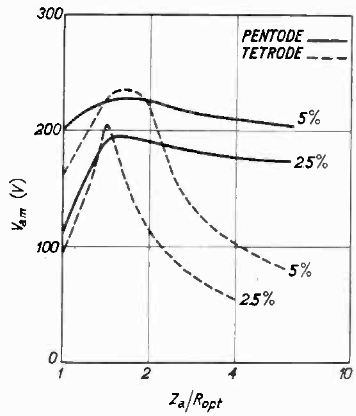

Fig. 14.—*Peak value of A.C. anode voltage at* 5 *per cent. and at* 2.5 *per cent. distortion as a function of the load impedance* ($\cos \phi = 1$) *for an output pentode and for a beam-power valve.*

tically the entire field of operation exerts a greater influence with the pentode than with the triode.

These shortcomings of the pentode as compared with the triode may be eliminated or even turned to account by the employment of reversed feed-back, without forfeiting the advantages mentioned. The simplest form of reversed feed-back is undoubtedly that in which the condenser C_k across the cathode resistance of the output valve is omitted. The sensitivity of the pentode output stage, though somewhat diminished by this coupling, is always about 5 times as good as in

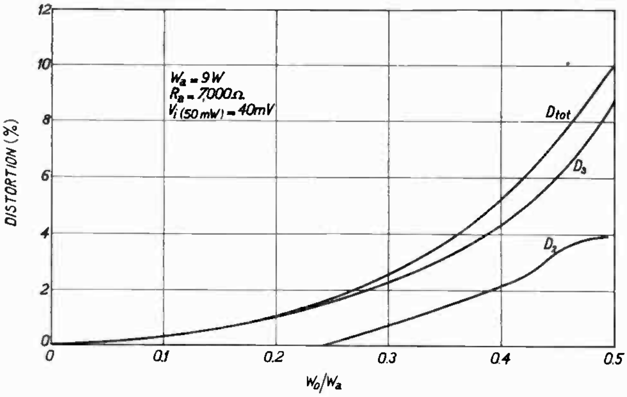

Fig. 15.—*Distortion curves for the combination TDD4 + Pen A4 without a condenser across the cathode resistance of the Pen A4.*

the triode output stage. The distortion curve for this scheme of connection is given in Fig. 15. It will be seen that, as a result of this expedient, the distortion curve is made practically identical with that of the triode combination SP4B + AD1, whether we are considering total distortion or the separate harmonics. Fig. 16 gives a picture of the influence exerted by the value and phase angle of the load. As a result of the inverse feed-back formed by omission of the cathode condenser, the maxima of the curves are shifted to the left, so that when

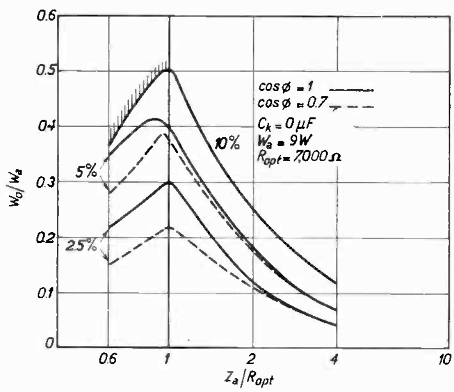

Fig. 16.—*Distortion at 10 per cent., 5 per cent. and 2.5 per cent. as a function of the load impedance when $\cos\phi = 1$, and when $\cos\phi = 0.7$ for the combination TDD4 + Pen A4, without a cathode condenser for the Pen A4.*

using this circuit it is advisable not to make the load impedance equal to $\frac{V_a}{I_a}$ but 10-15 per cent. less than this value.

The combination TDD4 + Pen A4 with a negative feed-back giving a loss in sensitivity of 4 times, and the combination SP4B and Pen A4 with a negative feed-back giving a loss in sensitivity of 10 times, are typical examples of the more usual form of circuit in which inverse feed-back is obtained by applying a voltage from the speaker circuit or anode circuit of the output stage to the grid of the pre-amplifier valve. The last-mentioned combination shows approximately the same sensitivity on the grid of the preamplifier valve as the combination SP4B + AD1.

Figs. 17 and 18 give the distortion curves for these two circuits. As the combination TDD4 + Pen A4 with a non-shunted cathode

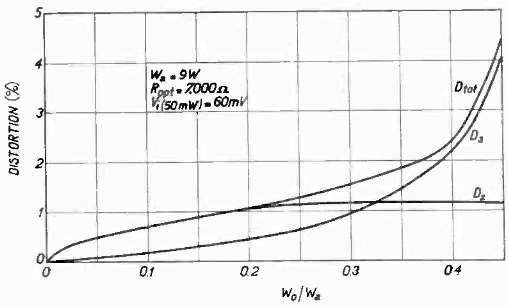

Fig. 17.—*Distortion curves for the combination TDD4 + Pen A4 with feed-back giving a loss in sensitivity of 4 times.*

resistance already gave the same distortion curve as a combination with a triode output valve, it is obvious that when using a stronger feed-back these circuits will give considerably less distortion than the triode.

The feed-back may, as is known, be proportional either to the speaker voltage or to the speaker current. The measurements following below refer to the first case. A low internal resistance may be an advantage in cases where a cheap loud speaker is used, and is of particular importance in amplifier installations with a varying load, as may be expected in the case of L.F. radio-distribution-systems. By comparatively simple reasoning it may be shown that, for a negative feed-back proportional to the anode

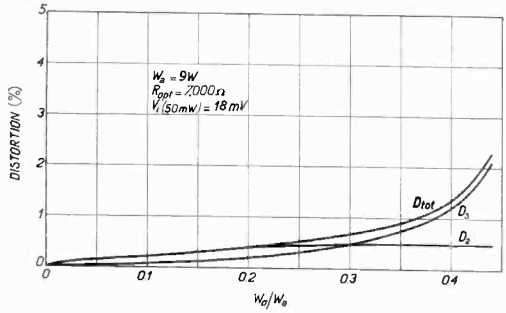

Fig. 18.—*Distortion curves for the combination SP4B + Pen A4 with feed-back giving a loss in sensitivity of 10 times.*

voltage, in which the sensitivity for $R_a = R_{opt}$ decreases by a factor k, the internal resistance R_i of the output stage becomes approximately equal to $1/k \times$ the optimum load resistance. For the combination TDD4 + Pen A4 with a feed-back giving a loss in sensitivity of 4 times, the internal resistance will therefore be about $\frac{1}{4}$ of the optimum load resistance, thus being approximately equal to that of the triode AD1, whose internal resistance is 0.3 times the optimum load resistance. With a feed-back of 10, proportional to the speaker voltage, the internal resistance becomes very small, so that the A.C. voltage given by the amplifier

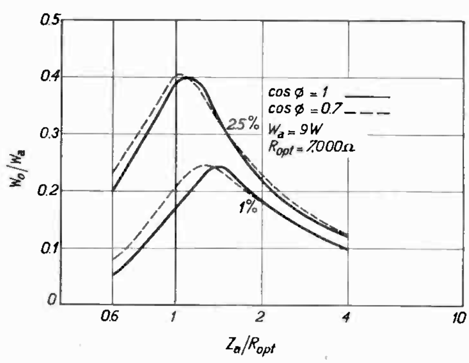

Fig. 19.—*Output at 2.5 per cent. and at 1 per cent. distortion as a function of the load impedance for TDD4 + Pen A4 with feed-back giving a loss in sensitivity of 4 times.*

will be practically independent of the external resistance. Negative feed-back proportional to the anode current gives a rise in internal resistance, hence by combining current and voltage feed-back we can arrive at practically any desired value for the internal resistance.

Inverse feed-back also has a large influence, in a favourable sense, upon output at other load impedances than the normal. This is shown by the Figs. 19 and 20, in which output at 2.5 per cent. and at 1 per cent. is plotted as a function of the ratio $\frac{Z_a}{R_{opt}}$. Hence a feed-back of 4 (which, as already mentioned, has approximately the same ratio $\frac{R_i}{R_{opt}}$ as the triode output valve) gives already at 2.5 per cent. distortion a somewhat more favourable result than the triode, whilst at 1 per cent. distortion—especially if the load is inductive—the performance of the

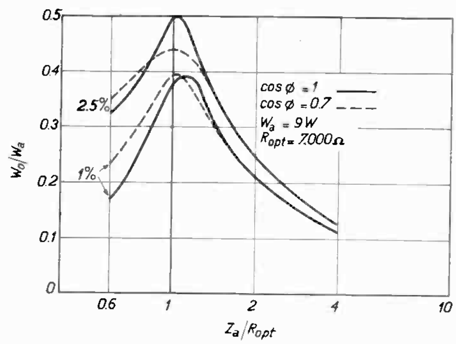

Fig. 20.—*Output at 2.5 per cent. and at 1 per cent. distortion as a function of the load impedance for SP4B + Pen A4 with feed-back giving a loss in sensitivity of 10 times.*

pentode combination is considerably better than that of the triode combination. If a back-coupling of 10 times is used, making the sensitivity of the pentode equal to that of the triode, the output of the pentode at a given distortion is very much larger than that of the triode; at 1 per cent. distortion the gain even mounts to 2 or 3 times.

Tetrode Output Valves

As already stated, the 3rd grid in the modern pentode has been so constructed that it just suppresses secondary emission. In this respect matters have been carried a step further by omitting the 3rd grid entirely, thus giving a tetrode. Secondary emission then has to be suppressed by the space charge alone. This has not as yet been achieved to a sufficient extent, so that most output tetrodes on the market are pentodes in a disguised form. In other words, the 3rd grid is no longer designed as a grid but is in the form of a window or is replaced by screening plates which enhance the effect of space charge upon the secondary electrons.

In these output tetrodes or beam-power valves, anode current increases also very rapidly with anode voltage. In this respect these valves are much better than old type output pentodes and are only slightly inferior to a modern output pentode such as the Pen A4. These two qualities are clearly seen in the $I_a - V_a$ diagram of the beam-power valve (Fig. 21). It will be noticed that at low anode voltages and comparatively small anode currents there is still a fairly large number of secondary electrons passing from the anode to the screen-grid. This does not generally cause any trouble at the optimum value of the load impedance, because, with a pure resistance load equal to R_{opt}, operation does not take place within that region of the $I_a - V_a$ diagram in which secondary emission phenomena are conspicuously visible in the characteristics.

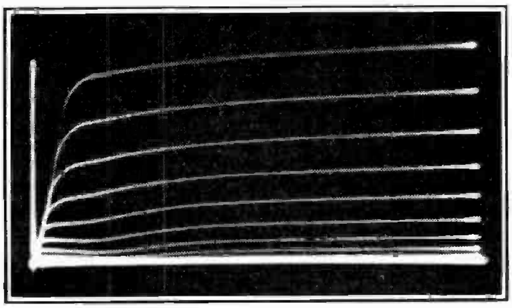

Fig. 21.—*Oscillogram of the $I_a - V_a$ curves for a standard type beam-power valve.*

Matters become different, however, when the load impedance acquires higher values or when it is not a pure resistance but has a certain phase angle.

Fig. 22 gives the output as a function of the load impedance for a standard type beam-power valve in combination with a TDD4. Comparing this with the corresponding curves of the output pentode, we see that the points where the lines for cos $\phi = 1$ intersect $\frac{Z_a}{R_{opt}} = 1$, i.e., the points representing the normal distortion curve, are comparatively little lower than for the pentode. For values of $\frac{Z_a}{R_{opt}}$ greater than 2, however, output diminishes far more rapidly

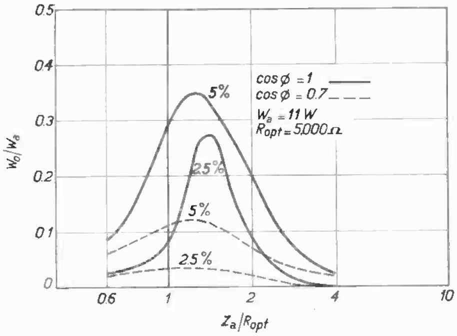

Fig. 22—*Output at 5 per cent. and at 2.5 per cent. distortion as a function of the load impedances when cos $\phi = 1$ and when cos $\phi = 0.7$ for a combination of a beam-power valve or tetrode output valve with the TDD4.*

with the tetrode than with the pentode, so that when $Z_a = 3\ R_{opt}$ the output of the tetrode at a given distortion is only $\frac{1}{6}$ to $\frac{1}{3}$ that of the pentode. With the tetrode, in contrast to the pentode, distortion at higher values of the load resistance is not predominantly determined by the A.C. anode voltage. This is also clearly shown by the dotted curves in Fig. 14, in which the A.C. anode voltage for a beam-power valve is plotted at 2.5 per cent. and at 5 per cent. distortion as a function of Z_a/R_{opt}. In view of this peculiarity it is sometimes recommended that the load impedance should be given a lower value than $\frac{V_a}{I_a}$; this, however, results in a worse distortion curve as can be seen from Fig. 22.

When the load is not a pure resistance, the beam-power tube even at $Z_a = R_{opt}$ is much less favourable than the pentode. This is due to the fact that the $I_a - V_a$ diagram is then traversed by a curve having more or less the form of an ellipse (Fig. 23). Although these curves do not actually pass through the region where secondary emission is evident in the $I_a - V_a$ characteristic, this phenomenon does already cause additional curvature of the $I_a - V_a$ characteristics, resulting in additional distortion, in the region actually traversed. The fact that the $I_a - V_a$ curves in the vicinity of the normal anode voltage show a greater curvature for the beam-power valve than for the pentode is evident from Fig. 24, which gives for a tetrode and for a pentode the curves for which the anode current at the working point is $\frac{1}{8}$ of the normal value. (This is dealt with in greater detail in " Pentode and Tetrode Output Valves," by J. L. H. Jonker, in *The Wireless Engineer*, June and July, 1939.)

Combination Frequencies

Although, according to the researches mentioned in the Introduction, the distortion factor would be a serviceable criterion for quality provided this factor does not exceed about 5 per cent. and provided no phenomena of a discontinuous nature occur in the non-linear characteristics traversed, it has been suggested from numerous quarters (see *inter alia*, J. H. Owen Harries in *The Wireless Engineer*, February, 1937) that the combination frequencies occurring during reproduction of two sine-wave A.C. voltages might be taken as a standard for quality. Leaving out of consideration the question whether the distortion factor alone, or distortion split up into the various harmonics, or the value of the combination frequencies is the most correct criterion for quality, we are setting forth some measurements of this

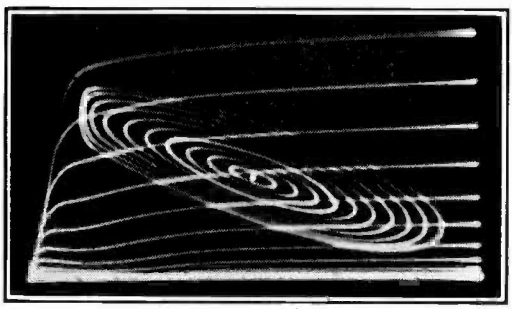

Fig. 23.—*$I_a - V_a$ diagram for a beam-power valve, with load curves for different values of the A.C. grid voltage.*

nature for the benefit of readers who are familiar with the latter method. If measurement is carried out with two frequencies of such an amplitude that $\frac{V_2}{V_1 + V_2} = \frac{1}{10}$ and if the resulting combination frequencies are expressed as a percentage of the smallest signal, the distortion limits (5 per cent. for good and $1\frac{1}{2}$ per cent. for very good quality) stated in the Introduction will correspond

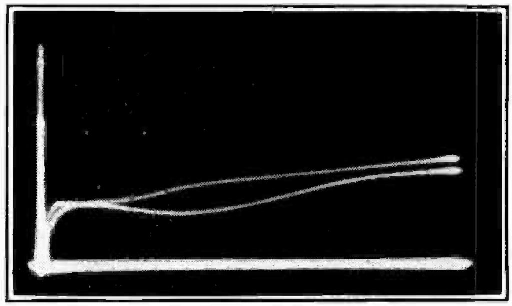

Fig. 24.—*$I_a - V_a$ curves for a pentode and for a beam-power valve for $\frac{1}{8}$ of the normal anode current. The lower curve is for the beam-power valve.*

to maximum values of the combination frequencies of 10 per cent. and 3 per cent. respectively, and to prevent hoarseness, special attention should be given to the side bands of the 1st order ($f_1 \pm f_2$).

Fig. 25 gives the frequency spectra at $\frac{W_0}{W_a} = 0.3$, for the combination SP4B + AD1 (*a*), and for the combination TDD4 + Pen A4 without and with inverse feed-back (*b*, *c* and *d*). To simplify the figures we have omitted the harmonics of the two primary notes (100 c/s and 1,000 c/s). In accordance with what has been noted from the distortion curves, the pentode combination without feed-back gives more distortion than the triode combination but is always below the above-mentioned limit of 10 per cent. With a small feed-back such as is obtained by omission of the cathode condenser (Fig. 25c), the spectrum is approximately identical with that of the triode combination ; with a feed-back of 4 (Fig. 25d) the spectrum is much better and complies with the standard for very good quality.

Conclusions

A.—Triode Output Valves

The outstanding features of triode output stages are :

(1) Low sensitivity ;
(2) Low internal resistance ;

(3) At optimum load resistance the value of $\frac{W_0}{W_a}$ for good quality (max. distortion 5 per cent.) is approximately 0.3. In this case, however, output is abruptly limited by the occurrence of grid current. As the pre-amplifier valve in most receivers is not dimensioned for the energy required, the commencement of grid current in the output valve is generally accompanied by very troublesome distortion ;

(4) For very good quality (distortion about 1 per cent.), $\frac{W_0}{W_a}$ is approximately 0.17 ;

(5) Distortion shows but little dependence upon the phase angle of the load impedance, unless the distortion factor is so low (e.g., 1 per cent.) that the neutralisation of distortion in the output valve by distortion in the preceding valve is pronounced.

In view of these qualities the triode is particularly suitable in cases where sensitivity and efficiency of the output stage are unimportant and where a low internal resistance is desired. Compared with a pentode or tetrode, the triode then offers the advantage that this low resistance is a property of the output valve itself and can therefore be obtained in a simple manner without recourse to feed-back. A further advantage

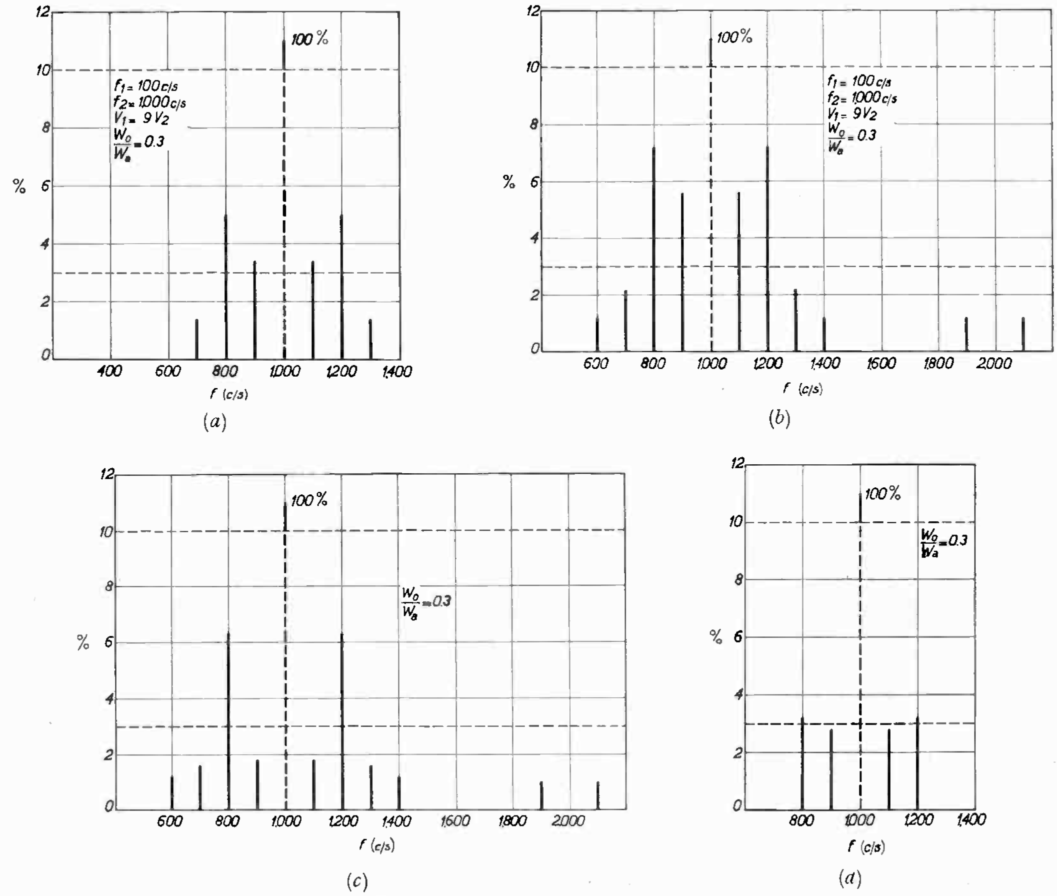

Fig. 25.—*Frequency spectra for* $\frac{W_0}{W_a} = 0.3$ *for the triode combination SP4B + AD1 (a) ; for the pentode combination TDD4 + Pen A4 without feed-back (b) ; for the same combination without a cathode condenser for the Pen A4 (c), and for TDD4 + Pen A4 with feed-back giving a loss in sensitivity of 4 times (d).*

is the simple construction of the triode, as a result of which it is cheaper than a pentode of the same anode dissipation.

B.—Pentode Output Valves

The principal features of modern output pentodes are :

(1) High sensitivity ;

(2) High internal resistance, which, however, may be reduced to the same value as that of a triode by using a negative feed-back of about 4 ;

(3) If no feed-back is used, the value of $\frac{W_0}{W_a}$ at optimum load resistance is approximately 0.3 for good quality. With a well-designed pentode, however, output is not limited in an abrupt manner by the commencement of grid current, but by a gradual increase of distortion. Abrupt limitation of output due to grid current does not occur until $\frac{W_0}{W_a}$ = about 0.5. At $\frac{W_0}{W_a} = 0.4$ to 0.5 the output is less abruptly limited by the D.C. anode voltage ;

(4) When using a little feed-back such as is obtained by omission of the cathode condenser, the value of $\frac{W_0}{W_a}$ at optimum load resistance is about 0.4 for good quality (D less than 5 per cent.) and about 0.2 for very good quality ($D = 1$ per cent.) ;

(5) When no feed-back is used, the output at 2.5 per cent. and at 5 per cent. distortion is more adversely affected by a phase angle of the load impedance in the case of a pentode than in the case of a triode ;

(6) By using a certain feed-back, this shortcoming of the pentode as compared with the triode can be remedied without causing sensitivity to become less than with the triode.

In view of these features, the pentode is ideally adapted for use in cases where sensitivity and efficiency of the output stage are important considerations. The pentode offers, as against the triode, the advantage that output is not limited abruptly by the starting of grid current but gradually through increase of distortion, thus allowing a certain margin for sudden occurrences of fortissimi in the music. The pentode will, moreover, find application in all cases where very high quality standards are stipulated, as it is possible by applying a strong inverse feed-back to diminish distortion to a very great extent without lowering sensitivity to an unserviceable level.

C.—Tetrode Output Valves

The characteristics of tetrode output valves are in many respects identical with those of pentodes, so that, on the whole, their field of application will be the same. As, however, a rather high secondary emission is still present, tetrode output valves show in comparison with pentodes the disadvantage that output at a given distortion is far more adversely affected by the value and phase angle of the load resistance than is the case with a pentode.

Electrolytic Condensers : Their Properties, Design and Practical Uses

By Philip R. Coursey. Second edition. Pp. xii + 190 with 112 Figs. Chapman and Hall, Ltd., 11, Henrietta Street, London, W.C.2. Price 10s. 6d.

The author is Technical Director of the Dubilier Condenser Co. and a well-known authority on the subject. It is two years since the first edition appeared, and the opportunity has been taken of removing a few errors that had been detected, of improving the treatment where possible, and of bringing the book up to date by giving data concerning the latest developments. After a preliminary chapter on condensers and dielectrics in general, the origin and development of the electrolytic condenser is traced and separate chapters are devoted to the wet, the semi-dry and the dry types.

The effect of the separator is considered in detail and a chapter is devoted to the electrical characteristics of electrolytic condensers. Methods and apparatus for testing such condensers are described and the final chapter deals with their commercial applications. All is described very fully and well illustrated ; much of it is absolutely essential to anyone using this type of condenser.

As points to be corrected in the next edition we noted " considerations have lead " on p. 157, and " thermonic " on p. 161 ; also the author refers sometimes to single-wave and double-wave rectifiers and at other times to half-wave and full-wave rectifiers (Figs. 102, 104, 105). On p. 4 the author says that " the electrical capacity of a condenser should properly be called its *capacitance*, but as this term has as yet obtained little popularity, the term more usually employed in practical work —viz., the *capacity*—has been employed for the most part [entirely would be more correct] throughout this book." What an opportunity this would have been for increasing the popularity of the officially recommended term among those employed in practical work. Perhaps in the next edition.

G. W. O. H.

A Coil for Use at Radio Frequencies*

By W. H. Ward and E. J. Pratt

(From The National Physical Laboratory)

ABSTRACT.—A new form of wire of the "Litz" type, woven as a tape, makes possible coils of good quality that are easily assembled from simple components. The properties of a group of such coils, and the precautions found necessary in their design are described.

Introduction

THE purpose of this paper is to describe a form of coil suitable for laboratory measurements at radio frequencies, conveniently and cheaply made in sizes covering a considerable range of inductance values. The basis of design is a new type of stranded wire, in the form of a tape.† The coils are stable, and have magnification factors of more than 250. They are of low self-capacitance, and are light enough to be supported by their terminals, and small enough to be enclosed in convenient screens. The various sizes are made from standardised parts of simple construction. The wire is the only one of the materials used that has any considerable cost, and, including the time spent on various trial forms, the five coils described were made up in about forty hours.

Construction

(a) Single Disc Coils

The stranded tape that was the foundation of these coils has an advantage over Litz wire, of which it is a variant, in being self-supporting when it is wound as a disc. As a result a very simple former may be used, and elaborate machining is eliminated. The tape is 4 mm. wide and 0.2 mm. thick. It has 30 strands of double-silk-covered copper wire, of diameter 0.06 mm. transposed every 5 mm., and woven into a ribbon with a silk thread. The resistance at zero frequency is approximately 0.2 ohm/metre. Coils having inductances from 50 μH have been wound and used successfully, but the smaller ones were of a different form and are not described.

The simplest form of coil is obviously a single disc, wound on a disc of insulating material and of the present series No. 1 was made in this way. The upper part of Fig. 1 and the left-hand diagram of Fig. 2 refer to it. On a disc of keramot $\frac{3}{16}$in. thick, and $1\frac{1}{2}$in. diameter were wound 118 turns of the

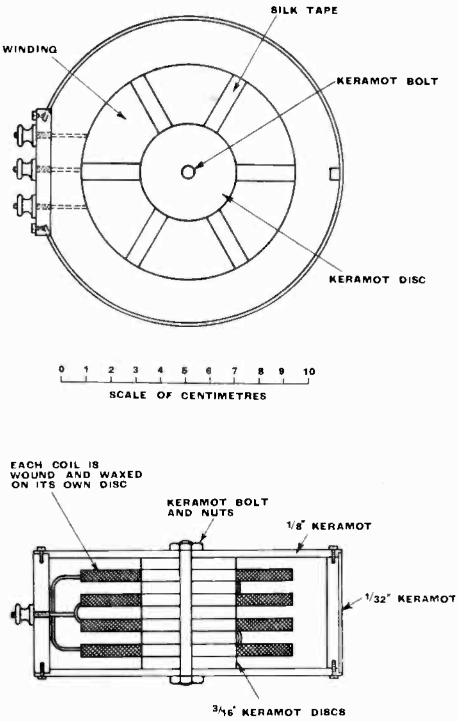

Fig. 1.

tape, and the winding was made fast by tying with silk tape at six points. On each side of the wound disc were put two keramot discs, also $\frac{3}{16}$in. thick, and $1\frac{1}{2}$in. diameter. Two other discs, $\frac{1}{8}$in. thick and $4\frac{7}{8}$in. diameter were added, one at each side, to form the side faces of a cylindrical cover for the coil, and the whole was held together by a keramot

* MS. accepted by the Editor, June, 1939.

† Made by Mr. W. Hamilton Wilson of 125, Red Lion Road, Tolworth, Surrey.

bolt. The open space between the side faces was covered partly by a keramot terminal block ¼in. thick, and for the rest by a strip of keramot $\frac{1}{32}$in. thick, resting on flanges on the side faces, and held at its ends by the terminal block. The cover was reinforced by a strut of keramot $\frac{3}{16}$in. × ⅛in. on the opposite side to the terminal block. If the coil were liable to unusually rough handling, thicker keramot than ⅛in. and $\frac{1}{32}$in. might be used for the cover. The amount of metal, especially near the winding, was kept as small as possible. Since the coils were to be used with a series-fed Hartley oscillator, a centre-tap was necessary. The mechanical details of the coil are shown in Table 1, and its electrical properties in Table 2.

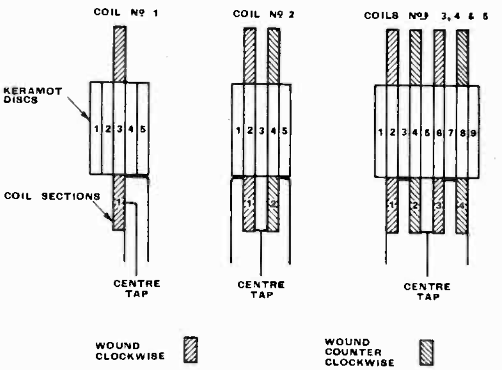

Fig. 2.—*Diagram of connections between coil sections.*

(*b*) *Multiple Disc Coils*

In one case a coil having a single wound disc gave the required inductance in the space available. For the remainder single wound discs of the required inductances would have been too large in diameter. After trying several arrangements that will be described later, the design shown in Figs. 1 and 2 was evolved. Coils, similar to the single disc already described, were made, an unwound keramot disc was used as a spacer between each pair, and assembly then proceeded as before. The number of wound sections used was two for coil 2, and four for coils 3, 4 and 5. Coils of self-inductances up to 100 mH could be made from the same components by using eight wound sections, but for values higher than this larger diameters would be needed if the magnification factor was to be kept high.

In connecting together the various wound discs the inside turn of one was connected to the inside turn of its neighbour, or the outside to the outside. This was done to decrease the amount of metal in the neighbourhood of the winding by keeping the connections as short as possible, and for the same reason the leads to the terminals were taken from the outside turn of a coil wherever possible, and were made of thin wire. With this arrangement of connections, alternate sections must be wound in opposite directions.

When there are four wound sections, the axial length of the complete coil is increased; otherwise the component parts are identical in the five coils. This is one of the major points of the design, for to make coils of a considerable range of inductance by varying only the number of turns, the number of coil sections, and one dimension, leaves much less opening for difficulty and possible mistakes than the variation of size and number of slots that are commonly needed.

TABLE 1.

WINDING DATA.

	Coil No.				
	1	2	3	4	5
No. of keramot discs $\frac{3}{16}$in. thick, 1½in. diameter.	5	5	9	9	9
No. of wound sections.	1	2	4		
Winding on discs No.	3	2 and 4	2, 4, 6 and 8		
Total length of stranded tape (metres).	23	42	84	115	200
Turns/section ..	118	110	105	145	210

TABLE 2.

ELECTRICAL PROPERTIES.

	Coil No.				
	1	2	3	4	5
Inductance mH. ..	0.83	2.57	6.56	14.5	33.8
Frequency kc/s ..	586	335	205	141	91
Magnification factor	370	263	380	290	285
Self - capacitance $\mu\mu$F.	10	8	12	10	11

Factors affecting Performance

(a) Method of Winding

When it was known that the smallest coil was satisfactory when wound as a single disc, but that single discs of the other self-inductances required were too large, several methods of increasing the number of turns without increasing the outside diameter were tried. The results are shown in Fig. 3. An ebonite cylinder 12 cms. diameter and a length of the stranded tape were taken, and coils were made by winding the tape on the cylinder in different ways. Since the

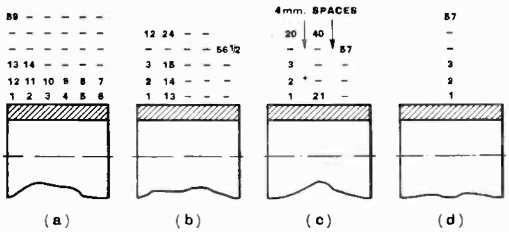

Fig. 3.—*The effect of various winding arrangements for a multi-layer coil. In each case the same length of wire was wound on an ebonite cylinder of 12 cms. diameter. The diagram shows half of the cross-section of the finished coil, the numbers indicating the order in which the turns were put on.*

	(a)	(b)	(c)	(d)
Capacitance ($\mu\mu$F) *to tune to* 400 *kc/s* ..	120	220	240	206
Relative magnification	0.29	0.9	1.0	1.0

arrangement of Fig. 3 (*c*) gave results comparable with those of a single disc, this form was used in the final design

(b) Terminal Arrangements

It is of some interest to know what influence the various parts of the coil have on the magnification factor, and during its final assembly coil No. 1 was measured after each of the various parts had been added to it. In Table 3 are given the relative magnification factor and the capacitance needed to tune to a fixed frequency. It will be seen that about 0.93 of the loss is due to the actual winding, and the remainder to the terminal arrangements. For the measurements made without terminals, connection was made to the tape itself—eddy currents in the wires which connect the ends of the coils to the terminals have an appreciable effect on the loss.

(c) Insulating Material

When the measurement at the head of Table 3 was made, the section of coil was wound on a keramot disc. After this measurement the keramot disc was forced out, and a similar trolitul one put into its place. There was no discernible decrease of loss. Since keramot has a power factor of 0.01 and trolitul of about 0.0001, this means that there is no significant dielectric loss in the coil former.

(d) Screens

The coils as first designed had a screen of sheet copper in the place now occupied by the keramot case. The screen was split both around the cylindrical edge and across the two faces, to limit the path of eddy currents. The self-capacitance was high, and the magnification factor of coil No. 1, the only one made in this form, was about 120. Various other trials were made with screens and other metal in the neighbourhood of the coil, and it was found that any metal that caused an increase in self-capacitance also caused an appreciable increase in loss. It seems likely that this is a phenomenon common to coils of all shapes, and is an additional reason for making them small, so as to reduce the effect that a piece of metal can have. The experiments clearly showed that it is undesirable to fit sheet metal screens to these coils. When screening is essential they are used inside a wire cage made large enough to take the largest of them. The effect of

TABLE 3.

THE INFLUENCE ON MAGNIFICATION FACTOR AT 410 KC/S OF VARIOUS PARTS OF COIL NO. 1.

Condition	Capacitance to tune to 410 kc/s	Relative magnification factor
Coil section on either keramot or trolitul disc	150 $\mu\mu$F.	1.00
Coil complete, except for terminal block and terminals	145 $\mu\mu$F.	1.00
Coil complete, except for centre tap	140 $\mu\mu$F.	0.96
Complete	140 $\mu\mu$F.	0.93

such a screen on the magnification factor is negligibly small.

Conclusion

Satisfactory coils can be made up, using a ribbon variant of Litz wire, by winding a number of flat coils on insulating discs, and assembling them with separators of a thickness equal to the width of the ribbon. The dielectric loss due to the coil former is negligibly small, but considerable loss may be introduced by any metal in the field of the winding. The coils may be made with little equipment or skilled labour, and are at least as satisfactory in use as other coils wound on formers of similar materials.

The authors wish to thank Dr. Hartshorn, under whose direction the work was carried out, and Mr. H. A. Cox, to whose suggestions the final form of the coils is largely due.

Cathode-Ray Tubes.

By Manfred von Ardenne. Translated by G. S. McGregor, and R. C. Walker. Pp. xiii + 530. Published by Sir Isaac Pitman & Sons, Ltd., 39, Parker Street, London, W.C.2. Price 42s.

This is the translation of a book published in Germany in 1933. Those of us who find foreign languages too hard on the dictionary, always welcome such a translation, in that it affords us an insight into Continental technique that we might not otherwise get. In this edition the original work has been retained practically in its entirety, and new material has been added in order to bring it up to date. It seems questionable whether this method can be considered satisfactory, for, as is mentioned in the preface to the English edition, the rate of progress in the design and utilisation of cathode-ray tubes has been very great, fostered mainly by the new art-cum-science of television. This book was written six years ago, and in that time not only has our knowledge of the subject been added to, but it has been considerably modified. Perhaps one should say that we now look at the subject with a new viewpoint, for with new types of tube, and the attendant circuit modifications, we have come to expect a far better performance (especially as regards frequency characteristics), and since the oscillograph is now used about the laboratory together with the voltmeter and ammeter, portability, and stability of operation have increased in importance. The new viewpoint is not apparent in this book, and one is left with the impression that cathode-ray oscillography is still an art, rather than an exact science, and that an oscillograph requires a good many square feet of valuable space on the bench. The 50 odd pages of new material which have been added certainly do give some hint of modern practice, but are not enough, and one tends to get confused between the old and the new.

This book is divided into only four chapters, each chapter being sub-divided into as many as nine sections.

Chapter I, "The Cathode-Ray Tube" (173 pages) contains most of the material new to this edition. There are one or two pages of simple non-mathematical electron-optics, mainly matter that was in the 1933 edition. This seems hardly adequate for a modern treatise on cathode-ray tubes. The information on gas-focusing is of course good, and there are some details of the von Ardenne method of removing origin distortion, methods of deflection and modulation are considered, and the chapter concludes with an interesting section on tube construction.

Chapter II is entitled "Accessories," and covers the power supply, amplifiers, time-bases, and photographic recording methods. Unfortunately the amplifiers described here make use of triode valves only: the interesting possibilities resulting from the use of modern pentodes are not discussed.

Chapter III is "The Cathode-Ray Tube and Auxiliary Equipment for Making Measurements." This is a chapter on applications of the cathode-ray oscillograph. It is fairly comprehensive, and its 100 pages will be, to many people, the most interesting in the book. The types of problem dealt with are most varied, and reproductions are shown of actual oscillograms obtained. The technique described for any one problem could very easily be adapted to suit modern English apparatus, and, one presumes, with improved results. Before working on a problem, a study of the pioneer methods will generally reduce the amount of experimental work to be done, and will suggest a method of getting preliminary results without building up expensive special apparatus.

Chapter IV, "The Cathode-Ray Tube as an Operating Unit," has two sections. The first is on sound-film recording, and the second on television. The latter section does not contain much that is directly applicable to modern receiver practice, being mainly concerned with a film scanning unit, and the very interesting "velocity modulation" system of television due to von Ardenne in Germany, and Bedford and Puckle in England.

Considering the book as a whole, it is disappointing in that a clear definition is not always made between the technique of 1933 and that of the present day, it has not been brought up to date as successfully as it might have been, and there are perhaps too many photographs of apparatus, etc., which are not sufficiently informative for a book, being of the type usually associated with a catalogue of apparatus.

On the other hand, the book is of great interest as an example of the German methods of cathode-ray oscillography. It covers a very wide field of applications, has a good bibliography for the years preceding 1934, and in many ways is a well written and informative book of reference.

The book should be in the hands of all those who are interested in the applications of cathode-ray tubes, and who already know something of the subject, for it should be read only by those with sufficient knowledge to criticise and supplement.

B. C. F-W.

Class B Audio-Frequency Amplification*

By M. Gordon

THERE are two main types of apparatus in which Class B amplification is used. It is employed in P.A. equipment and for the modulation amplifier of transmitters, and it is used in low power battery driven apparatus. In the former case it is adopted generally when the output exceeds some 25 watts and usually to reduce the cost of the power supply.[1] In a battery amplifier it is employed to reduce the mean anode current consumption.[2, 3]

By Class B amplification is meant a stage in which the valves are working on the bottom bends of their characteristics and are driven into grid current. This system is sometimes known as Class B2. Methods of approximate calculation are treated in this article from the point of view of the circuit designer and not from that of the valve maker.

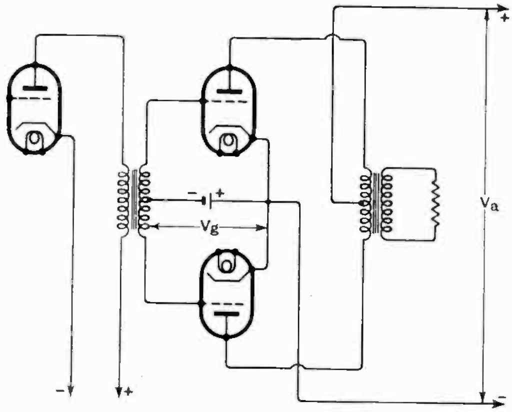

Fig. 1.

The circuit considered is shown in Fig. 1 and the operating conditions of the valves are usually specified by the valve maker. That is, he specifies the H.T. voltage V_a, the output power P, the anode-to-anode load resistance R_{aa}, and sometimes also the grid bias V_g.

The undistorted alternating current, in the primary of the output transformer, which is necessary to obtain the power P is given by

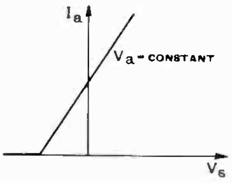

Fig. 2.

$$I = \sqrt{\frac{P}{R_{aa}}} \quad .. \quad (1)$$

In the following, it is assumed that the initial anode current is zero and that the anode current characteristic is a straight line, as shown in Fig. 2. These simplifications do not lead to any great inaccuracy, for the initial current is in practice no more than 5–6 per cent. of the full load current.

The anode current of one output valve is shown in Fig. 3 and has the maximum value

$$I_{\max} = \sqrt{2}I \quad .. \quad .. \quad .. \quad (2)$$

From this a simple integration gives the average value of the current for one valve

$$I_{av1} = \frac{1}{\pi} I_{\max} \quad .. \quad .. \quad (3)$$

The current drawn from the H.T. supply is clearly the average current of both output valves and is

$$I_{av} = \frac{2\sqrt{2}}{\pi} I \quad .. \quad .. \quad .. \quad (4)$$

Now the alternating voltage between the anodes is given by

$$E_{aa} = \sqrt{pR_{aa}} \quad .. \quad .. \quad (5)$$

So that the anode voltage of one valve is

$$E_a = \tfrac{1}{2}\sqrt{pR_{aa}} \quad .. \quad .. \quad (6)$$

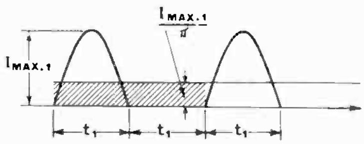

Fig. 3.

It should be pointed out that the current given by equation (1) has no physical

* MS. accepted by the Editor, February, 1939.
[1] *Wireless World*, 1937, Vol. I, p. 358.
[2] *Funktech. Monatshefte*, 1936, p. 181.
[3] *Wireless Engineer*, 1937, p. 293.

reality, but that the other quantities do exist.

Each of the valves works into only one-half of the output transformer; when current flows through one valve, the other passes no current. This means that the resistance into which the valve works is $R_{aa}/4$. A straight line corresponding to this resistance is drawn in the usual way (Fig. 4) on the family of valve curves $I_a = f(V_a)_{V_g = \text{const.}}$

The sector $V_a - X$ corresponds to $E_{amax} = \sqrt{2}E_a$ from equation (6). The line yX is parallel to the I_a-axis and the grid potential corresponding to the point y is the maximum positive grid voltage. The potential difference between y and V_a is the maximum grid swing at full load.

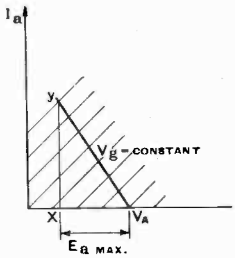

Fig. 4.

It is possible to calculate the grid voltage from the well-known equation

$$E_a = \mu V_g \frac{R_{aa}/4}{R_a + R_{aa}/4}$$

where μ is the amplification factor of the valve and R_a its internal resistance. The graphical method is more accurate, however, because it takes into account the changes in μ and R_a along the curves.

When the grid current I_g is known, and it depends on the grid voltage V_g, the driver stage can be designed. The grid current of one valve is shown in Fig. 5, assuming a certain negative grid bias and pure resistance coupling. The minimum input resistance is

$$R_{g2} = E_{gmax}/I_{gmax} \quad \cdots \quad \cdots \quad (7)$$

The internal resistance of the driver valve with the resistance of the coupling elements should be much smaller than R_{g2}. If it is not small enough, there will be amplitude distortion. The two conditions—that the driver stage has to deliver a certain voltage and that its output resistance must be less than a certain value—put narrow limits to the choice of the driver valve. Naturally, its anode dissipation must be closely controlled.

If the relation between grid current and grid voltage is unknown, it is usual to choose for the driver a valve giving an output power which is a certain percentage of the output of the Class B stage. It is commonly believed that the ratio of the outputs should not be more than 1 : 6, but the writer has had good results with a ratio of 1 : 25. This was with two Tungsram OQ71/1000 valves in the output stage driven by two AD1 valves.

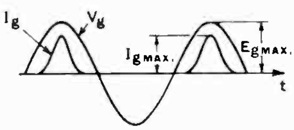

Fig. 5.

Much has been written about the output transformer. It is usually said that the resistance in the anode circuit of Class B stage should be as small as possible, but this is only partly correct. Referring to Fig. 6, it can be seen that with a resistanceless transformer the working point moves along the dotted line 1, whereas with a practical transformer it follows the full line 2. This is, of course, during the half-cycles when the valve is operative.

It is clear the output is smaller in the second case, but this is a phenomenon common to all valve circuits and is not peculiar to Class B. It is possible, of course, that the point Z will move from its initial position to the left, but this depends largely on the power supply system. This must always be built with low resistance elements

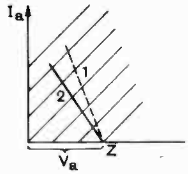

Fig. 6.

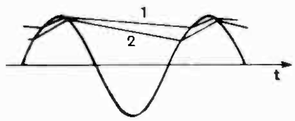

Fig. 7.

and it is consequently nearly always necessary to use a mercury-rectifier.

The smoothing circuit must be carefully designed and in the design it is necessary to work on the basis of the full load current.

If the usual π-filter is employed, the voltage at the first or reservoir condenser is of the form shown in Fig. 7. Curve 1 depicts the voltage on a light load and Curve 2 that on a heavy load, while the sine curve illustrates the input A.C. waveform to the rectifier. Even although the hum level is low when the amplifier gives a small output, the variation in waveform shown in Fig. 7 shows that the filtering is not good.

With really good smoothing, even at large output the output waveform of the Class B amplifier is as shown in Fig. 8(*a*) but takes the form of Fig. 8(*b*) when the smoothing is poor. The output is modulated by the hum frequency of 100 c/s. This modulation effect causes a very characteristic distortion which, in the case of a poor amplifier, appears much earlier than overloading distortion.

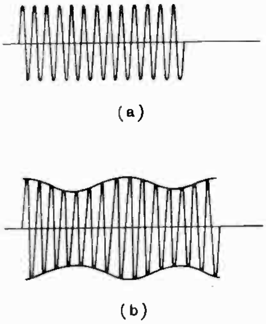

Fig. 8.

The input or driver transformer has been frequently treated,[3] and as indicated above, must have low-resistance windings. The introduction of inductance to the grid circuit rather complicates the discussion and is responsible for the appearance of new phenomena, such as grid impulse oscillations.[4]

When the grid circuit is inductive, the grid current is out of phase with the grid voltage. When the grid voltage passes through zero from a positive value to a negative the grid current is not zero but must immediately become so. This sudden change of current sets up a damped oscillation similar to that produced by the sudden switching of an inductive circuit.

In view of this, it is necessary to reduce the leakage inductance of the transformer

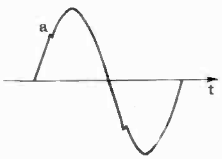

Fig. 9.

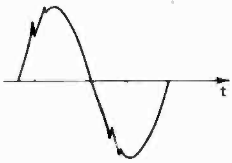

Fig. 10.

as much as possible and this leads to the use of high quality iron, large core volume and small copper volume.

It is difficult completely to avoid grid impulse oscillations and the output waveform of a Class B amplifier is consequently often of the type shown in Fig. 9. This causes negligible distortion, for the peak at (*a*) grows naturally with the growth of the amplified frequency and gives a shape such as that of Fig. 10.

The writer met a case, however, where the output waveform was as shown in Fig. 11, which represents severe distortion. This curve represents a sinusoidal wave with a superimposed damped oscillation. The frequency of this oscillation caused by the grid impulse, was independent of the input frequency, which was 8,000 c/s. This distortion was almost eliminated by reducing by 1.5 times the inductance of the output transformer, the ratio remaining unchanged.

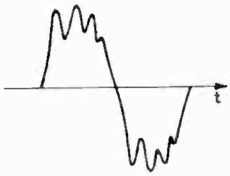

Fig. 11.

The writer is indebted to P. Szulkin for his help in the preparation of this article.

[3] *loc. cit.*

[4] Barkhausen, "Elektronenröhren," Vol. 11, p. 284.

Correspondence

Triode Oscillators for Ultra-Short Wavelengths

To the Editor, The Wireless Engineer.

SIR,—In your June issue Mr. Gavin shows that an oscillator is at its short wave limit when the transit-time delay between cathode and anode is about half a period. If the grid voltage were in antiphase to the anode voltage this would mean that the anode current would be in phase with the anode voltage, the valve then representing a positive resistance. It appears, therefore, that with grid voltage phased 180 deg. the delay cannot be more than a quarter of a period in order that there may be a component of anode current in antiphase to the anode voltage effectively providing a negative resistance component. The quadrature component of anode current leads the voltage by 90 deg. and represents a capacity component which will lower the resonant frequency. It does not appear that this dynamic reactance is important compared with that of the usual capacity even in a concentric line circuit.

If the grid voltage were phased less than 180 deg. the possible transit-time delay would be increased by the corresponding amount. The presence of resistance in parallel with the grid-cathode capacity resulting from transit-time and grid-current loading causes a dephasing of the grid voltage from the 180 deg. position in the required direction. It is thus apparently possible for the time delay to be more than a quarter-period. Mr. Gavin's calculations are made with respect to a planar diode; Moullin (*The Wireless Engineer*, July, 1935, p. 372) has shown that in a cylindrical structure the delay may be reduced by a factor between ½ and 1. The experimental results would then indicate a maximum delay between one-quarter and half a period, in agreement with the conclusion arrived at above and substantially in agreement with Wagener's results allowing for the time of transit between grid and anode.

Turning now to a consideration of the effect of transit time in reducing the efficiency of an oscillator from the long-wave value, the anode current component in antiphase to the anode voltage will be reduced by the factor cos $\omega\tau$, i.e., a reduction of 13 per cent. when $\omega\tau$ is 30 deg. If the grid voltage, instead of being in antiphase to the anode voltage, were advanced 30 deg. the reduction would not occur (assuming, of course, that the grid voltage is the chief controlling factor, that is a high μ valve). The resistance between grid and cathode representing grid current loading causes a dephasing in the required direction opposite to that due to the transit-time. It appears possible for the transit-time dephasing to be compensated at one frequency. The feedback dephasing will itself be a cause of reduced efficiency at somewhat lower frequencies at which the transit time effect is negligible, more especially as it is greater at lower frequencies. The feedback dephasing from strict antiphase will be 30 deg. when $1/\omega CR = \tan 30 \text{ deg.} = 1/\sqrt{3}$, where R is the shunt resistance across grid-cathode capacity C; R tends to one-half the value of the grid-leak resistance for an extreme class C oscillation. For an E770, 10 $\mu\mu$F and 1,000 Ω appear appropriate values, giving $f = 30$ mc/s for 30 deg. dephasing. It may be of importance in explaining the observations in the cases of the E770 and E773 valves, that the wavelengths at which the 10 per cent. drop was observed were considerably lower than those calculated.

O. L. Ratsey,
H.M. Signal School, Portsmouth.

Theory and Design of Valve Oscillators.

By H. A. Thomas, D.Sc., M.I.E.E. With Foreword by Dr. E. V. Appleton, F.R.S. Pp. 270 + xvii: 103 diagrams. Published by Chapman and Hall, Ltd., 11, Henrietta Street, London, W.C.2. Price 18s.

This volume is one in a series of Monographs on Electrical Engineering intended to fill gaps in the literature on specialised subjects. Its inclusion in such a series is more than justified, for as far as the reviewer is aware it is the only book on the subject. Hitherto one has had to refer to scattered papers; a selection of which, to the number of 83, is drawn upon in the text and listed in the Bibliography.

The general principles of valve oscillators; their types; the amplitude and waveform of the oscillations; and the efficiency of the oscillators, are dealt with theoretically in the first few chapters. Frequency stability is then considered in detail, with reference in turn to the maintaining system, inductance coils, and condensers. It is shown that the oscillatory circuit, rather than the valve, is usually responsible for the greater part of undesired frequency changes. The last four chapters deal with practical means for stabilising frequency. A valuable feature is the performance data on many of these systems; and it is helpful for comparison that consistently throughout the book frequency changes are expressed in parts in one million.

Although fairly comprehensive, the scope is of course not exhaustive, and specifically excludes crystal control: some important types of valve oscillators (e.g., the magnetron) are also omitted, but the dynatron and relaxation oscillators are included. Although the principles given can readily be applied by the reader to the design of valve oscillators in receivers, the practical chapters reveal that the author's interests lie on the transmitting side. Thus for example the maintenance of accuracy in "push-button" tuning is not specifically referred to, and the special problems of frequency-changers are barely mentioned. Evidently, too, the design of discriminators for automatic monitoring (better known as A.F.C., automatic tuning correction) is less developed on the transmitting than on the receiving side.

In the present rapid state of progress the difficulties of covering even a restricted field in one volume are very great. For example, in the theoretical chapters the leading authorities are well represented, but the necessary condensation is occasionally at the expense of some lucidity; as in the use of such terms as "load" and "resistance." It is not always clear whether "resistance of a tuned circuit" is series or parallel. Some idea of what negative resistance under actual (non-linear) conditions means would be helpful (*vide* Brunetti in *Proc. Inst. Rad. Eng.*, Dec. 1937). On the other hand, the practical chapters, which are confined very largely to the author's own work, are perfectly clear.

It is rather surprising to find that the work of Griffiths on the design of compensated condensers, and on dynatron oscillators of precise frequency, is nowhere even mentioned. And a page and a half seems hardly adequate for considering the design of stable fixed condensers.

The volume is however most welcome; and, as the earlier chapters reveal clearly the severe limitations of available theory of the valve's part in maintaining oscillation, the concise practical guidance given later is most valuable. The layout and drawing of the diagrams is exemplary, and so is the freedom from errors (rare exceptions are "E" for "E_b" in Fig. 27 and absence of scale label in Fig. 50; Fig. 13 (B), described as a special type of Hartley circuit, is actually a Colpitts, as in Fig. 14). All radio engineers, and some others, will find the book helpful. M. G. S.

Radiolympia

In the October issue of *The Wireless Engineer* will be included a technical survey of the National Wireless Exhibition at Olympia, which closes on Saturday, September 2nd. The Show provides an annual opportunity to review the progress made in the design of British broadcast and television receivers, components and laboratory apparatus associated with the design and maintenance of receivers.

Abstracts and References

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

PROPAGATION OF WAVES

3419. NATURAL ELECTROMAGNETIC OSCILLATIONS OF A SPHERICAL CAVITY [Equations for Frequencies of Axially Symmetrical Oscillations, Magnetic & Electric Types: from Maxwell's Equations in Polar Co-ordinates].—M. Jouguet. (*Comptes Rendus*, 3rd July 1939, Vol. 209, No. 1, pp. 25–27.)

3420. DIELECTRIC RESONATORS [Theory: Resonant Frequencies and Losses: Behaviour of Dielectric Wave Guides].—R. D. Richtmeyer. (*Journ. of Applied Phys.*, June 1939, Vol. 10, No. 6, pp. 391–398.)

"Suitably shaped objects made of a dielectric material can function as electrical resonators for high-frequency oscillations." This paper proves that a dielectric resonator must radiate, shows how to calculate the resonant frequencies and modes of oscillation, discusses some resonant modes of a dielectric sphere and of a circular ring resonator, and considers the effect of bending dielectric wave guides.

3421. EXPERIMENTAL RESEARCHES ON THE PROPAGATION OF ELECTROMAGNETIC WAVES IN CYLINDRICAL GUIDES [particularly Those at the L.M.T. Laboratories].—A. G. Clavier & V. Altovsky. (*Rev. Gén. de l'Élec.*, 27th May & 3rd June 1939, Vol. 45, Nos. 21 & 22, pp. 697–706 & 731–743.)

3422. VELOCITY OF RADIO WAVES IN AIR [Effect of Velocities Smaller than That of Light on Polar Diagrams of Directional Arrays: Measured Patterns agree closely with Velocities equal to That of Light in Free Space].—G. H. Brown. (*Phys. Review*, 1st June 1939, Series 2, Vol. 55, No. 11, pp. 1100–1101.) Figs. 1 & 2 appear to have been interchanged in printing.

3423. MEASUREMENT OF THE VELOCITY OF PROPAGATION OF MICRO-WAVES OVER THE SURFACE OF THE EARTH [Interferometric Methods, over Distance of 4–6 Wavelengths from Transmitting Dipole, over Dry Sandy Soil: Phase Velocity Same as in Lecher Wires, within Limits of Error of Method (2–3%)].—V. Savelli. (*U.R.S.I. Proc. of 1938 Gen. Assembly*, Vol. 5, Fasc. 1, 1938, pp. 359–361: in Italian.)

3424. WAVE PROPAGATION ALONG WIRES [Correct and Exact Form of Equations for Attenuation and Wavelength along Lecher System].—J. Placinteanu. (*Comptes Rendus*, 12th June 1939, Vol. 208, No. 24, pp. 1890–1891.)

3425. NOTES ON THE RANDOM FADING OF 50 Mc/s SIGNALS OVER NON-OPTICAL PATHS [Field-Strength Measurements on Empire State Building Television Transmissions at 32, 72, & 172 Miles].—K. G. MacLean & G. S. Wickizer. (*U.R.S.I. Proc. of 1938 Gen. Assembly*, Vol. 5, Fasc. 1, 1938, pp. 285–286: summary only, in English & French.) The greatest variation in one day at 32 miles was 10 db; at 72 miles, 35 db. A mean increase of 3 db was observed at night at 32 miles, although the path was optical.

3426. SOME ASPECTS OF THE PROPAGATION OF ULTRA-SHORT WAVES.—Smith-Rose. (*See* 3637.)

3427. IONISATION IN THE TROPOSPHERE [Balloon Flights show No Ionisation Oscillations].—S. Ziemecki. (*Nature*, 10th June 1939, Vol. 143, pp. 979–980.) It is concluded that the oscillations found by Suckstorff (1934 Abstracts, p. 435) are due to instrumental faults; the anomalies found by Juilfs (884 of March) may be due to radioactive substances of terrestrial origin.

3428. REFLECTION OF MEDIUM AND SHORT RADIO WAVES IN THE TROPOSPHERE [can occur at Interface between Two Air Masses: Direct Aeroplane Observations of Atmospheric Temperature Changes agree with Pulse Measurements of Reflecting Heights of C Region].—R. C. Colwell & A. W. Friend. (*Nature*, 1st July 1939, Vol. 144, p. 31.) Agreement is found with Englund's theory (417 of February).

3429. THE LOWER IONOSPHERE [Problem of Mode of Reflection from These Regions where μ is always Greater than Unity: Condition for Reflection is Rapid Change of μ with Increasing Electron Density within Distance Small compared with One Vacuum Wave-length: Application of Pannekoek's Theory to Possible Modes of Formation of E_2 and D Layers].—S. K. Mitra, J. N. Bhar, & S. P. Ghosh. (*Indian Journ. of Phys.*, Dec. 1938, Vol. 12, Part 6, pp. 455–465.)

"It is quite possible that the C_2 layer at about 30 km is due to O_3 ionisation," but lack of spectroscopic knowledge of O_3 prevented the writers from confirming this.

3430. THE ABSORPTION COEFFICIENT OF GASES FOR LIGHT OF WAVELENGTH 1215.7 AU [which, coming from Sun, might Penetrate Far Enough to influence Lower Ionospheric Regions: Measurements for Atmospheric Gases].—W. M. Preston. (*Phys. Review*, 1st June 1939, Series 2, Vol. 55, No. 11, p. 1125: abstract only.)

3431. AN EFFECT PECULIAR TO GASES SUBJECTED TO THE ACTION OF ULTRA-VIOLET LIGHT [Apparent Persistence of Ionising Effect after Withdrawal of Ionising Agent: Production of Abnormal Ions].—G. Reboul. (*Comptes Rendus*, 26th June 1939, Vol. 208, No. 26, pp. 2065–2067.)

3432. RECOMBINATION IN THE IONOSPHERE [Regions E and F_1: Martyn & Pulley's Theory ignores that Association of Oxygen Atoms is Three-Body Collision Process (so that Simple Attachment Theory would give Ionisation varying as Cos χ, at Variance with Experiment): Recombination Theory in Greater Detail].—E. V. Appleton & J. Sayers. (*U.R.S.I. Proc. of* 1938 *Gen. Assembly*, Vol. 5, Fasc. 1, 1938, pp. 272–277: in English & French.)

Rôle of negative ions, and consequences of maintenance of balance between negative ions and electrons in reducing effective rate of electron production and increasing effective electron-recombination coefficient: influence of photo-detachment of electrons from negative ions: etc.

3433. THE APPARENT MOTION OF CLOUDS OF ABNORMAL E REGION IONISATION [Estimation of Vertical Thickness and Lateral Distance to Reflecting Surface as Function of Time: Suggested Formation by Ionising Beam sweeping across Atmosphere].—J. A. Pierce & H. R. Mimno. (*Phys. Review*, 1st June 1939, Series 2, Vol. 55, No. 11, p. 1128: abstract only.)

3434. VARIATIONS OF IONISATION IN THE F_2 REGION OF THE IONOSPHERE: I—METEOROLOGICAL ASSOCIATIONS [Results suggesting that Local Climatological Factors may exert Profound Influence on Magnitude, and Seasonal & Diurnal Variations, of F_2 Ionisation].—J. Bannon, A. J. Higgs, D. F. Martyn, & G. H. Munce. (*Proc. Roy. Soc.*, Series A, 19th May 1939, Vol. 171, No. 945, pp. S 45–S 46: abstract only.)

3435. ON THE NOON DECREASE OF IONISATION IN THE HIGHER IONOSPHERE [and a New Hypothesis].—I. Ranzi. (*La Ricerca Scientifica*, June 1939, 10th Year, No. 6, pp. 540–545.)

"An annual thermal oscillation such as that demanded by the hypothesis of Appleton & Naismith would only be possible if there were present in the higher atmosphere notable quantities of ozone and water vapour with concentrations varying seasonally [*see* Godfrey & Price, 396 of 1938]. The hypothesis which I now propose overcomes this difficulty completely: it is based essentially on the process of capture of the electrons by atomic oxygen. Following on the dissociation of the molecular oxygen caused by the ultra-violet solar radiation, the atomic oxygen which is produced, with its high electron affinity, provokes a diminution of the electronic density. If therefore it is assumed that atomic oxygen begins to form in appreciable quantities under the action of the solar ultra-violet radiation, and reaches its maximum concentration at about mid-day, the noon decrease of electronic density in Region F_2 is readily explained."

The rest of the letter is occupied in discussing the pros and cons of such an assumption: "acceptable values for the probability of electron capture by atoms of oxygen, and for the collisional frequency between oxygen atoms and electrons, permit the interpretation of the observed diminution in the maximum noon electron density in Region F_2 as one passes from winter to summer. On such a hypothesis it appears, moreover, that the prevalent process in the disappearance of free electrons in Region F_2 may be, even in winter, their capture by atomic oxygen. Such a result agrees with an observational fact of notable importance: during the partial solar eclipse of 3rd February 1935, Kirby, Gilliland, & Judson [2161 of 1935] observed that the maximum electron density in Region F_2 followed the variation of solar-radiation intensity according to a law of simple proportion, as would be expected in the case of a disappearance of the free electrons by a process of capture; whereas for the two other ionised regions E and F_1 there was a proportionality to the square root of the solar intensity, such as is demanded by a process of recombination between electrons and positive ions."

3436. ON THE INTENSITY OF IONISATION IN THE EARTH'S ATMOSPHERE [Chapman's Neglect of Variation of Gravity at Heights as Great as 300 km: Derivation of Formulae for Ionisation Intensities in Three Regions of Atmosphere].—A. C. Banerji & P. L. Bhatnagar. (*Indian Journ. of Phys.*, Dec. 1938, Vol. 12, Part 6, pp. 387–398.)

The three regions are: the adiabatic region from sea level to 11 km: from 11 km to 82 km (temperature assumed constant at 260°, to avoid complications in analysis): and 82 km to 300 km (temperature assumed to increase linearly with height; variation of gravity taken into account).

3437. THE F_2 REGION AS AN INDICATING MECHANISM FOR SOLAR ACTIVITY [Monthly Average Character Figure based on Radio Observations gives Reasonably Good Measure of Solar Activity, in particular Central-Zone Calcium Flocculi].—W. M. Goodall. (*Nature*, 10th June 1939, Vol. 143, pp. 977–978.)

3438. PHASE, ENERGY, AND GROUP VELOCITIES IN AN IONISED MEDIUM.—J. van Mieghem. (*U.R.S.I. Proc. of* 1938 *Gen. Assembly*, Vol. 5, Fasc. 1, 1938, pp. 304–308: in French.)

The "velocity of transport of energy" is here introduced by an extension of de Donder's interpretation of the Poynting theorem. The formula giving this velocity of energy contains as a special case the velocity defined by Brillouin. It is shown that the group velocity, as defined by Raleigh's formula, is equal to the mean velocity of the energy *only* in the case of a non-absorbent medium.

3439. RADIO-LYONS BACKGROUND [produced by Radio-Paris? Bailey's "Luxemburg Effect" Theory]. — "Log - Roller": Wingrove. (*World-Radio*, 7th July 1939, Vol. 29, p. 8.)

3440. CALCULATION OF THE FIELD STRENGTH ON SHORT WAVES, TAKING INTO ACCOUNT THE DIRECTIVITY OF TRANSMITTING AERIALS IN THE VERTICAL PLANE.—Dolukhanov. (*See* 3562.)

3441. FURTHER INVESTIGATIONS OF VERY LONG WAVES REFLECTED FROM THE IONOSPHERE.—K. G. Budden, J. A. Ratcliffe, & M. V. Wilkes. (*Proc. Roy. Soc.*, Series A, 19th May 1939, Vol. 171, No. 945, pp. 188–214.)

Extension of investigation referred to in 1 of 1937. More precise information about the downcoming wave is obtained by extending previous measurements to greater distances with improved phase apparatus. "The reflection height varied during the day as though the waves were reflected from the lowest portions of a 'Chapman region' at a level where the atmospheric 'scale height' was about 6 km . . . There was some evidence that the whole of the reflecting region was about 3 km lower in winter than in summer. Sudden anomalous decreases of reflection height . . . showed a close relation to fade-outs on short wavelengths and to other phenomena usually associated with catastrophic ionospheric disturbances." Abnormalities occurred during and after severe magnetic storms or auroral activity. "Propagation conditions were found to be similar in northerly and easterly directions."

3442. THE PROPAGATION OF VERY LONG WAVES OVER SHORT DISTANCES [Theoretical Investigation of 15 000 m Waves over Distances up to 2500 km, over Sea, assuming Reflecting Layer to be at 400 or 100 km Height].—P. Bouvier. (*Bull. de la Soc. Franç. Radioélec.*, 1st Quarter 1939, Vol. 13, No. 1, p. 1–8.)

Since surface waves of such a wavelength are very slowly attenuated over sea, the direct and indirect fields beyond 500–1200 km (according to time of day and season) have absolute values of the same order of magnitude, so that very sharp zones of reinforcement and of weakening occur. This fact explains the large and sudden variations of field strength with distance, and the very inconsistent results obtained at a given distance with waves of neighbouring wavelengths; also the rapid variations in intensity at sunrise and sunset, when the height of the reflecting layer changes quickly.

3443. COMPOSITION AND TEMPERATURE OF THE UPPER ATMOSPHERE.—F. A. Paneth & others. (*Nature*, 24th June 1939, Vol. 143, pp. 1074–1076.) Notes on joint discussion by Chemical, Physical, & Roy. Meteorological Societies.

3444. RECORDING OF CRITICAL FREQUENCIES OF THE IONOSPHERE [using Double-Detection Sweep-Frequency Receiver and Recording Amplifier].—O. Rydbeck. (*Phys. Review*, 1st June 1939, Series 2, Vol. 55, No. 11, pp. 1127–1128: abstract only.)

3445. DEVICE FOR MEASURING THE HEIGHT OF IONISED REGIONS IN THE UPPER ATMOSPHERE [at the Torrechiaruccia Radio Centre].—V. Savelli. (*Bollettino del Centro Volpi di Elettrologia*, English Edition, July/Sept. 1938, Year 1, No. 3, p. 127d: summary only.) *See* also Bottini, 3847 of 1938.

3446. THE IONOSPHERIC ECLIPSE OF 1ST OCT. 1940 [Projections on Earth of Paths of Totality at 100 & 300 Kilometres].—(*Monthly Notices of Roy. Astron. Soc.*, No. 8, Vol. 98.) *See* also Hulburt, 2647 of July.

3447. IONOSPHERE DISTURBANCES ASSOCIATED WITH SOLAR ACTIVITY.—Dellinger, Kirby, Gilliland, & Smith. (*U.R.S.I. Proc. of* 1938 *Gen. Assembly*, Vol. 5, Fasc. 1, 1938, pp. 251–254.)

3448. THE EFFECTS OF IONOSPHERE STORMS ON RADIO TRANSMISSION [Nature of Ionosphere Storm (*see* 4224 of 1938): Effects of Turbulent and of Moderate Phases].—Kirby, Smith, & Gilliland. (*U.R.S.I. Proc. of* 1938 *Gen. Assembly*, Vol. 5, Fasc. 1, 1938, pp. 286–289.)

3449. THE IONOSPHERE AND THE RAPID FADING OF SHORT RADIOELECTRIC WAVES [Survey, introducing Other Papers (*see* below) read to the French Society of Physics].—R. Jouaust. (*Journ. de Phys. et le Radium*, June 1939, Series 7, Vol. 10, No. 6, pp. 251–259.)

3450. THE STRENGTHENING OF THE PROPAGATION OF LONG WAVES IN COINCIDENCE WITH THE FADING OF SHORT WAVES: ITS OBSERVATION BY THE RECORDING OF ATMOSPHERICS.—R. Bureau. (*Journ. de Phys. et le Radium*, June 1939, Series 7, Vol. 10, No. 6, pp. 260–270.)

3451. RELATIONS BETWEEN FADINGS AND TERRESTRIAL MAGNETISM.—L. Eblé. (*Journ. de Phys. et le Radium*, June 1939, Series 7, Vol. 10, No. 6, pp. 271–273.)

3452. RECENT DEVELOPMENT OF RESEARCHES ON SOLAR ERUPTIONS AND THEIR RELATIONS TO IONOSPHERIC PERTURBATIONS.—L. d'Azambuja. (*Journ. de Phys. et le Radium*, June 1939, Series 7, Vol. 10, No. 6, pp. 274–281.)

Among the papers discussed are those of R. S. Richardson of the Mount Wilson Observatory [*cf.* 1346 of 1936 and 405 of 1938]. The average time lag between the terrestrial and solar phenomena is now reduced to only 1.1 minute, for 84 cases where the beginning of the eruption could be timed.

3453. LONG-PERIOD EFFECTS IN SHORT-WAVE COMMUNICATION [and Their Relation to Sunspot Numbers].—T. W. Bennington. (*World-Radio*, 14th July 1939, Vol. 29, pp. 10–11 and 13.)

3454. A PREDICTION OF THE REMAINING COURSE OF THE PRESENT SUNSPOT CYCLE [Numbers obtained by fitting Four-Parameter Analytical Representation of Course of Outburst Cycles to Smoothed Run of Monthly Spot Numbers].—J. Q. Stewart & F. C. Eggleston. (*Phys. Review*, 1st June 1939, Series 2, Vol. 55, No. 11, p. 1102.)

3455. 89-YEAR SUNSPOT CYCLE REPORTED BY SMITHSONIAN INSTITUTION.—H. H. Clayton. (*Sci. News Letter*, 6th May 1939, Vol. 35, No. 18, p. 280.)

3456. THE PRIMARY AND SECONDARY SCATTERING OF SUNLIGHT IN A PLANE-STRATIFIED ATMOSPHERE OF UNIFORM COMPOSITION [for Monochromatic Constituent of Light: Theory].—A. Hammad & S. Chapman. (*Phil. Mag.*, July 1939, Series 7, Vol. 28, No. 186, pp. 99–110.)

3457. THE LYMAN LINES OF HYDROGEN IN SOLAR EMISSION [Difference between Spectra of "Normal" and "Excited" Solar Regions].—H. Hemmendinger. (*Phys. Review*, 1st June 1939, Series 2, Vol. 55, No. 11, p. 1119: abstract only.)

3458. INTEGRATING METERS FOR [Solar] ULTRA-VIOLET RADIATION [Photocells connected with Fixed Condensers and Cold-Cathode Gas-Filled Tubes: Reliable Operation without Skilled Attention].—J. B. H. Kuper & F. S. Brackett. (*Phys. Review*, 1st June 1939, Series 2, Vol. 55, No. 11, p. 1128: abstract only.)

3459. THE FRINGE OF THE ATMOSPHERE, AND THE ULTRA-VIOLET LIGHT THEORY OF AURORA AND MAGNETIC DISTURBANCES [Merging of Fringe Region into Interstellar Space at about 2000–2550 km: Possible Sources of Super-Elastic Collisions, Calculation of Metastable Oxygen Atoms: "Spray" Region may extend to 14 000 km but Not to Hulburt's 42 000 km: etc.].—S. K. Mitra & A. K. Banerjee. (*Indian Journ. of Phys.*, April 1939, Vol. 13, Part 2, pp. 107–144.)

3460. MOTION OF AN ELECTRIFIED CORPUSCLE IN THE PRESENCE OF A MAGNETIC DIPOLE [in connection with Theory of Aurora: New Prime Integral of Equations of Motion: etc.].—C. Agostinelli. (*Bollettino del Centro Volpi di Elettrologia*, English Edition, July/Sept. 1938, Year 1, No. 3, p. 125d: summary only.)

3461. NEW RESULTS RELATING TO THE POLAR AURORA [Differences between Spectra of Upper and Lower Height Limits].—R. Bernard. (*Comptes Rendus*, 5th June 1939, Vol. 208, No. 23, pp. 1831–1833.)

3462. AURORA AND GEOMAGNETIC DISTURBANCES [Near Zone of Maximum Auroral Frequency, Electric Current Systems causing Surface Geomagnetic Disturbance and Those manifested as Auroral Arcs may be More Closely Associated Spatially than Hitherto Supposed].—J. M. Stagg & J. Paton. (*Nature*, 3rd June 1939, Vol. 143, p. 941.)

3463. MYSTERIES OF TERRESTRIAL MAGNETISM [and the Mission of the Sailing Ship *Research*].—R. W. Hallows. (*World-Radio*, 7th July 1939, Vol. 29, pp. 6 and 7, 10.)

3464. FORBIDDEN TRANSITIONS IN NITROGEN [are favoured by High Pressures and Small Volumes: Characteristic of Afterglows generated by Weak Discharges: Observations of Nebular Lines].—J. Kaplan. (*Nature*, 24th June 1939, Vol. 143, p. 1066.)

3465. SELECTIVE EXCITATION OF THE BANDS OF THE NITROGEN MOLECULE BY METASTABLE ATOMS.—R. Bernard. (*Journ. de Phys. et le Radium*, May 1939, Series 7, Vol. 10, No. 5, pp. 75 S–76 S.) The writer is extending this study to the problem of the upper layers of the atmosphere, where molecules and metastable atoms both exist.

3466. SOME REMARKS ON THE LUMINESCENCE OF THE NIGHT SKY [Atomic Processes required to produce Observed Bands, Intensities, etc.].—J. Cabannes. (*Comptes Rendus*, 5th June 1939, Vol. 208, No. 23, pp. 1770–1772.)

3467. RESEARCHES ON ATMOSPHERIC OZONE [Clear Correlation between Layer Thickness and Average Layer Temperature: Great Heterogeneity in Distribution—Existence of "Ozone Clouds"].—D. Barbier & D. Chalonge. (*Journ. de Phys. et le Radium*, March 1939, Series 7, Vol. 10, No. 3, pp. 113–123.)

A method of calculating the temperature, more precise than those previously used, is described and applied to observations on 83 nights between 1934 & 1938, in Abisko, Arosa, and on the Jungfraujoch. For comments by Vassy, and the authors' reply, see *ibid.*, May & June, pp. 250 & 324–325.

3468. ON THE VARIATIONS OF THE MEAN TEMPERATURE OF THE ATMOSPHERIC OZONE [and Their Relations to the Layer Thickness and to the Meteorological Situation].—A. & É. Vassy. (*Journ. de Phys. et le Radium*, June 1939, Series 7, Vol. 10, No. 6, pp. 93 S–94 S.)

3469. Dissymmetry of Ozone Distribution in the Two Hemispheres [Comparison of Data shows Higher Values in Southern Hemisphere: Possibly due to Different Distribution of Land and Water].—A. & É. Vassy. (*Comptes Rendus*, 5th June 1939, Vol. 208, No. 23, pp. 1829–1830.) *See* also Bureau & others, 2701 of July.

3470. Observations with a New Radiation Pyrometer [Solar and Infra-Red Observations bearing on Height and Temperature of Atmospheric Ozone Layer].—J. Strong. (*Phys. Review*, 1st June 1939, Series 2, Vol. 55, No. 11, p. 1114: abstract only.)

3471. Ground Conductivity Measurements in Canada [by Field-Strength Measurements on Broadcasting Stations: Comparison of Eckersley, van der Pol, & U.S.A. (Bucharest) Approximations: Adoption of Eckersley Curves: Comparison of Conductivities, thus found, with Geological Characteristics: etc.].—K. A. MacKinnon. (*U.R.S.I. Proc. of* 1938 *Gen. Assembly*, Vol. 5, Fasc. 1, 1938, pp. 255–260.)

3472. Velocity of Light Apparatus [using Radio-Frequency Interferometry: Improvements and Changes].—W. C. Anderson. (*Phys. Review*, 1st June 1939, Series 2, Vol. 55, No. 11, p. 1128: abstract only.) *See* also 3248 of 1937.

3473. Elementary Spherical Waves with Rectilinear Polarisation.—A. Foix. (*Journ. de Phys. et le Radium*, March 1939, Series 7, Vol. 10, No. 3, pp. 41 S–42 S.)

"The waves in question, or rather eqns. 2 & 3, explain marvellously this effect of the variation of frequency, this metamorphosis which is the passage from electromagnetism to optics."

3474. The Cauchy Problem for the Equation of Waves which are Symmetrical with respect to an Axis, *also* On the Cauchy Problem for a Differential Equation appearing in Symmetrical Electromagnetic Propagation, *and* On the Abnormal Case of the Cauchy Problem for the Equation of Waves.—Agostinelli: Agostinelli: Frola. (*Bollettino del Centro Volpi di Elettrologia*, English Edition, July/Sept. 1938, Year 1, No. 3, p. 57d: p. 57d: p. 59d: summaries only.)

3475. The Birth of Conical-Front Waves from the Total Reflection of a Spherical Wave [in Seismic Prospecting].—L. Cagniard. (*Journ. de Phys. et le Radium*, June 1939, Series 7, Vol. 10, No. 6, p. 94 S.)

3476. On Some Phenomena of Wave Propagation [Propagation of Elastic Waves in Polar Crystals—Electric & Acoustic Analogies: Propagation of Electric Waves in a Chain of Circuits coupled by Mutual Induction—Mechanical Analogy and Application to Ferromagnetism].—N. Parodi. (*Rev. Gén. de l'Élec.*, 22nd April 1939, Vol. 45, No. 16, pp. 521–526.) *See* also 2130 of May.

3477. On Calculating the Optical Constants from Reflection Coefficients.—R. Tousey. (*Journ. Opt. Soc. Am.*, June 1939, Vol. 29, No. 6, pp. 235–239.)

3478. Calculation of Great Circle Bearings [Formula applicable to Both Hemispheres, and reducing Usual Calculations].—F. Addey. (*P.O. Elec. Eng. Journ.*, July 1939, Vol. 32, Part 2, pp. 142–144.)

ATMOSPHERICS AND ATMOSPHERIC ELECTRICITY

3479. Radio-Atmospheric Researches [Perugia Observations: Close Relation between Atmospherics and Barometric Pressure: Aural Method the Only Sure Field of Research at Present: etc.].—B. Paoloni. (*Bollettino del Centro Volpi di Elettrologia*, English Edition, Dec. 1938, Year 1, No. 4, p. 83d: summary only.)

3480. Report on the Recording of Atmospherics [and Its Importance for Ionospheric Research (including Study of Fade-Outs) and Meteorology].—R. Bureau. (*U.R.S.I. Proc. of* 1938 *Gen. Assembly*, Vol. 5, Fasc. 1, 1938, pp. 228–230.)

3481. Researches on Origin of Atmospherics: Report to Commission III, Subcommission I [Short Survey of Work since 1934].—H. Norinder. (*U.R.S.I. Proc. of* 1938 *Gen. Assembly*, Vol. 5, Fasc. 1, 1938, pp. 248–249.)

3482. Statically Charged Rain: Occasional Effect on Reception where "Skyrod" Type of Aerial is used.—Belling & Lee, Ltd. (*Electrician*, 14th July 1939, Vol. 123, p. 51.)

3483. The Atomphysical Interpretation of "Lichtenberg Figures" and Their Application for studying Electric Discharge Phenomena.—F. H. Merrill & A. von Hippel. (*Phys. Review*, 1st June 1939, Series 2, Vol. 55, No. 11, p. 1122: abstract only.)

3484. The Mechanism of the Lightning Discharge [with Consideration of Resistance Change in Discharge Channel due to Ion Recombination].—J. M. Meek. (*Phys. Review*, 1st June 1939, Series 2, Vol. 55, No. 11, pp. 1122–1123: abstract only.)

3485. The Distribution of Lightning Strokes and Hail Storms in the Department of Hautes-Pyrénées [depends on Geological Nature of Terrain: Importance of Geological Faults, Gulfs, etc: Lightning frequently strikes Cols rather than Summits: Connection of Dangerous Lightning Areas with Hailstorms].—C. Dauzère & J. Bouget. (*Comptes Rendus*, 5th June 1939, Vol. 208, No. 23, pp. 1833–1835.) For previous work *see* 1376 of April.

3486. Observation of Ball Lightning [Brick-Coloured Luminous Sphere: Details of Appearance and Motion].—R. Garreau. (*Comptes Rendus*, 3rd July 1939, Vol. 209, No. 1, pp. 60–61.)

3487. The Protection Zone of Lightning Conductors and its Determination by Tests on Models.—A. Matthias & W. Burkhardtsmaier. (*E.T.Z.*, 8th & 15th June 1939, Vol. 60, Nos. 23 & 24, pp. 681–687 & 720–726.)
Further development of the work referred to in 4013 of 1937.

3488. Cloud Chamber Studies of Positive Point-to-Plane Discharge in Air at Atmospheric Pressure [Streamer Characteristics: Mechanism for Formation of Large Ion Clouds].—S. Gorrill. (*Phys. Review*, 1st June 1939, Series 2, Vol. 55, No. 11, pp. 1121–1122: abstract only.)

3489. Negative Point-to-Plane Corona Studies.—A. F. Kip. (*Phys. Review*, 1st June 1939, Series 2, Vol. 55, No. 11, p. 1122: abstract only.) Continuation of work referred to in 1188 of March (Trichel). *Cf.* also 2693 & 2694 of July.

3490. Offset and Breakdown Potentials in Point-to-Plane Corona Discharge in Air as a Function of Pressure up to 30 Atmospheres.—G. G. Hudson. (*Phys. Review*, 1st June 1939, Series 2, Vol. 55, No. 11, p. 1122: abstract only.)

3491. Cellular and Banded Electroconvective Eddies in Gases [Experiments on Effect of Electric Field on Movements of Gas: Eddies may play Essential Part in Discharges in Rarefied Gases].—Luntz. (*Comptes Rendus*, 12th June 1939, Vol. 208, No. 24, pp. 1886–1888.) *See* also Avsec & Luntz, 1697 of 1937 & back reference.

3492. On the Interchange of Electricity between Solids, Liquids, and Gases in Mechanical Actions [Available Data: New Experiments to investigate Electrical Double-Layer Theory: Mechanical Action in Atmosphere (Simpson's Calculation of Sparking Potential by Breaking of Drops criticised): etc.].—S. K. Banerji. (*Indian Journ. of Phys.*, Dec. 1938, Vol. 12, Part 6, pp. 409–436.)

3493. The Mobility of Alkali Atoms in Gases: I–The Attachment of Water Molecules to Alkali Ions in Gases: II–The Attachment of Inert Gas Atoms to Alkali Ions: III–The Mobility of Alkali Ions in Water Vapour.—R. J. Munson, A. M. Tyndall, K. Hoselitz. (*Proc. Roy. Soc.*, Series A, 19th May 1939, Vol. 171, No. 945, pp. S 48, 49, 49: abstracts only.)

3494. Diurnal Variations of the Vertical Electric Current, Ionic Mobility, and Space Charge of the Air at the Geophysical Observatory of Chambon-la-Forêt.—O. Thellier. (*Comptes Rendus*, 19th June 1939, Vol. 208, No. 25, pp. 2013–2015.) For previous work *see* 2275 of June.

3495. The Earth's Charge and its Permanence [Results of Work on Experimental Model: Permanent Negative Charge due to Photo-electrons: Theory].—G. Petrucci. (*Bollettino del Centro Volpi di Elettrologia*, English Edition, Dec. 1938, Year 1, No. 4, p. 93d: summary only.)

3496. "Physical and Dynamical Meteorology: Second Edition" [Book Review].—D. Brunt. (*Journ. Scient. Instr.*, July 1939, Vol. 16, No. 7, p. 237.)

3497. On Alfvén's Hypothesis of a "Cosmic Cyclotron" [as a Cosmic-Ray Generator: Objections].—E. R. Sabato. (*Phys. Review*, 15th June 1939, Series 2, Vol. 55, No. 12, pp. 1272–1273.) *See* 41 of 1937.

3498. On the Fundamental Principles underlying the Theory of Cosmic Radiation [Theory of Motion of Charged Particles in Field of Magnetic Dipole: Allowed and Forbidden Directions of Cosmic Rays: Application of Liouville's Theorem].—A. Baños. (*Journ. Franklin Inst.*, May 1939, Vol. 227, No. 5, pp. 623–645.)

3499. Variations of Cosmic Ray Intensity with Variations of Atmospheric Pressure and Temperature at Sea Level, *and* Ionisation by Cosmic Rays in Gases.—Clay & Bruins: Clay & Stammer. (*Physica*, July 1939, Vol. 6, No. 7, pp. 628–632: pp. 663–672: both in English.)

(1). Results leading to the final remark ". . . for the time being, we are unable to offer any explanation as to the origin of this difference. We may, however, remark on this point also that we know very little about the significance of the variation of pressure at the bottom of the atmosphere for the structure of the atmosphere as a whole." (2). Measurements avoiding causes of disagreement in previous values of ionisation at sea level.

3500. A Integrator for Polar, Rectangular, and Curvilinear Co-ordinates.—J. Lugeon. (*Comptes Rendus*, 12th June 1939, Vol. 208, No. 24, pp. 1874–1876.)

Development of planimeter used in the determination of the heights of sounding balloons (*see* 1829 of May and 2703 of July). *See* also an article by Lugeon & Schüepp in *Flugwehr und -Technik* (Zurich), No. 5, 1939, on the Swiss radio-sonde service and its various uses, including the army's use of it in connection with acoustic direction finders (an article by Sänger on the errors to which these instruments are liable will appear in a later issue of the paper).

PROPERTIES OF CIRCUITS

3501. The Interpretation of Amplitude and Phase Distortion in Terms of "Paired Echoes."—Wheeler. (*See* 3642.)

3502. New System of Feedback [for Reduction of Distortion: Distortion is Rectified, Amplified, and used to Destroy Itself: Experimental Confirmation of Theory].—G. Zanarini. (*Bollettino del Centro Volpi di Elettrologia*, English Edition, July/Sept., 1938, Year 1, No. 3, p. 79d: summary only.)

3503. A Low-Distortion Limiting Amplifier [for Volume Compression: Limiting Effect produced by Application of Variable Amounts of Feedback through a Remote Cut-Off Pentode].—E. G. Cook. (*Electronics*, June 1939, Vol. 12, No. 6, pp. 38–40.)

3504. Graphical Treatment of Back-Coupled Circuits [Description of the Bartels Construction (395 of 1935): Its Advantages and Limitations: Evolution of a More General Construction].—(*Marconi Review*, July/Sept. 1939, No. 74, pp. 35–39: to be contd.) The new method will be given in a further instalment.

3505. Stability and Instability in Electric Circuits with Parameters Variable in Time, with and without an Inserted E.M.F.—R. Einaudi. (*U.R.S.I. Proc. of 1938 Gen. Assembly*, Vol. 5, Fasc. 1, 1938, pp. 242–248: in Italian, with French summary.)

3506. Oscillations in Certain Non-Linear Driven Systems [Differential-Analyser Solutions of Relaxation-Oscillation Equations, illustrating Automatic Synchronisation and Frequency Demultiplication: Synchronisation suddenly effected on Nearest Odd Subharmonic: Only Effect of varying Initial Phase Angle is to hasten or retard, by a Few Cycles, the Appearance of Steady Synchronised State: etc.].—D. L. Herr. (*Proc. Inst. Rad. Eng.*, June 1939, Vol. 27, No. 6, pp. 396–402.)

3507. Note on the Synchronisation of Relaxation Oscillations.—Y. Rocard. (*Bull. de la Soc. Franç. Radioélec.*, 4th Quarter 1938, Vol. 12, No. 4, pp. 90–94: in French & English concurrently.)

1.—Case of the writer's special simple oscillator, comparable to the lever escapement of clocks (eqn. 2); it is pointed out that its synchronising equation shows that if $\Delta\omega/\omega$ is very small, the minimum necessary synchronising amplitude is independent of the harmonic content τ unless the latter is itself very small, and that for a fairly large variation $\Delta\omega$ the necessary synchronising amplitudes (which are large) *decrease* with decrease of τ. On the other hand, in the case of frequency division eqn. 4 shows that the necessary synchronising amplitude *increases* as τ decreases. 2.—Case of van der Pol's special pseudo-sinusoidal oscillator (eqn. 5); it is pointed out that there is no relation between the time constant and the harmonic content. This holds good also for the oscillator represented by eqn. 6: such an oscillator has the curious property that it is the *amplitude* which is very easily modulated by variations of the synchronising force: in neither eqn. 5 nor eqn. 6 is there any mechanism allowing frequency division.

3508. Switching Action of the Eccles-Jordan Trigger Circuit [Mode of Action of the Small Shunting Condensers, and a Highly Sensitive Variant with Unidirectional Response].—H. Toomin. (*Review Scient. Instr.*, June 1939, Vol. 10, No. 6, pp. 191–192.)

3509. Certain Properties of Dissymmetrical T Pure Reactance Networks: Part II [Note on Image Impedance of Dissymmetrical Networks: Generalised A-Matrix for *n* Similar Sections connected in Alternated Cascade].—H. Cafferata. (*Marconi Review*, July/Sept. 1939, No. 74, pp. 24–34.) For Part I *see* 2340 of June.

3510. "Frequency-Shunting" Circuits [Separating Filters] of Constant Effective Resistance.—W. Cauer. (*E.N.T.*, April 1939, Vol. 16, No. 4, pp. 96–120.)

For papers on shunting circuits *see* Brandt, 2937 of 1936; Piloty, 3623 of 1937; and Cauer (*Mix & Genest-Nachrichten*, 1937, No. 2, p. 75). The present work gives "a complete theoretical solution of the 'shunt' problem under the following assumptions: 1.—limitation to constant input impedance; 2.—limitation to two reactance quadripoles connected in parallel or in series at the input, or to 'shunt' circuits equivalent to these." The relations of the circuits previously investigated to one another and to those discussed by Norton (2900 of 1937) are analysed mathematically, starting from the matrices of the circuits. Formulae for shunting circuits whose attenuation varies according to Tschebyscheff functions are found (§ 3) and the representation of symmetrical and antimetrical reactance quadripoles and shunts by "Q-functions" (*see* above references) is given (§§ 4, 5). The chain circuits considered by Norton are derived (§ 9); numerical examples are given in Appendix II and Tschebyscheff approximations in Appendix III.

3511. Single-Sideband Filter Theory with Television Applications [Graphical Analysis Method: Suitability or Unsuitability of Various Filter Structures, including Lattice Filters and Filters using Transmission Lines as Circuit Elements: Design Formulae for These: Gain in Amplifier Stages].—J. M. Hollywood. (*Proc. Inst. Rad. Eng.*, July 1939, Vol. 27, No. 7, pp. 457–472.)

3512. The Operation of [Band-Pass] Filters in Parallel [with Special Reference to Terminal Equipment for London/Birmingham Coaxial Cable: Connection of Filters having Contiguous or Overlapping Pass-Bands].—H. Stanesby. (*P.O. Elec. Eng. Journ.*, July 1939, Vol. 32, Part 2, pp. 135–137.)

3513. The Production of Quartz Resonators for the London/Birmingham Coaxial Cable System.—Booth & Sayers. (*See* 3689.)

3514. Note on the Resistance Noise in a Coaxial Pair [including Simple Formula useful for Predicting the Limit of Noise Reduction].—H. J. Josephs. (*P.O. Elec. Eng. Journ.*, April 1939, Vol. 32, Part 1, pp. 61–62.)

3515. Fluctuations of Thermionic Current and the "Flicker Effect."—Surdin. (*See* 3586.)

3516. "EINFÜHRUNG IN DIE SIEBSCHALTUNGS-THEORIE" [Introduction to Filter-Network Theory: Book Beview].—R. Feldtkeller. (*Proc. Inst. Rad. Eng.*, June 1939, Vol. 27, No. 6, pp. 419–420.) Following on the work on quadripoles referred to in 2686 of 1938.

3517. WIDE-BAND AMPLIFIERS FOR TELEVISION.—H. A. Wheeler. (*Proc. Inst. Rad. Eng.*, July 1939, Vol. 27, No. 7, pp. 429–439.) A summary was dealt with in 3700 of 1938.

3518. THE FREQUENCY RANGE OF THE OUTPUT TRANSFORMER.—H. Pitsch. (*Funktech. Monatshefte*, May 1939, No. 5, pp. 133–138.)

For a previous paper *see* 463 of February. With the help of the equivalent circuit the question of matching is examined, with its effect on the frequency characteristic; triodes and pentodes are compared. The effects of the winding resistances and of the inductance of the loudspeaker (neglected in the preliminary calculations) are then considered, and the paper ends with a numerical example.

3519. A HIGH-FREQUENCY TRANSFORMER FREE FROM LEAKAGE INDUCTANCE IN THE SECONDARY WINDING.—Yu. V. Denisov. (*Journ. of Tech. Phys.* [in Russian], No. 3, Vol. 9, 1939, pp. 222–225.)

The inductive coupling between two coaxial tubes is examined and it is shown that the external tube has no magnetic flux which is not coupled with the inner tube, *i.e.* it has no leakage magnetic flux. Transformers consisting essentially of two coaxial tubes bent into the shape of a ring (Figs. 4 & 5) were built for h.f. electric furnaces. An energy density of 2.7 kw/cm³ was thus obtained with an efficiency of 38%.

3520. THE PRECISE DETERMINATION OF THE FOUR LINE QUANTITIES *R*, *L*, *C*, AND *G* FROM OPEN-CIRCUIT AND SHORT-CIRCUIT TESTS [Application of Electrical-Machine Methods to Long Lines].—F. Niethammer. (*E.T.Z.*, 4th May 1939, Vol. 60, No. 18, pp. 530–531.)

TRANSMISSION

3521. SMALL-SIGNAL THEORY OF VELOCITY-MODULATED ELECTRON BEAMS [allowing Accurate Calculation of Space-Charge Effects in Drift Tube and of Induced-Current Coefficient in a Gap].—W. C. Hahn. (*Gen. Elec. Review*, June 1939, Vol. 42, No. 6, pp. 258–270.) In connection with the design of the velocity-modulated valves dealt with in 1901 of May.

3522. "KLYSTRON" ULTRA-HIGH-FREQUENCY GENERATOR APPLIED TO BLIND LANDING BEAMS (HORN PROJECTOR).—(*Inter Avia*, 31st March 1939, pp. 2–3.)

3523. A VARIABLE OSCILLATOR FOR ULTRA-HIGH-FREQUENCY MEASUREMENTS [Theorem on Ultra-High-Frequency Circuits: Its Importance in Current and Voltage Measurement: Design of Variable Oscillator for Range 50–300 Mc/s].—R. King. (*Phys. Review*, 1st June 1939, Series 2, Vol. 55, No. 11, p. 1127: abstract only.)

3524. FREQUENCY INVESTIGATIONS ON DECIMETRIC-WAVE TRANSMITTERS [Triode with Retroaction, Magnetron] BY MEANS OF A CRYSTAL DETECTOR.—Schmidt. (*See* 3680.)

3525. THE STABILISATION OF ULTRA-HIGH FREQUENCY IN A RESONANCE-LINE RADIO TRANSMITTER.—G. T. Shitikov. (*Izvestiya Elektroprom. Slab. Toka*, Nos. 3 & 4, 1939, pp. 3–13 & 15–24.)

In the first part of the paper the natural frequency of a concentric line is determined for the cases when (a) the line is terminated by a capacity and (b) the loading capacity is connected at an intermediate point on the line. The operation of an oscillating circuit using a concentric line is then considered, and the effect of the input capacity of the valve on the frequency of the line is discussed. The optimum parameters of the line are determined and methods are indicated for designing the circuit. The second part describes experiments with the circuit when this was used as a driving stage and also when it was coupled directly to an aerial. A valve with an output of 7 to 8 watts was employed, and the wavelength was varied between 80 and 100 cm. The temperature-compensation of the line is also discussed.

3526. SIMPLICITY ON 112 MC: AN EASILY CONSTRUCTED TRANSMITTER CAPABLE OF OUTPUTS UP TO 100 WATTS ["Old Reliable T.N.T. Circuit" (avoiding Transmission-Line Frequency Stabilisation) applied to a Pair of the New HK-24 Valves, modulated by 6L6's in Push-Pull].—B. W. Griffith, Jr. (*QST*, July 1939, Vol. 23, No. 7, pp. 38–39.)

3527. WSOC's PACK TYPE TRANSMITTER [Ultra-Short-Wave, Crystal-Controlled].—S. T. Carter. (*Electronics*, April 1939, Vol. 12, No. 4, pp. 29–31.)

3528. FIELD TESTS OF FREQUENCY- AND AMPLITUDE-MODULATION WITH ULTRA-HIGH-FREQUENCY WAVES: PARTS I & II [including Transmitter Requirements for Given Service Area: Relative Cost Data: etc.].—I. R. Weir. (*Gen. Elec. Review*, May & June 1939, Vol. 42, Nos. 5 & 6, pp. 188–191 & 270–273.) *See* also 2733 of July.

3529. ANALYSIS OF LOAD-IMPEDANCE MODULATION. Roder: Parker. (*See* 3639.)

3530. HIGH-EFFICIENCY GRID MODULATION IN A PORTABLE 14-MC 'PHONE TRANSMITTER: CIRCUIT DESIGN AND TUNING PROCEDURE IN THE NEW TERMAN SYSTEM [and Its Advantage for Portable Sets].—F. L. Denton: Terman & Woodyard. (*QST*, July 1939, Vol. 23, No. 7, pp. 33–37.) For this type of grid-modulated amplifier *see* 4300 of 1938.

3531. FRACTIONAL-FREQUENCY GENERATORS UTILISING REGENERATIVE MODULATION.—Miller. (*See* 3687.)

3532. BIMODULATED OSCILLATIONS.—A. I. Kostsov. (*Izvestiya Elektroprom. Slab. Toka*, No. 3, 1939, pp. 22–31.)

A new method is proposed for transmitting two frequency bands, not necessarily displaced with respect to one another, on the same carrier wave. This is achieved by passing the carrier frequency through a modulating element consisting in principle of two parallel detectors connected in opposition and each followed by a microphone (Fig. 7). A doubly modulated wave may thus be obtained, the two halves of which would correspond respectively to the outputs from the two detectors (Fig. 10). In receiving, the current flowing through the telephone will depend on the direction in which the receiving detector is connected, and in this way the frequency bands can be separated. The theory of the method is discussed and practical circuits are suggested for the modulating unit (Fig. 9) and the receiving detector (Fig. 11).

3533. AN EXPERIMENT IN PARALLEL OPERATION OF OSCILLATORS ON SHORT WAVES [Russian 120 kW station].—Nevyazhski. (*See* 3791.)

3534. A LOW-DISTORTION LIMITING AMPLIFIER [for Volume Compression].—Cook. (*See* 3503.)

3535. FREQUENCY-DRIFT COMPENSATION [by Special Condenser and Warming Unit].—Levy. (*See* 3548.)

3536. A "CHOPPED-SIGNAL" VACUUM-TUBE GENERATOR WITH GOOD VOLTAGE REGULATION.—Williams & Fairweather. (*See* 3688.)

3537. "INSTITUTE OF RADIO ENGINEERS STANDARD, 1938: TRANSMITTERS AND ANTENNAS" [Book Review].—I.R.E. (*Gen. Elec. Review*, June 1939, Vol. 42, No. 6, p. 285.)

3538. 100 KILOWATT SHORT-WAVE BROADCASTING TRANSMITTER TYPE S.W.B. 14 & 18.—E. Green & L. T. Moody. (*Marconi Review*, July/Sept. 1939, No. 74, pp. 1–23.)

3539. SHORT-WAVE TRANSMITTER TYPE B.E.C.1/20 [for 18–48 m Waves, C.W. or Modulated C.W. Telegraphy, Aerial Power 150–200 Watts].—(*Bull. de la Soc. Franç. Radioélec.*, 1st Quarter 1939, Vol. 13, No. 1, pp. 31–37.)

3540. RADIOPHONIC TRANSMITTER TYPE B.E.M.1/2 FOR SHIPS OF SMALL TONNAGE [Pilot Boats, Fishing Boats, etc.].—(*Bull. de la Soc. Franç. Radioélec.*, 4th Quarter 1938, Vol. 12, No. 4, pp. 100–106: in French & English concurrently.)

3541. A HURRICANE EMERGENCY TRANSMITTER AND POWER SUPPLY [a "Flea-Power Cake-Pan" Crystal-Controlled Transmitter weighing under Two Pounds].—G. M. Smith. (*QST*, July 1939, Vol. 23, No. 7, pp. 18–22.) For the corresponding receiver *see* 2327 of June.

RECEPTION

3542. A RECEIVER FOR FREQUENCY MODULATION [using 7 Valves: Sensitivity about 5 Microvolts: Flat within 2 db from 30 to 15 000 c/s: Wavelengths around 7 m].—J. R. Day. (*Electronics*, June 1939, Vol. 12, No. 6, pp. 32–35.) Handling the present maximum deviation of ± 75 kc/s "with negligible amplitude and frequency distortion."

3543. STEPPING-UP RECEIVER PERFORMANCE: A NEW APPROACH TO THE PROBLEMS OF HIGH-[and Ultra-High] FREQUENCY RECEPTION [Use of Two Intermediate Frequencies to provide Basis for Noise Silencer and Other Advantages].—J. P. Veatch & D. D. Kahle. (*QST*, July 1939, Vol. 23, No. 7, pp. 12–17 and 66 . . 74.)

3544. THE SOUND SOURCE WITH RESONANT CHAMBER [having One or More Openings], AND THE ACOUSTICAL CORRECTION OF RADIO RECEIVERS [Mathematical Treatment, with Application to Correction of Common Defects of Receiver Cabinets, and to Acoustical Labyrinths & Folded Horns], *and* ACOUSTICAL MEASUREMENTS OF LINEARITY IN RADIO RECEIVERS.—D. Faggiani: M. Santoro. (*Bollettino del Centro Volpi di Elettrologia*, English Edition, July/Sept. 1938, Year 1, No. 3, p. 91d: p. 91d: summaries only.)

3545. THE STANDARDISATION OF THE CHARACTERISTICS OF OSCILLATING AND RESONATING CIRCUITS USED IN BROADCAST RECEIVERS [Objects of Standardisation: Circuit Calculation for Superheterodynes: the Soc. des Radioélectriciens Standards 1939/1940, and the Cairo & Montreux Conferences].—M. Adam. (*Rev. Gén. de l'Élec.*, 17th June 1939, Vol. 45, No. 24, pp. 787–792.)

3546. "INSTITUTE OF RADIO ENGINEERS STANDARDS 1938: RADIO RECEIVERS" [Book Review].—I.R.E. (*Gen. Elec. Review*, June 1939, Vol. 42, No. 6, p. 285.)

3547. CIRCUIT DESIGN RELATED TO TUBE PERFORMANCE [Difficulties in Receiver Circuits, and Their Conquest: Change in Sensitivity with Valve Replacement, Plate Compensation (reducing Transients which affect Valve Life): "Blocking" in Filament-Type Valves: etc.].—L. C. Hollands. (*Electronics*, March 1939, Vol. 12, No. 3, pp. 18–21.)

3548. FREQUENCY-DRIFT COMPENSATION [in Superheterodyne Receivers: by Silver-Plated-Ceramic Negative-Temperature-Coefficient Condenser housed with Resistor Warming Unit: Description of Drift Measurements in Push-Button Receivers].—M. L. Levy. (*Electronics*, May 1939, Vol. 12, No. 5, pp. 15–17.)

3549. DISTORTIONS AT THE COMING INTO ACTION OF DELAYED AUTOMATIC VOLUME CONTROL [Consideration of Their Causes, leading to a Three-Diodes Circuit for Their Suppression: Dependence of Control on Depth of Modulation almost Eliminated].—F. C. Saic. (*E.T.Z.*, 8th June 1939, Vol. 60, No. 23, pp. 691–694.)

3550. SERVICE INSTRUCTIONS FOR THE DETECTION AND ELIMINATION OF INTERFERENCE WITH RADIO RECEPTION.—Instituto Sperimentale delle Communicazioni. (*Bollettino del Centro Volpi di Elettrologia*, English Edition, Dec. 1938, Year 1, No. 4, p. 73d: summary only.)

3551. STUDY OF THE ATTENUATUON OF THE RIPPLES OF THE MAGNETIC FIELD OF A D.C. SERIES MOTOR DRIVEN BY RECTIFIED CURRENT CONTAINING A RIPPLE.—Ch. Vasiliu. (*Rev. Gén. de l'Élec.*, 22nd April 1939, Vol. 45, No. 16, pp. 527–528: long summary only.)

3552. SIMPLE NOISE LIMITER FOR PUSH-PULL AUDIO [easily added: One 6H6 as Limiter]. C. Mowery. (*QST*, July 1939, Vol. 23, No. 7, p. 47.)

3553. ON THE APPLICATION POSSIBILITIES OF THE UNIVERSAL OUTPUT TRANSFORMER: SUPPLEMENTARY REMARK [on the Different Conditions for Triodes and Pentodes].—H. Pitsch: Wünsch. (*Funktech. Monatshefte*, May 1939, No. 5, p. 154.) *See* Wünsch, 3142 of August.

3554. ADVANTAGES AND PROPERTIES OF THE VARIOUS CORE SHAPES FOR H.F. IRON-CORED COILS.—Henniger. (*Funktech. Monatshefte*, May 1939, No. 5, pp. 155–157.)

3555. A NEW SHORT-WAVE TRANSATLANTIC RADIO RECEIVER [for a Transmission with Two Independent Single-Sideband Speech Channels occupying about Band-Width of One Double-Sideband Transmission].—W. J. Bray & W. R. H. Lowry. (*P.O. Elec. Eng. Journ.*, April 1939, Vol. 32, Part 1, pp. 24–31.)

3556. SHORT-WAVE S.F.R. RECEIVER TYPE B.R.C.1/8 [15–120 m: for Marine Use].—(*Bull. de la Soc. Franç. Radioélec.*, 1st Quarter 1939, Vol. 13, No. 1, pp. 38–40.)

3557. GAS-OPERATED RADIO WITHIN THE REACH OF ALL: NOTES ON THE NEWLY DEVELOPED ALL-GAS WIRELESS SET.—Milnes Elec. Eng. Company. (*Gas Journal*, 5th July 1939, Vol. 227, pp. 48–49.)

3558. PLASTIC CABINET DESIGN.—H. Chase. (*Electronics*, June 1939, Vol. 12, No. 6, pp. 16–19.)

3559. MODERN FASTENERS IN THE RADIO INDUSTRY.—C. Walsh. (*Electronics*, May 1939, Vol. 12, No. 5, pp. 27–29.)

3560. THE WORLD'S LISTENERS: AN INCREASE OF THIRTY-THREE MILLIONS.—A. R. Burrows. (*World-Radio*, 7th July 1939, Vol. 29, p. 7.)

AERIALS AND AERIAL SYSTEMS

3561. ELECTROMAGNETIC-HORN RADIATORS.—W. L. Barrow. (*U.R.S.I. Proc. of* 1938 *Gen. Assembly*, Vol. 5, Fasc. 1, 1938, pp. 277–284.) Based on the papers dealt with in 1446 of April. The work dealt with in 1338 & 1447 of April is also quoted, together with earlier papers.

3562. CALCULATION OF THE FIELD STRENGTH ON SHORT WAVES, TAKING INTO ACCOUNT THE DIRECTIVITY OF TRANSMITTING AERIALS IN THE VERTICAL PLANE.—M. P. Dolukhanov. (*Izvestiya Elektroprom. Slab. Toka*, No. 4, 1939, pp. 4–15.)

A short survey is given of the observations made during recent years on the propagation of short waves, and the importance of the vertical directivity of the transmitting aerial is stressed. A formula (4) is derived for calculating the directivity coefficient ϵ of a complex aerial, as determined by the vertical and horizontal angles of the radiated beam, and another formula (6b) is quoted giving, in terms of ϵ, the field strength of a Telefunken aerial. It is then shown that the angle of incidence of the incoming ray can be regarded as equal to the radiation angle, and on the basis of the monthly reports on the average height of the ionospheric layers published in the *Proc. Inst. Rad. Eng.*, curves are plotted showing the angles of incidence of the incoming rays (up to ray No. 5) as determined by the height of the reflecting layer and the transmission range (Fig. 4). A table (1) is also prepared giving the limits within which the incidence angle of the main incoming ray may vary for different transmission ranges. In the remaining section of the paper curves are plotted and data given for simplifying calculations in the case of a Telefunken aerial. It is pointed out that similar methods can also be applied to other types of aerials.

3563. THE "WAVE LOOP" AERIAL.—A. A. Pistolkors. (*Izvestiya Elektroprom. Slab. Toka*, No. 4, 1939, pp. 25–31.)

It was shown in a previous paper [in another journal] that if two parallel horizontal conductors are short-circuited at one end and connected respectively to ground through a resistance Z and to an oscillator (Fig. 1) at the other end, then if Z is made equal to ρ (characteristic impedance of the loop) the input impedance of the loop becomes a pure resistance equal to ρ at any frequency. In the present paper a similar loop, but in a vertical plane (Fig. 2), is considered, and its application as a receiving aerial is discussed: the author calls it a wave loop aerial.

Formulae (4) and (10) are derived for determining ρ and the equivalent height respectively, and the accuracy of these formulae is confirmed by experimental results obtained on wavelengths from 200 to 2000 metres. The main conclusion reached is that the aerial cannot be called strictly aperiodic, since although its impedance remains constant and purely resistive throughout the whole frequency range, the induced e.m.f. varies approximately in inverse proportion to the wavelength. Possible applications of the aerial are discussed and it appears that it would be particularly useful in the case when a long transmission line has to be employed.

3564. ON THE ELECTRICAL BEHAVIOUR OF VERTICAL AERIALS IN RELATION TO THEIR DIAMETER [Measurements at 1.5–9 Mc/s on Models of Cylindrical (2 mm Wire and 30, 80, & 564 mm Tube) Aerials and Lattice Masts: Impedance at Base, Radiation Resistance: Effect of Different Shapes of Insulated Footing: etc.].—G. Rösseler, F. Vilbig, & K. Vogt. (*T.F.T.*, May 1939, Vol. 28, No. 5, pp. 170–178.)

From the authors' summary:—"The values obtained for the impedance and radiation resistance, referred to the base of the aerial, showed an apparent lengthening of the geometrical aerial height and a decrease of radiation resistance compared with the theoretical value. It is shown that for characteristic impedances down to 150 ohms and for electrical lengths up to $\lambda/4$ the radiative damping has no *influence on the current distribution along the aerial* [other writers have attributed the apparent lengthening of the geometrical height to this cause: *see* Schmidt, 1933 Abstracts, p. 160]. On the other hand, the behaviour of the aerials investigated can be explained completely by the capacity of the terminating plate at the top of the aerial and the phase-suppression due to the connecting lead [at the base of the aerial] to the measuring apparatus [for discussion of these points *see* p. 175 (last paragraphs) and p. 176]. The characteristic impedances can be calculated by a simple formula." Attention is drawn to the helpfulness of Abraham's paper on the natural oscillation of rod conductors (*Wied. Ann.*, 1898, Vol. 66, p. 435).

3565. ON THE THEORY OF THE RADIATING CYLINDRICAL CONDUCTOR [Derivation of Differential Equation with Variable Complex Coefficients (reducing to Greatly Simplified Form for Very Thin Conductor): Tables of Values of Coefficients: Some Deductions].—P. Baudoux. (*U.R.S.I. Proc. of* 1938 *Gen. Assembly*, Vol. 5, Fasc. 1, 1938, pp. 300–304: in French.) For the writer's book *see* 4352 of 1938.

3566. PHASE MONITOR FOR DIRECTIVE ANTENNA ARRAYS [giving Ratio and Relative Phase Angles of Currents in the Towers: embodying the Morrison "Multiple Sinusoidal" Condenser].—Western Electric: Morrison. (*Proc. Inst. Rad. Eng.*, June 1939, Vol. 27, No. 6, pp. iii..viii.) For Morrison's work on which the instrument is based *see* 118 of 1938.

3567. ON THE RECEIVING IMPEDANCE OF A RECEIVING ANTENNA: I—RADIATION RESISTANCE: II—REACTANCE AND ITS CURVES.—K. F. Niessen & G. de Vries. (*Physica*, July 1939, Vol. 6, No. 7, pp. 601–616 & 617–627: in German.)

Authors' summaries:—In this work the receiving impedance of a receiving aerial (*i.e.* the radiation impedance of the aerial considered as unloaded) is dealt with, for a current distribution such as occurs according to Korshenewsky [1930 Abstracts, pp. 159–160] on the assumption of a plane incident signal-wave with its electrical vector parallel to the aerial. In Fig. 4 the current distributions on some receiving aerials [of various lengths] are given, and in Fig. 5 those on some centre-fed transmitting aerials [Labus, 1933 Abstracts, p. 214]. In Fig. 6 these current distributions given by Korshenewsky and Labus respectively are superposed.

In Part I the receiving resistance of the receiving aerial is, in particular, worked out more completely as a function of the aerial length expressed in wavelengths. In Part II, for a receiving aerial of length $2l$ and cross-sectional radius ρ_0 the reactance X is calculated for the conditions laid down in Part I. The receiving resistance R (already found in I) and the reactance X are expressed in eqns. 25 and 26 in quotients ρ_0/λ and l/λ, where λ is the wavelength. R and X are related to the factor i_0 in the formula for the current amplitude at the middle of the aerial, $i_M = i_0\ (1 - \cos 2\pi l/\lambda)^2$, so that from eqns. 25a and 26a it is also possible to calculate the values R_M and X_M [suffix "M" represents the value at the middle of the aerial] related to i_M.

For a wire of diameter $2\rho_0 = 2.05$ mm acting as a receiving aerial, the full-line curves in Figs. 8 and 9 show R and X calculated from eqns. 25 and 26 as functions of $b = 2\pi l/\lambda$. For comparison, the analogous curves are added, in dotted lines, for the case where the same wire is used as a centre-fed transmitting aerial. These values of R and X calculated by Labus are related to the factor i_0 appearing in the formula $i_M = i_0 \sin 2\pi l/\lambda$.

3568. THE NOVEL AERIAL OF THE HERZBERG "DEUTSCHLANDSENDER."—(*See* 3793.)

3569. "INSTITUTE OF RADIO ENGINEERS STANDARD, 1938: TRANSMITTERS AND ANTENNAS" [Book Review].—I.R.E. (*Gen. Elec. Review*, June 1939, Vol. 42, No. 6, p. 285.)

3570. THE "DOUBLE PITCHFORK" ANTENNA: VARIABLE DIRECTIVITY WITH A FIXED ARRAY.—W. J. Breuer. (*QST*, July 1939, Vol. 23, No. 7, pp. 40–41.)

3571. CERTAIN PROPERTIES OF DISSYMMETRICAL T PURE REACTANCE NETWORKS.—Cafferata. (*See* 3509.)

3572. NEW COAXIAL TRANSMISSION LINE AT WTAM [Details].—W. S. Duttera. (*Electronics*, March 1939, Vol. 12, No. 3, pp. 30–32.) *See* also 2771 of July.

3573. THE LOCALISATION OF SMALL LEAKS IN THE UNDERGROUND TRANSMISSION-LINE SYSTEM AT COOLING RADIO STATION [16 Miles of Concentric-Tube Line connecting 16 Aerials to Receiving Station: by pumping Air smelling of Mercaptan into Line and using Trained Dog].—Hall, Lloyd, & Richards. (*P.O. Elec. Eng. Journ.*, July 1939, Vol. 32, Part 2, pp. 138–141.)

3574. VIBRATIONS OF CONDUCTORS OF ELECTRICAL ENERGY COVERED BY A LAYER OF HOAR FROST.—J. L'hermitte. (*Rev. Gén. de l'Élec.*, 22nd April 1939, Vol. 45, No. 16, pp. 516–518.)

VALVES AND THERMIONICS

3575. CATHODE-RAY AMPLIFIER TUBES: A REVIEW OF THE NEW BEAM-GROUP PRINCIPLE AND ITS SEVERAL APPLICATIONS [Rhumbatron & Klystron (Hansen & others, Stanford University), U-H-F Amplifier (Haeff, RCA Radiotron), and Velocity-Modulated Tubes of General Electric (Hahn & Metcalf)].—(*Electronics*, April 1939, Vol. 12, No. 4, pp. 9–11 and 76.)

"The earliest published reference to this principle [the basic principle common to the three devices] which the editors have been able to find is contained in a German publication" [Brüche & Recknagel, 2325 of 1938: no reference is made to the work of Arsenjewa-Heil & Heil, 3380 of 1935 and 2124 of 1936]. The "phase-focusing" dealt with in this German paper is outlined and the three devices considered in succession. For the various papers referred to *see* 1849 of May, 1901 of May, 2295 of June, and 63 of January (*also* 1848 of May).

3576. SMALL-SIGNAL THEORY OF VELOCITY-MODULATED ELECTRON BEAMS.—Hahn. (*See* 3521.)

3577. VALVES WITH DIRECTED ELECTRON PATHS AND SECONDARY-EMISSION VALVES ["Beam" Valves: the "Cyclotron" Valve: Secondary-Emission Valve (Miniwatt Dario) 4696 and Its Uses (Phase Opposition independent of Frequency): the EE 50 and Its Use in Television: Calculation of Over-All Amplification of Amplifier with 3 Mutually Detuned Stages].—R. Aschenbrenner. (*L'Onde Élec.*, June 1939, Vol. 18, No. 210, pp. 241–259.)

3578. NEW TYPE OF MAGNETRON FOR ULTRA-SHORT WAVES.—H. Chireix. (*U.R.S.I. Proc. of* 1938 *Gen. Assembly*, Vol. 5, Fasc. 1, 1938, pp. 323–324: in French.) These are the S.F.R. magnetrons dealt with in 2767 of 1938 (Gutton & Berline).

3579. MAGNETRONS FOR CENTIMETRIC WAVES.—L. A. Dudnik. (*Izvestiya Elektroprom. Slab. Toka*, No. 3, 1939, pp. 32–36.)

The oscillating circuit and the anode of a magnetron are normally made of molybdenum ribbon bent into a rectangular shape (Figs. 1, 2, 5, 6). The author has developed a new type of magnetron in which the oscillating circuit consists of two hemispherical copper cups to which are attached molybdenum ribbon anodes (Figs. 3, 4, 7, 8). It is claimed that a considerably higher frequency stability is obtained with the "spherical" magnetrons and that their natural wavelength is much shorter. It is also pointed out that the heat-dissipating surface of the spherical magnetron is 10 to 12 times greater than that of the "rectangular" type.

Formulae are quoted for calculating the natural wavelengths for both types of magnetrons, and tables are given showing the results of experiments on wavelengths from 6 to 13 cm. It can be seen from these tables that the formulae quoted gave sufficiently accurate results and that power outputs were obtained of 2 to 5 w for the rectangular magnetron and 0.5 w for the spherical type.

3580. INERTIA MEASUREMENTS OF THE DYNATRON EFFECT.—I. F. Pes'yatski. (*Journ. of Tech. Phys.* [in Russian], No. 3, Vol. 9, 1939, pp. 194–197.)

The effect of increasing the frequency of the primary current on the phase and amplitude of the secondary oscillations was investigated by observing the Lissajous curves on the screen of a cathode-ray oscillograph. Experiments were carried out with pure metal (silver and nickel), dielectric (NaCl), and composite (caesium-oxide) surfaces, at frequencies used for television. The main conclusion reached is that no inertia of the dynatron effect could be detected at these frequencies.

3581. TERMINOLOGY OF THE TECHNIQUE OF SECONDARY-ELECTRON MULTIPLIERS.—Herold. (*See* 3634.)

3582. THE SECONDARY ELECTRON EMISSION FROM THIN FILMS.—Pes'yatski. (*See* 3635.)

3583. SECONDARY EMISSION OF ELECTRONS FROM SODIUM FILMS CONTAMINATED BY GAS.—P. L. Copeland. (*Phys. Review*, 15th June 1939, Series 2, Vol. 55, No. 12, p. 1270.) Phenomenon for high primary energies similar to that for low primary energies dealt with in 3171 of August (Nelson). *See* also Copeland, 1980 of 1938.

3584. ELECTRON FIELD EMISSION OBTAINED FROM THE BOMBARDMENT OF ALUMINIUM OXIDE BY ELECTRONS OR NEGATIVE IONS: H^-, N^-, O^-, & O_2^- [Experimental Phenomena: Suggested Explanation].—A. Bojinesco. (*Comptes Rendus*, 5th June 1939, Vol. 208, No. 23, pp. 1800–1802.)

3585. RADIATION OF MATTER ACCOMPANYING ELECTRON BEAM EMISSION FROM INCANDESCENT CATHODES [Neutral Atoms emitted from Cathode acquire Negative Charge, are focused with Electron Beam and form Protective Layer on Metal Surface].—W. Reichelt. (*Physik. Zeitschr.*, 15th May 1939, Vol. 40, No. 10, p. 387.)

3586. FLUCTUATIONS OF THERMIONIC CURRENT AND THE "FLICKER EFFECT."—Surdin. (*Journ. de Phys. et le Radium*, April 1939, Series 7, Vol. 10, No. 4, pp. 188–189.)

"The object of the present work is to show that it is possible to attribute the fluctuations of thermionic current in the 'flicker effect' to the fluctuations of the number of free electrons in the metal, and to connect them with the fluctuations of resistance discovered and studied by Bernamont" [1715 of 1937]. The writer concludes his paper by saying: "the above study allows us to foresee, in view of the similarity between the phenomena, an effect in photoelectric emission analogous to the 'flicker effect'. A fundamental verification of what precedes is to be looked for in the experimental identification of the constants α_1 and α_2 for the two effects, that of Bernamont and the 'flicker' effect."

3587. THE DIAGRAMS OF VOLT/AMPERE CHARACTERISTICS OF TRANSMITTING VALVES, *and* ON THE SO-CALLED "SATURATION" CURRENT IN TRANSMITTING VALVES WITH INCANDESCENT CATHODES [Papers bearing on the Gossling Method of Extrapolation from Reduced-Emission Results].—R. Warnecke. (*Bull. de la Soc. Franç. Radioélec.*, 2nd Quarter 1939, Vol. 13, No. 2, pp. 41–44: pp. 45–62.)

"The method of obtaining the emission from the simplified Richardson equation is shown. The necessity of introducing, as base values, those obtained by the Schottky straight lines (*i.e.* the values for zero field) is indicated. The explanation of the upper bend of the saturation characteristic is developed from the mechanism proposed by Gossling. The importance of the difference which exists between the emission current defined as a function of the temperature only and the current corresponding to the flattening of the characteristic —function of the configuration and of the applied potentials—is mentioned." For the I.E.E. paper in which the reduced-emission method is mentioned, *see* 3962 of 1938.

3588. DIRECT OSCILLOGRAPH RECORDING OF THE VOLT/AMPERE CHARACTERISTICS OF TRANSMITTING VALVES [Short-Time Method using 3-Thyratron Combination to give Short "Active Times" (not exceeding 1/100th Second): Objections raised for Oxide Cathodes found to be Invalid].—M. Boissinot. (*Bull. de la Soc. Franç. Radioélec.*, 2nd Quarter 1939, Vol. 13, No. 2, pp. 63–73.)

3589. CIRCLE DIAGRAMS FOR TUBE CIRCUITS [for Voltage Gain: Minimum Gain Locus: Power Output: Maximum Power Locus: Maximum Undistorted Power Locus: Phase-Shift Curves].—A. A. Nims. (*Electronics*, May 1939, Vol. 12, No. 5, pp. 23–26.)

3590. AMPLIFICATION FACTOR CHART [for determining μ for a Receiving Valve from Its Geometrical Construction, by a Graphical Solution of the Vodges (Vogdes ?)- Elder Formulae].—E. R. Jervis. (*Electronics*, June 1939, Vol. 12, No. 6, pp. 45–46.)

3591. [Receiver] CIRCUIT DESIGN RELATED TO TUBE PERFORMANCE.—Hollands. (*See* 3547.)

3592. THE PERMATRON—A MAGNETICALLY CONTROLLED INDUSTRIAL TUBE.—Overbeck. (*See* 3769.)

3593. THE PERMATRON AND ITS APPLICATION IN INDUSTRY.—Overbeck: Spencer. (*See* 3818.)

DIRECTIONAL WIRELESS

3594. CORRECTION TO PAGINATION OF THE PAPER "THE MEASUREMENT OF DISTANCES BY MEANS OF ULTRA-SHORT WAVES (WIRELESS RANGE FINDING)."—U. Tiberio. (*Alta Frequenza*, June 1939, Vol. 8, No. 6, Inset to replace pp. 307–310, of which 308 & 309 were transposed in the May issue.) *See* 3175 of August.

3595. "KLYSTRON" ULTRA-HIGH-FREQUENCY GENERATOR APPLIED TO BLIND LANDING BEAMS (HORN PROJECTOR).—(*Inter Avia*, 31st March 1939, pp. 2–3.)

3596. TELEVISION APPLIED TO BLIND LANDING BY THE R.C.A.—(*Inter Avia*, 31st March 1939, p. 1.)

3597. IMPROVEMENTS IN THE LORENZ BLIND LANDING SYSTEM [Entirely Straight-Line Approach Path down to Ground: etc.].—(*Inter Avia*, 28th April 1939, p. 7.)

3598. BLIND GUIDING AND LANDING-BEAM ARRANGEMENTS, S.F.R. SYSTEM: INSTALLATION OF TOULOUSE-FRANCAZALS.—R. Girerd. (*Bull. de la Soc. Franç. Radioélec.*, 1st Quarter 1939, Vol. 13, No. 1, pp. 23–30.)

ACOUSTICS AND AUDIO-FREQUENCIES

3599. A SYNTHETIC SPEAKER [Electrical Device for Production of Synthetic Vocal Sounds and Their Combination into Speech: Development: Training of Operators].—H. Dudley, R. R. Riesz, & S. S. A. Watkins. (*Journ. Franklin Inst.*, June 1939, Vol. 227, No. 6, pp. 739–764.) For previous papers on "Pedro the Voder" *see* 1495 of April.

3600. "LINE" MICROPHONES [Directive Microphones consisting of Large Number of Small Tubes all connected to Large Pipe containing Ribbon Element terminated by Acoustic Resistance equal to Combined Surge Resistance of Small Tubes: Various Types, including an Ultra-Directional Microphone with Uniform Directional Characteristics over 85–8000 c/s Range].—H. F. Olson. (*Proc. Inst. Rad. Eng.*, July 1939, Vol. 27, No. 7, pp. 438–446.) *Cf.* the "machine gun" microphone (1518 of April).

3601. HIGH-FIDELITY MICROPHONES [Various Special Types: Methods of Improving the Response Characteristics: etc.].—C. Crescini. (*Bollettino del Centro Volpi di Elettrologia*, English Edition, July/Sept. 1938, Year 1, No. 3, p. 85d: summary only.)

3602. THE THERMAL-AGITATION BACKGROUND NOISE OF MICROPHONES [Electrostatic & Moving Coil Types: Derivation of Formulae: Noise completely Negligible in Former Type, Audible and Measurable in Second].—Y. Rocard. (*Bull. de la Soc. Franç. Radioélec.*, 4th Quarter 1938, Vol. 12, No. 4, pp. 95–99: in French & English concurrently.)

3603. THE MICROPHONE/LOUDSPEAKER TRANSDUCER IN RADIO BROADCASTING [Examination of Quality of Reproduction through Whole System from Studio to Home].—F. Marietti. (*L'Elettrotec.*, Nos. 5 & 6, Vol. 26, 1939, pp. 242–248 & 263–266.)

3604. SOME REMARKS ON THE GENERALISED GROUP OF BESSEL LOUDSPEAKER HORNS.—V. V. Furduev. (*Journ. of Tech. Phys.* [in Russian], No. 2, Vol. 9, 1939, pp. 165–167.)

It was Ballantine who first suggested that a general equation of the type $S = S_0 x^m$ could be used for describing a loudspeaker horn whose cross-section is varying in accordance with a power series (Bessel horns). A modified form (3) of the general equation was proposed by Stenzel. Hanna, and later Stenzel, showed that the exponential horn also belongs to the Bessel group and can be regarded as a limiting case for this group. In the present paper the fact that the exponential horn belongs to the Bessel group is demonstrated in a different manner and it is also shown that the range of the Bessel group can be extended beyond the exponential horn to include, for example, the hyperbolic type of loudspeaker.

3605. HIGH-POWER LOUDSPEAKERS.—C. Borsarelli. (*Bollettino del Centro Volpi di Elettrologia*, English Edition, July/Sept. 1938, Year 1, No. 3, p. 89d: summary only.)

3606. MECHANICAL AND VIBRATIONAL PROPERTIES OF MOVING-COIL LOUDSPEAKER CONES, *and* EXPERIMENTS ON THE TRANSIENT PHENOMENA IN MOVING-COIL LOUDSPEAKERS.—A. Manfredi: R. Rago. (*Bollettino del Centro Volpi di Elettrologia*, English Edition, July/Sept. 1938, Year 1, No. 3, p. 87d: p. 87d: summaries only.)

3607. Mechanical Distortions of Vibrating Systems in a Resisting Medium, with Reference to Loudspeakers.—G. Rutelli. (*Bollettino del Centro Volpi di Elettrologia*, English Edition, July/Sept. 1938, Year 1, No. 3, p. 89d: summary only.)

3608. The Corbino Method of Calibrating Electrostatic Microphones applied to Electrodynamic Loudspeakers.—M. Santoro. (*Bollettino del Centro Volpi di Elettrologia*, English Edition, July/Sept. 1938, Year 1, No. 3, p. 85d: summary only.)

3609. An Automatic Audio-Frequency Response Recorder and Some of Its Applications [for Loudspeaker Testing].—B. Olney. (*Proc. Inst. Rad. Eng.*, July 1939, Vol. 27, No. 7, pp. 480–481: summary only.)

3610. A Method of Determining the Sense of Small Phase Differences [in Note Frequencies: for Time Differences down to $\pm 3 \times 10^{-7}$ Second in Frequency Range 40–8000 c/s].—H. Sattler: Opitz. (*Zeitschr. f. tech. Phys.*, No. 7, Vol. 20, 1939, pp. 212–213.)

Opitz's method (3100 of 1937) of measuring phase differences between otherwise similar alternating voltages, by converting them, with an amplitude filter, into square-wave voltages and making these act in a differential manner on a thermoelement, gives the amount but not the sense of the phase difference. The present paper describes a development of this method which fills this gap: the sense is indicated either by the different behaviour of two milliammeters, or by the use of two small glow-discharge lamps, the one in the phase-leading branch of the circuit remaining dark while that in the lagging branch lights up.

3611. The Sound Source with Resonant Chamber, and the Acoustical Correction of Radio Receivers, *and* Acoustical Measurements of Linearity in Radio Receivers. — Faggiani: Santoro. (*See* 3544.)

3612. Non-Linear Distortion of Music Channels, with Particular Reference to the Bristol/Plymouth System [including Measurement by Combination-Tone Method, Correlation of Measurement & Judgment, etc.].—R. E. Jones. (*P.O. Elec. Eng. Journ.*, April 1939, Vol. 32, Part 1, pp. 45–51.)

3613. The Reduction of Crosstalk on Trunk Circuits, by the Use of the Volume Range Compresser and Expander.—J. Lawton. (*P.O. Elec. Eng. Journ.*, April 1939, Vol. 32, Part 1, pp. 32–38.)

3614. Non-Linear Acoustics of Sound Waves of Finite Amplitude.—E. Fubini-Ghiron. (*Bollettino del Centro Volpi di Elettrologia*, English Edition, July/Sept. 1938, Year 1, No. 3, p. 59d: summary only.) For previous work *see* 1502 of 1938 and back references.

3615. Ohm's Fundamental Acoustical Law and the New Views on the Sound Analysis by the Ear.—F. Trendelenburg. (*E.T.Z.*, 13th April 1939, Vol. 60, No. 15, pp. 449–452.)

3616. CBS Hollywood Studios [Columbia Network's West-Coast Headquarters and Home of Station KNX: including New Constructional Features].—H. A. Chinn & R. A. Bradley. (*Proc. Inst. Rad. Eng.*, July 1939, Vol. 27, No. 7, pp. 421–428.)

3617. NBC, Hollywood [Studio Plant].—C. A. Rackey & R. F. Shuetz. (*Electronics*, May 1939, Vol. 12, No. 5, pp. 11–14 and 73..75.)

3618. The Problem of Sound in Large Halls [and a Method of Calculating the Limits of Average Absorption to give Good Acoustics in Any Closed Room].—S. Mollica. (*Bollettino del Centro Volpi di Elettrologia*, English Edition, Dec. 1938, Year 1, No. 4, p. 67d: summary only.)

3619. On the Physical Interpretation of the Damping Factor in the Formula for the Calculation of the Time of Acoustic Reverberation.—A. Bargone. (*Bollettino del Centro Volpi di Elettrologia*, English Edition, Dec. 1938, Year 1, No. 4, p. 67d: summary only.) "In this [new] formula the value of the constant [0.0331] is greatly superior to that given by Sabine, but in experiments it appears much more accurate."

3620. On the Neutral Tones of Rooms with Uneven Walls, and the Diffuse Reflection of Sound [Experiments at Supersonic Frequencies on Tubes representing Various Irregularly Shaped Rooms, and on Diffuse Reflection from Rough Surfaces—Establishment of Law analogous to Lambert's Law in Optics].—E. Skudrzyk. (*Akust. Zeitschr.*, May 1939, Vol. 4, No. 3, pp. 172–186.)

3621. Mechanical-Electrical Negative-Feedback System for Valve Voltmeters with Logarithmic Indication.—Keidel. (*See* 3698.)

3622. Recent Improvements in the Measurement of Sound [particularly an Electrostatic Microphone (connected to Calibrated Amplifier) which is Very Small and almost Perfectly Linear to 10 000 c/s: Velocity Vibrometers: etc.].—M. Vecellio & U. Brusaferro. (*Bollettino del Centro Volpi di Elettrologia*, English Edition, July/Sept. 1938, Year 1, No. 3, p. 73d: summary only.)

3623. "Institute of Radio Engineers Standards, 1938: Electroacoustics" [Book Review].—I.R.E. (*Gen. Elec. Review*, June 1939, Vol. 42, No. 6, p. 285.)

3624. The Frequency Range of the Output Transformer, *and* On the Application Possibilities of the Universal Output Transformer: Supplementary Remark. —Pitsch: Pitsch, Wünsch. (*See* 3518 & 3553.)

PHOTOTELEGRAPHY AND TELEVISION

3625. Electron Distribution in Electron-Optically Focused Electron Beams [Experimental Method for Study of Fine Structure of Electron Image: Importance in Connection with Television Scanning Systems].—L. Jacob. (*Phil. Mag.*, July 1939, Series 7, Vol. 28, No. 186, pp. 81–98.)

A demountable tube (Fig. 1) with Faraday cages with accurately cut slits at right angles, and associated apparatus (circuit Fig. 4), is used to determine the electron distribution in a focused beam. The relation between electron distribution and spot size is found; the former is found to follow a Gaussian law while "the image size decreases with decreasing modulation and with increase in first accelerator voltage" [Figs. 8–10]. "A variation of 5% in focus voltage can increase the image size in the ratio of 2/1." The effect of variation of cathode temperature, the current density in the image, and the error due to the slit width are also investigated.

3626. Measurement of the Charge Distribution in a Cathode Ray [Experimental Investigation primarily in Connection with the Scanning Rays for Television Pick-up Tubes]. —W. Reusse. (*T.F.T.*, May 1939, Vol. 28, No. 5, pp. 184–187.)

In the first arrangement used, the cathode ray (represented in cross section by S) is deflected to-and-fro by a sinusoidal voltage applied to the deflecting plates P_1 & P_2 (Fig. 2). In this motion it passes over a stretched insulated wire D of diameter (0.05 mm) small compared with that of the ray; this wire is led out to a d.c. amplifier whose input stage is an electrometer valve with a grid leak W. A suitable deflection frequency is 25 c/s for a wire capacity of 10 pF and a W of 25 megohms. The amplifier output is taken to one pair of plates of an oscillograph, the other pair being supplied with the same sinusoidal deflecting voltage (of different amplitude but as nearly as possible of the same phase). This arrangement gives curves of the type Fig. 3, but more convenient results are obtained by adding a second stretched wire connected in parallel to form the pair seen in Fig. 4, giving oscillograms of the double type of Fig. 5. The way in which the charge distribution is deduced from such oscillograms, by comparison with graphically derived or calculated "ideal" curves for various ray diameters, is described on p. 186, where it is also pointed out that the arrangement may be used to measure secondary-emission coefficients, the stretched wires being then replaced by a narrow strip of the material. Actually, the secondary emission from the wires, when the apparatus is used for its original purpose, is liable to produce errors: the wires are therefore surrounded by a screening cage at such a voltage that the secondary electrons are led back to the wires.

Preliminary results indicate that attempts to deduce the charge distribution in an electron beam by observations of the spot produced by the beam on a fluorescent screen lead to wrong results; thus Fig. 9 shows the true ray cross section as a function of the ray current, obtained with the method here described, while Fig. 10 shows the erroneous idea given by spot observations.

3627. On the Present Position of the Problem of Post-Deflection Acceleration in Cathode-Ray Tubes.—E. Schwartz. (*Zeitschr. der Fernseh A.G.*, Dec. 1938, Vol. 1, No. 2, pp. 19–23.)

"Through the recently published paper by Bigalke [226 of January and back reference] interest has been directed afresh onto the problem of post-acceleration. It therefore seems desirable to give some hitherto unpublished observations by the present writer." His previous paper (3131 & 3551 of 1935) gave a survey of the various suggested methods, with literature references. To be added now is the arrangement described by Bigalke. Altogether there are three groups: the first includes the accelerating gratings of Scheller (1920 German Patent: an accelerating field is built up close to the screen by parallel gratings), and Bigalke's accelerating lens with its conducting rings (on the tube wall) also near the screen: the second group is represented by the writer's spiral accelerating resistance covering the whole length between deflecting system and screen. The remaining methods have not yet been carried out experimentally: they are based on theoretical consideration of the action of an electrical "double layer" (SS_1 in Fig. 1a) near the deflecting system: the focusing lens must be such that without the accelerating action of the "double layer" the spot focus would lie well short of the screen, at B'', so that the accelerating action may bring the spot onto the screen (with a smaller diameter than it would otherwise have).

Author's summary:—"While arrangements of the type of the Schiller grating increase the resolving power only linearly with U_1/U_0, an additional increase can be obtained by post-accelerating fields in the neighbourhood of the deflecting plates. In the case of a spherical 'double layer' close to the deflecting plates, the resolving power increases with $(U_1/U_0)^{5/2}$." The development of practical devices to give such double-layer effects would therefore lead to important improvements in post-deflection acceleration.

3628. The Deflection of the Electron Ray in the Cathode-Ray Tube by Magnetic Fields produced by Coils.—H. Bähring. (*Zeitschr. der Fernseh A.G.*, Dec. 1938, Vol. 1, No. 2, pp. 15–19.)

Author's summary:—For cathode-ray tubes with parallel-conductor deflecting systems the approximate formula here derived, $A = 0.24\ (i.n)\ .\ a/b^2\ .\ l_A\ .\ l\ .\ \sqrt{1/U}$ gives, in a simple form, the relation between the deflection amplitude A, the ampere turns of the deflecting coil $i.n$, the coil width l_A [that is, the length of the electron path through the deflecting field—*see* Fig. 1], the diagonal distance b between the longitudinal conductors of the two coils [*see* Fig. 2], the projected "pointer length" l [that is, the length of the ray in the field-free space between the screen and the deflecting field, plus half the length of the latter: $l = l_Z + l_A/2$ in Fig. 1], and the anode voltage U. Thus the constructor is provided with a useful formula for the design of cathode-ray tubes and the necessary time-base units.

3629. THE PRODUCTION OF X-RAYS BY CATHODE-RAY TUBES [Measurements on Television Projecting Tubes: for Voltages over 20 kV, Protection is Necessary: Calculation of Lead Thicknesses: Data on Absorbing Powers of Materials used in Television Receivers].—H. W. Paehr. (*Zeitschr. der Fernseh A.G.*, Dec. 1938, Vol. 1, No. 2, pp. 23–27.) *Cf.* Bode & Glöde, 2487 of June.

3630. LUMINISCENCE AND PHOTOCONDUCTIVITY OF SOLIDS [Direct Evidence of Existence of Excitation States in Uranyl Salts, Tungstates, and Compounds Activated by Manganese].—J. T. Randall & M. H. F. Wilkins. (*Nature*, 10th June 1939, Vol. 143, pp. 978–979.)

3631. THE PHOTOELECTRIC EFFECT AND THE PHOTOCONDUCTIVITY OF PHOSPHORESCENT SULPHIDES [CaS, ZnS] AND OF FLUORIDES [CaF_2: Disappearance of Photoeffects on Desiccation of Salts].—E. Voyatzakis. (*Comptes Rendus*, 3rd July 1939, Vol. 209, No. 1, pp. 31–33).

3632. THE FORMATION OF COLOUR CENTRES IN KI-CRYSTALS [Measurement of Heat of Solution: Linear Connection between Colour Centre Concentration and Vapour Pressure of Metal in External Space].—R. Vossnack. (*Ann. der Physik*, Series 5, No. 2, Vol. 35, 1939, pp. 107–117.) For similar work on other crystals *see* 3405 of 1937 (Rögener & others).

3633. THE USE OF ZINC-BLENDE RELAY SCREENS IN STORAGE-TYPE PROJECTING RECEIVERS WITH CATHODE-RAY TUBES.—M. von Ardenne. (*T.F.T.*, May 1939, Vol. 28, No. 5, pp. 180–184.) Description of the experimental work on which was based the paper dealt with in 1063 of March (*see* also 2432 of June).

3634. TERMINOLOGY OF THE TECHNIQUE OF SECONDARY-ELECTRON MULTIPLIERS [and Suggested Symbols: including Discussion of the Difference between the "Pure" Secondary-Emission Factor and the "Gain" (or "Yield") Factor (Ausbeutefaktor) which includes the Elastically Reflected Primary Electrons in addition to the True Secondary Electrons].—O. Herold. (*T.F.T.*, May 1939, Vol. 28, No. 5, pp. 178–180.)

3635. THE SECONDARY ELECTRON EMISSION FROM THIN FILMS.—I. F. Pes'yatski. (*Journ. of Tech. Phys.* [in Russian], No. 3, Vol. 9, 1939, pp. 188–193.)

The object of this investigation was to study the secondary electron emission from very thin pure metal films of the order of 10^{-6} cm from the side opposite to that subjected to electron bombardment. The maximum depth within a film at which secondary emission can take place was also determined. Experiments were conducted with pure silver films, and apparatus developed for this purpose, as well as the technique employed, is described in detail. Of particular interest is the method used for obtaining free silver films 40 to 50 atomic layers thick. The results obtained are shown in a number of curves and tables.

3636. A NEW TELEVISION PICK-UP TUBE ["Orthiconoscope" or "Orthicon"].—A. Rose & H. Iams. (*Proc. Inst. Rad. Eng.*, July 1939, Vol. 27, No. 7, p. 479: summary only.)

"Analysis of the operation of the iconoscope suggests that improved efficiency and freedom from spurious signals should result from operating the mosaic at the potential of the thermionic cathode, rather than near anode voltage. The beam electrons then approach the target with low velocity . . ." The new pick-up was developed on these lines.

3637. SOME ASPECTS OF THE PROPAGATION OF ULTRA-SHORT WAVES [particularly the Effects of the Electrical Properties of the Earth, and Their Measurement: with a Discussion including a Variety of Points].—R. L. Smith-Rose. (*Journ. of Television Soc.*, [dated] Dec. 1938, Series 2, Vol. 2, Part 12, pp. 475–488.)

3638. NOTE ON THE RESISTANCE NOISE IN A COAXIAL PAIR [including Simple Formula useful for Predicting the Limit of Noise Reduction].—H. J. Josephs. (*P.O. Elec. Eng. Journ.*, April 1939, Vol. 32, Part 1, pp. 61–62.)

3639. ANALYSIS OF LOAD-IMPEDANCE MODULATION [Advantages Claimed are countered by Disadvantages: Efficiency is substantially Same as That of Grid-Bias Modulation, and Band-Width is Not materially Greater: etc.].—H. Roder: Parker. (*Proc. Inst. Rad. Eng.*, June 1939, Vol. 27, No. 6, pp. 386–395.) *See* 4447 of 1938.

3640. TELEVISION TRANSMISSION TECHNIQUE: VI—CARRIER-FREQUENCY IMAGE-MODULATION [Choice of Carrier-Frequency: Modulation Circuits: Multi-Stage Modulation, Frequency-Transposition].—F. Ring. (*Funktech. Monatshefte*, May 1939, No. 5, Supp. pp. 37–39.) For previous parts *see* 3674 of 1938 and 2427 of June.

3641. WIDE-BAND AMPLIFIERS FOR TELEVISION.—H. A. Wheeler. (*Proc. Inst. Rad. Eng.*, July 1939, Vol. 27, No. 7, pp. 429–439.) A summary was dealt with in 3700 of 1938.

3642. THE INTERPRETATION OF AMPLITUDE AND PHASE DISTORTION IN TERMS OF "PAIRED ECHOES" [in Television & Facsimile Systems: a Simplified Application of Fourier Integral, useful in Interpretation of Phase Curves and Determination of Tolerance of Distortion (in Terms of "Weighted Distortion")].—H. A. Wheeler. (*Proc. Inst. Rad. Eng.*, June 1939, Vol. 27, No. 6, pp. 359–385.)

3643. SINGLE-SIDEBAND FILTER THEORY WITH TELEVISION APPLICATIONS.—Hollywood. (*See* 3511.)

3644. On the Possibility of recording Images in a Shorter Time than by Photography [Potassium Photocathodes prepared to stand Accelerating Voltages up to 48 000 V without Parasitic Emission: the High-Energy Photoelectrons produce Image on Photographic Plate].—A. Lallemand. (*Journ. de Phys. et le Radium*, June 1939, Series 7, Vol. 10, No. 6, pp. 94 S–95 S.) *See* also 2872 of July.

3645. The Optical Properties of Very Thin Potassium Films [Measurements: Position of Selective Reflection and Absorption Maxima].—D. Hacman. (*Comptes Rendus*, 19th June 1939, Vol. 208, No. 25, pp. 1982–1984.)

3646. Optical and Photoelectric Properties of Potassium at Liquid-Air Temperatures. —D. M. Packer. (*Phys. Review*, 1st June 1939, Series 2, Vol. 55, No. 11, p. 1121: abstract only.)

3647. An Automatic Spectral-Sensitivity Curve Tracer [Complete Curve for a Photosensitive Surface can be drawn in 30 Seconds].—T. B. Perkins. (*Journ. Opt. Soc. Am.*, June 1939, Vol. 29, No. 6, pp. 226–234.)

3648. On the Photoelectric Effect of the Deuteron.—L. Eisenbud. (*Phys. Review*, 1st June 1939, Series 2, Vol. 55, No. 11, p. 1129: abstract only.)

3649. Study of Semiconductors in a Variable Régime: I—Building-Up Régime for a Continuous Current in a Semiconductor: II—Case of an Alternating Current: Conclusions.—G. Déchêne. (*Journ. de Phys. et le Radium*, March & April 1939, Series 7, Vol. 10, Nos. 3 & 4, pp. 124–133 & 195–199.)

Experimental investigation, using a cathode-ray oscillograph. Author's summary to Part II:—"In Part I the building-up regime of a continuous current in a semiconductor was studied and the results explained by comparing the surface of separation between a metal and a semiconductor to a condenser shunted by a resistance of contact. When a semiconductor is submitted to an alternating voltage the current, on account of the existence of contact capacities, leads the voltage by a phase angle ϕ. Experimental measurement of ϕ (by a cathode-ray oscillograph) has permitted the values of the contact capacities to be calculated; the results agree with those obtained with continuous current. The principal conclusion derived from these measurements is that the rapid variation of potential at the metal/semiconductor contact extends into the substance the more deeply, the higher the resistivity; it is deduced that the hypothesis, which has become classic, of an insulating layer separating the two media (barrier layer) cannot satisfactorily interpret the properties of the contact" [though the writer admits that an insulating layer may form at the surface of certain semiconductors. The hypothesis of Joffé & Frenkel (*e.g.*, 1932 Abstracts, p. 290), of a thin space between metal and semiconductor, has been condemned as contradicting experimental results, but the writer's conclusions, that the greater part of the potential drop at the contact occurs in the semiconductor itself, removes this objection to the hypothesis].

3650. The Effect of X-rays on Semiconducting Sb_2S_3, SiC, and PbS Crystals.—A. Kronhaus. (*Journ. of Tech. Phys.* [in Russian], No. 3, Vol. 9, 1939, pp. 202–204.) X-rays produce a photo-effect in SiC and Sb_2S_3 crystals, and an increase in conductivity in all three types. A number of experimental curves are shown.

3651. On the Direct Measurement of the Energy of the Photoelectrons in the Barrier Layer of Selenium Cells.—G. Liandrat: Schweickert. (*Journ. de Phys. et le Radium*, March 1939, Series 7, Vol. 10, No. 3, pp. 50 S–52 S.) Replies to criticisms (*see* Schweickert, 4047 of 1938).

3652. Properties of Type II Photronic Cells affecting Photometric Measurement.—H. S. Stewart & B. O'Brien. (*Phys. Review*, 1st June 1939, Series 2, Vol. 55, No. 11, p. 1121: abstract only.)

3653. Electro-Optical Constants of Polar Liquids [Calculation on Two Hypotheses].—N. Dallaporta. (*Bollettino del Centro Volpi di Elettrologia*, English Edition, Oct./Dec. 1938, Year 1, No. 4, p. 99d: summary only.)

3654. The Lens-Raster Screen [as the "Ideal" Television Screen: Defects of Other Types ("Crystal Pearl", Curved Ground-Glass Mirror, etc.): Elements of the Lens-Raster Screen: Image Errors: Necessary Optical Accuracy of the Element: Preparation of the Lens-Raster: the Lens-Raster Concave-Mirror Screen].—R. Möller. (*Zeitschr. der Fernseh A.G.*, April 1939, Vol. 1, No. 3, pp. 72–81.)

3655. The Optical System of the Scophony Television Receivers.—D. M. Robinson. (*Journ. of Television Soc.*, [dated] Dec. 1938, Series 2, Vol. 2, Part 12, pp. 469–473: Discussion pp. 473–474.)

3656. Testing and Tuning of Television Receivers.—B. S. Mishin. (*Izvestiya Elektroprom. Slab. Toka*, Nos. 3 & 5, 1939, pp. 36–43 & 24–32.) Methods are discussed in detail for testing and adjusting the power-supply rectifiers, scanning and synchronising devices, and receiving circuits of the type TK-1 television receiver (3703 of 1938).

3657. Television Receivers in Production [on sale in New York City from 1st May: Typical Designs].—(*Electronics*, March 1939, Vol. 12, No. 3, pp. 23–25 and 78..81.)

3658. Power for Television Receivers [also, Modifications of Receiver Circuits to fit in with Recent Modifications in Transmission Standards arising from Attenuation of One Picture-Sideband].—Engstrom & Holmes. (*Electronics*, April 1939, Vol. 12, No. 4, pp. 22–24.)

3659. VIEWPOINTS FOR THE DESIGN OF HOME [Television] RECEIVERS.—F. Rudert. (*Funktech. Monatshefte*, May 1939, No. 5, Supp. pp. 33–36.)

3660. DATA ON TELEVISION RECEIVERS AT RADIOLYMPIA, 1938.—(*Journ. of Television Soc.*, [dated] Dec. 1938, Series 2, Vol. 2, Part 12, pp. 465–468.)

3661. THE FERNSEH SMALL RECEIVER DE 7 [with 28 cm Screen, Tube Length 35 cm].—F. Rudert. (*Zeitschr. der Fernseh A.G.*, Dec. 1938, Vol. 1, No. 2, pp. 1–5.)

3662. TELEVISION TRANSMITTERS [High-Definition Stations in U.S.A: including DuMont Comparative Tests of RMA Proposed Standards and the DuMont Scanning-Wave-Transmission Method].—(*Electronics*, March 1939, Vol. 12, No. 3, pp. 26–29 and 47.)

3663. TELEVISION IN THE FIELD [Short Report on One Month of Public Television Service in New York: Problems and Accomplishments].—(*Electronics*, June 1939, Vol. 12, No. 6, pp. 13–15 and 90 .. 92.)

3664. TELEVISION COMPONENTS [Tubes, Coils, Transformers, etc., specially made for Television Receivers and Kit Sets by Various Manufacturers].—(*Electronics*, May 1939, Vol. 12, No. 5, pp. 18–22 and 60.)

3665. ENGLISH AND CONTINENTAL TELEVISION [Outstanding Exhibits at Berlin Radio Exhibition and Radiolympia compared].—E. H. Traub. (*Journ. of Television Soc.*, [dated] Dec. 1938, Series 2, Vol. 2, Part 12, pp. 457–464, including long Discussion.)

3666. UNIVERSAL MECHANICAL SCANNER FOR TRANSMISSIONS OF PERSONS, FILMS, AND DIAPOSITIVES [as shown at 1938 Berlin Exhibition].—K. Thöm. (*Zeitschr. der Fernseh A.G.*, Dec. 1938, Vol. 1, No. 2, pp. 6–12.)

3667. THE INTERMEDIATE-FILM PROCESS [Total Time 85 Seconds: can be Reduced by Use of Special Pre-Treatment of Film, by Combined Developing & Fixing, or by Alcohol-Drying].—G. Schubert, W. Dillenburger, & H. Zschau. (*Zeitschr. der Fernseh A.G.*, April 1939, Vol. 1, No. 3, pp. 65–72.)

3668. THE GENERAL PROBLEM OF TELEVISION, AND ITS ACTUAL POSITION IN FRANCE, *and* THE INSTALLATION OF THE TRANSMITTING AERIAL OF THE EIFFEL TOWER.—Mallein: Rabuteau. (*Rev. Gén. de l'Élec.*, 1st July 1939, Vol. 45, No. 26, p. 849: pp. 849–850: summaries only.)

3669. THE MONTROUGE EXPERIMENTAL TELEVISION CENTRE.—R. Barthélémy. (*Rev. Gén. de l'Élec.*, 22nd April 1939, Vol. 45, No. 16, pp. 503–516.)

3670. THE PURDUE UNIVERSITY EXPERIMENTAL TELEVISION SYSTEM [2050 kc/s Transmitter with 1000 W Output: 60-Line Progressive Scanning: Good & Consistent Reception beyond 500 Miles quite Common during Winter].—C. F. Harding, R. H. George, & H. J. Heim. (*Research Series No.* 65, *Purdue University*, Lafayette, Indiana, March 1939, 53 pp.)

3671. A TELEVISION FORMULARY [Definitions, Equations, etc.].—D. G. Fink. (*Electronics*, March 1939, Vol. 12, No. 3, pp. 33–35.)

3672. TELEVISION APPLIED TO BLIND LANDING BY THE R.C.A.—(*Inter Avia*, 31st March 1939, No. 631, p 1.)

3673. TELESURGERY [Television between Operating Table and Lecture Auditorium].—(*Electronics*, April 1939, Vol. 12, No. 4, p. 8: photographs & caption only.)

3674. A SYSTEM OF TRANSMISSION TO A DISTANCE OF PHOTOGRAPHIC IMAGES IN COLOURS [Reproduction of Tricca's Article on his 1913 Patent].—A. Tricca. (*Radio e Televisione*, May 1939, Vol. 3, No. 6, pp. 374–377.)

3675. FACSIMILE BROADCASTING [of Morning Newspaper] IN CALIFORNIA.—McClatchy Newspapers. (*Elec. Engineering*, May 1939, Vol. 58, No. 5, p. 201.)

MEASUREMENTS AND STANDARDS

3676. WAVE PROPAGATION ALONG WIRES [Correct and Exact Form of Equations for Attenuation and Wavelength along Lecher System].—J. Placinteanu. (*Comptes Rendus*, 12th June 1939, Vol. 208, No. 24, pp. 1890–1891.)

3677. RESISTANCE MEASUREMENT WITH THE LECHER-WIRE SYSTEM [Theory and Experimental Investigation on Wavelengths around 2 m: Discussion of Possible Causes of Error (Natural Damping of Lecher Wires: Influence of Potential-Measuring Device: Irregularities in the Wires): etc.].—A. Klemt. (*Funktech. Monatshefte*, May 1939, No. 5, pp. 129–133.)

3678. A HIGH-FREQUENCY WAVEMETER [Handle & Scale at End of 16-Inch Insulating Spindle, and Use of Low-Impedance Thermocouple, gives Practical Wavemeter for 50–360 Mc/s Range].—H. R. Meahl. (*Gen. Elec. Review*, June 1939, Vol. 42, No. 6, p. 279.) For the special thermocouple *see* 2882 of July.

3679. A COMPACT, SENSITIVE WAVEMETER [for Ultra-Short Waves: Fixed-Contact Crystal (with Microammeter) in Circuit coupled Inductively to Resonant Circuit, thus keeping Resistance of Latter down to Minimum].—B. W. Brown. (*Review Scient. Instr.*, June 1939, Vol. 10, No. 6, p. 196.)

3680. FREQUENCY INVESTIGATIONS ON DECIMETRIC-WAVE TRANSMITTERS BY MEANS OF A CRYSTAL DETECTOR [and Double Frequency-Transformation].—H. Schmidt. (*Zeitschr. der Fernseh A.G.*, Dec. 1938, Vol. 1, No. 2, pp. 12–15.)

Author's summary :—A process is described for frequency investigation with decimetric waves, in which the formation of an intermediate frequency of some megacycles per second allows any changes in frequency to be observed with the help of a standard frequency-calibrated signal generator [by a second frequency-transformation, to note frequency : this double action removes trouble with "mitnahme" and also means that the decimetric-wave heterodyne oscillator remains untouched during a measurement. The note-frequency signal is received either on a headphone or a valve voltmeter].

Measurements taken in this way on a triode transmitter [retroaction circuit for 84 cm, using a Philips 4675 acorn valve] showed that the frequency dependence of the transmitter becomes smaller with increasing anode voltage [the frequency increased as the anode voltage was increased, but less rapidly at the higher voltages]. Measurements on a grid-controlled magnetron showed that to give the greatest frequency constancy the magnetic field must make an angle with the filament. The modulation of a magnetron provided with a grid is best accomplished (for amplitude modulation) on the anode, the grid being kept at a constant bias. For frequency modulation, on the other hand, grid control is to be recommended.

3681. THERMOJUNCTION CURRENT AND VOLTAGE METERS IN HIGH-FREQUENCY TECHNIQUE [including Ultra-High Frequencies].—O. Schmid. (*Funktech. Monatshefte*, May 1939, No. 5, pp. 139–143.)

3682. A VARIABLE OSCILLATOR FOR ULTRA-HIGH-FREQUENCY MEASUREMENTS.—King. (*See* 3523.)

3683. DISCUSSION ON "A BEARING-TYPE HIGH-FREQUENCY ELECTRODYNAMIC AMMETER" [Defence of Thermocouple Instruments (with Tubular Heaters) for Ultra-High Frequencies: the Photoelectric (Lamp) Method and Its Frequency Limitation].—H. R. Meahl: J. H. Miller. (*Proc. Inst. Rad. Eng.*, July 1939, Vol. 27, No. 7, p. 474.) *See* 3724 of 1938 : for Miller's paper on thermoammeter construction *see* 1907 of 1937. For Wallace & Moore's paper *see* 2710 of 1937.

3684. SHORT-WAVE RADIATION MEASUREMENTS [using Thermojunction and Circular Frame Aerial for Points near Emitter : Substitution Method for Greater Distances : Wavelength Range 10–50 m].—C. Gutton & F. Carbenay. (*Comptes Rendus*, 19th June 1939, Vol. 208, No. 25, pp. 1954–1957.) *See* also 1411 of 1938.

3685. A METHOD OF DETERMINING THE SENSE OF SMALL PHASE DIFFERENCES.—Sattler : Opitz. (*See* 3610.)

3686. APPLICATIONS OF THE CATHODE-RAY OSCILLOGRAPH TO MEASURING PURPOSES.—M. Demontvignier. (*Rev. Gén. de l'Élec.*, 15th April 1939, Vol. 45, No. 15, pp. 454–458.) Concluded from 2450 of June.

3687. FRACTIONAL-FREQUENCY GENERATORS UTILISING REGENERATIVE MODULATION [Advantages over Relaxation-Oscillator Methods: General Theory of Regenerative Modulation : Application to Second-Order, Second-Order/Multiplier, & Third-Order Regenerative Modulators : Use of Copper-Oxide, Silicon-Carbide, & Diode Modulating Elements].—R. L. Miller. (*Proc. Inst. Rad. Eng.*, July 1939, Vol. 27, No. 7, pp. 446–457.)

3688. A "CHOPPED-SIGNAL" VACUUM-TUBE GENERATOR WITH GOOD VOLTAGE REGULATION [*e.g.* 500 c/s/20 i/s Generator : with a Discussion of the Shapes of Voltage Wave-Forms of Multivibrators].—F. C. Williams & A. Fairweather. (*P.O. Elec. Eng. Journ.*, July 1939, Vol. 32, Part 2, pp. 104–111.)

3689. THE PRODUCTION OF QUARTZ RESONATORS FOR THE LONDON/BIRMINGHAM COAXIAL CABLE SYSTEM [Cutting & Lapping Processes : Accurate Determination of Directions of Axes : Mounting System : Final Processes, Tests, & Adjustments].—C. F. Booth & C. F. Sayers. (*P.O. Elec. Eng. Journ.*, April & July 1939, Vol. 32, Parts 1 & 2, pp. 7–15 & 88–93.) For previous instalment *see* 1390 of April.

3690. THE MEASUREMENT OF THE CHARACTERISTICS OF TRANSMISSIONS, AT THE NEW TECHNICAL CONTROL CENTRE OF THE UNION INTERNATIONALE DE RADIODIFFUSION, BRUSSELS.—M. Adam. (*Rev. Gén. de l'Élec.*, 15th April 1939, Vol. 45, No. 15, pp. 451–454.)

3691. A SIMPLE METHOD OF CAPACITY MEASUREMENT AND ITS APPLICATION TO THE DETERMINATION OF VARIATION OF CAPACITY OF STRING ELECTROMETERS WITH STRING DEFLECTION.—J. Tagger. (*Physik. Zeitschr.*, 1st June 1939, Vol. 40, No. 11, pp. 408–409.)

The principle of the method is that, when two condensers are connected in series and the outer plates connected to potential V or earthed, equal charges separate out on the inner plates at a potential v ; from the electrostatic equation expressing this equality, one capacity can be determined if the other is known and the potentials are measured. The practical development of this principle and its application to string electrometers are described.

3692. EDGE CORRECTION IN THE DETERMINATION OF DIELECTRIC CONSTANT [by Capacitance Method : Theoretical Formulae for Circular & Rectangular Electrodes, and Their Probable Errors : Experimental Methods compared with Guard-Ring Method : Empirical Equations, giving Errors less than 1% and Simpler than Theoretical].—A. H. Scott & H. L. Curtis. (*Journ. of Res. of Nat. Bur. of Stds.*, June 1939, Vol. 22, No. 6, pp. 747–775.) The only satisfactory experimental methods, other than the guard-ring method, had one electrode appreciably smaller than the other.

3693. A Low-Range Air Condenser [Micrometer Type, for Measurement of Capacitances of a Few Micro-Microfarads, to $\pm$ 0.001 $\mu\mu$F: Design avoiding the Three Main Causes of Instability].—W. H. Ward & E. J. Pratt. (*Journ. of Scient. Instr.*, June 1939, Vol. 16, No. 6, pp. 192–195.)

3694. The Thermal Method of measuring Losses in Sheet Dielectrics at Radio Frequencies and High Electrical Stresses [Theoretical Discussion: Accuracy: Method suitable for High-Voltage H.F. Stress: Apparatus for Measurements by Transient Thermal Method: Results for Various Materials].—J. T. MacGregor-Morris & G. L. Grisdale. (*Phil. Mag.*, July 1939, Series 7, Vol. 28, No. 186, pp. 34–63.)

3695. Loss Measurements on Dipole Liquids and Solid Commercial Insulating Materials, on Centimetric Waves [Determination of Dielectric Properties from Measurements of Transparency and Reflecting Power: Results for Water, Alcohols, Insulating Materials: Loss Angle increases with Frequency, Dielectric Constant the Same for Centrimetric and Longer Waves: No Dispersion for Solid Materials].—G. Bäz. (*Physik. Zeitschr.*, 1st June 1939, Vol. 40, No. 11, pp. 394–404.)

3696. Cells for Measuring the Electrical Properties of Small Samples of Dielectrics.—J. C. Balsbaugh & A. H. Howell. (*Review Scient. Instr.*, June 1939, Vol. 10, No. 6, p. 194.)

3697. A Feedback Micromicroammeter [Two-Stage Direct-Coupled Amplifier with Negative Feedback, for Small Direct Currents: Mains-Operated: Sensitivity approaching That obtained by Special Electrometer Valves].—S. Roberts. (*Review Scient. Instr.*, June 1939, Vol. 10, No. 6, pp. 181–183.)

3698. Mechanical-Electrical Negative-Feedback System for Valve Voltmeters with Logarithmic Indication [for Acoustic, Electric, & Photoelectric Measurements: dealing with Amplitude Ratios up to 1 : 10^4.—L. Keidel. (*Akust. Zeitschr.*, May 1939, Vol. 4, No. 3, pp. 169–171.) A new system developed from the earlier device described in 2006 of 1935.

3699. Investigations of the Resistance Material "Novokonstant" [Copper/Manganese Alloy containing Aluminium and Iron: Resistance/Temperature Curve: Thermoelectric Behaviour: Mechanical Properties: Manufacture and Time Constancy of Novokonstant Resistances].—A. Schulze. (*Physik. Zeitschr.*, 15th May 1939, Vol. 40, No. 10, pp. 357–361.)

3700. The Measuring Instruments of Telegraphy.—G. Keller. (*E.T.Z.*, 22nd June 1939, Vol. 60, No. 25, pp. 742–749.)

3701. "Institute of Radio Engineers Standards, 1938" [Book Review].—I.R.E. (*Gen. Elec. Review*, June 1939, Vol. 42, No. 6, p. 285.)

SUBSIDIARY APPARATUS AND MATERIALS

3702. On the Present Position of the Problem of Post-Deflection Acceleration in Cathode-Ray Tubes.—Schwartz. (*See* 3627.)

3703. The Production of X-Rays by Cathode-Ray Tubes.—Paehr. (*See* 3629.)

3704. New Investigations on Cathode-Ray Oscillographs: III—The Ultradynamic Transverse Deflection of a Cathode Ray taking the Stray Fields into Account [Hintenberger Formula for Correction Factor only valid for Triangular Stray Field: Factor for Parabolic Field].—A. Thoma. (*Funktech. Monatshefte*, May 1939, No. 5, pp. 143–146.) For I & II *see* 706 of February.

3705. The Deflection of the Electron Ray in the Cathode-Ray Tube by Magnetic Fields produced by Coils.—Bähring. (*See* 3628.)

3706. Applications of the Cathode-Ray Oscillograph to Measuring Purposes.—Demontvignier. (*See* 3686.)

3707. Calculation by Successive Approximations of the Electrostatic Field of a Cylindrical System [*e.g.* Electron Lens].—Boni. (*Radio e Televisione*, May 1939, Vol. 3, No. 6, pp. 335–346.)

From author's summary:—"Instead of studying directly the form of the equipotential surfaces, the distribution of electric charges on the conductors may also be calculated, which constitutes another aspect of the same problem. Starting from the Laplace equation expressed in cylindrical coordinates for an axially symmetrical electrostatic field, the electric charges of the elementary surfaces into which each conductor can be resolved are determined by successive approximations, the potentials of the conductors being fixed in advance. When the distribution of the charges is known it is easy, by a double summation, to determine the potential at any required point of the field."

3708. The Focusing of Electrons possessing High Velocities, and the General Properties of Centred Systems in Relativistic Mechanics [with Thin-Lens Formulae].—Cotte. (*Rev. Gén. de l'Élec.*, 20th May 1939, Vol. 45, No. 20, pp. 675–677.) Formulae 15, 16, & 18 "should replace those given by Webster & Hansen" (*see* 1570/1571 of 1936) which are stated to be incorrect.

3709. Measurement of the Charge Distribution in a Cathode Ray.—Reusse. (*See* 3626.)

3710. Electron Distribution in Electron-Optically Focused Electron Beams.—Jacob. (*See* 3625.)

3711. On the Effects produced by the Bombardment of a Metallic Surface by High-Velocity Electrons [20–60 kV Beam, almost Tangential to Surface: Progressive Disappearance of Diffraction Image, and Chemical Passivity of Surface, due to Deposit of Carbon].—Trillat & Mérigoux. (*Journ. de Phys. et le Radium*, May 1939, Series 7, Vol. 10, No. 5, pp. 245–249 and Plate.) For addendum see *ibid.*, June, No. 6, p. 326.

3712. Radiation of Matter accompanying Electron Beam Emission from Incandescent Cathodes.—Reichelt. (*See* 3585.)

3713. A Stabilised Sweep-Circuit Oscillator [Difficulties of Tube Replacement with Gas-Triode Relaxation Circuits avoided by Superposing a Varying Voltage from Discharge Circuit on the Constant Grid Bias, by Plate/Grid Coupling: Shortened Deionisation Time enables Upper Frequency Limit to be Extended].—Kock. (*Electronics*, April 1939, Vol. 12, No. 4, pp. 20–21.).

3714. Linear Time Sweep Circuit for 10–10^5 Periods/Second for Cathode-Ray Oscillograph, with Associated Frequency-Meter.—Legros. (*Journ. de Phys. et le Radium*, June 1939, Series 7, Vol. 10, No. 6, pp. 106 S–107 S.)

3715. The Shadow Microscope, a New Electron Super-Microscope [Central Shadow Projection of Object on Screen, with No Optical System between Object and Screen: Electron Beam passes through Object].—Boersch. (*Naturwiss.*, 9th June 1939, Vol. 27, No. 23/24, p. 418.)

3716. The Super-Microscope—a New Aid to Vision [Survey, with Chart of Comparative Limits of Resolution of Various Microscopic Devices, with Dates].—Ghosh. (*Science & Culture*, Calcutta, June 1939, Vol. 4, No. 12, pp. 691–697.)

3717. Diatom Photographs with the Electrical Super-Microscope.—Mahl. (*Naturwiss.*, 9th June 1939, Vol. 27, No. 23/24, p. 417.)

3718. The Construction of a Magnetic Electron Microscope of High Resolving Power [Overcoming of Difficulties such as Electric Charges building-up on Lens Diaphragms, etc., and Destruction of Colloidal Membranes by Heating Effect of Beam].—Prebus & Hillier. (*Canadian Journ. of Res.*, April 1939, Vol. 17, No. 4, Sec. A, pp. 49–63.)

3719. The Effect of Chromatic Error on Electron-Microscope Images [Physical Interaction between Beam and Object produces Two Independent Image Effects which have no Counterpart in Light Optics].—Hillier. (*Canadian Journ. of Res.*, April 1939, Vol. 17, No. 4, Sec. A, pp. 64–69.)

3720. Thin Mica Windows [Four Times Thinner, for Same Pressure, by mounting on Cylindrical Surface instead of Plane].—Arnold & others. (*Review Scient. Instr.*, June 1939, Vol. 10, No. 6, p. 197.)

3721. A Mechanical Valve [No Mercury or Rubber] for High-Vacuum Systems.—Lang. (*Review Scient. Instr.*, June 1939, Vol. 10, No. 6, pp. 196–197.)

3722. The Paths of Ions in the Cyclotron [Variation of Magnetic Field required for Ion Beam to remain in Resonance without being Defocused].—Thomas. (*Phys. Review*, 1st June 1939, Series 2, Vol. 55, No. 11, p. 1110: abstract only.)

3723. Cyclotrons at Chicago University, Massachusetts Institute of Technology, and Purdue University.—Harkins, Livingstone, Henderson, & others. (*Phys. Review*, 1st June 1939, Series 2, Vol. 55, No. 11, p. 1110: abstracts only.)

3724. A New Type of Low-Voltage, High-Current Ion Tube for the Production of Neutrons.—Crane & Oleson. (*Phys. Review*, 1st June 1939, Series 2, Vol. 55, No. 11, p. 1110: abstract only.)

3725. The Theory of the Electric Charge of Dusts and High-Tension Generators working with Gaseous Currents: General Results.—Pauthenier. (*Rev. Gén. de l'Élec.*, 6th May 1939, Vol. 45, No. 18, pp. 583–595.)

3726. Phosphorescence of Zinc Silicate Phosphors [Two Stages of Decay at Low Contents of Manganese Activator: Explanation: Abrupt Decay with High Manganese Content].—Fonda. (*Journ. of Applied Phys.*, June 1939, Vol. 10, No. 6, pp. 408–420.)

3727. The Response of Several Fluorescent Materials to Short Wavelength Ultra-Violet Radiations [Synthetic Phosphors: Deactivating Effect of Copper & Nickel: Characteristics of Zinc Silicate & Calcium Tungstate].—Beese. (*Journ. Opt. Soc. Am.*, July 1939, Vol. 29, No. 7, pp. 278–282.)

3728. Position occupied by the Activator in Impurity-Activated Phosphors [X-Ray Evidence of Expansion of Lattice Dimensions of Matrix Material due to Activator in Solid Solution].—Jenkins, McKeag, & Rooksby. (*Nature*, 10th June 1939, Vol. 143, p. 978.)

3729. The Photoelectric Effect and the Photoconductivity of Phosphorescent Sulphides and of Fluorides.—Voyatzakis. (*See* 3631.)

3730. Distribution of Fluorescence Excitation of Bivalent Europium in Calcium Fluoride and of Bivalent Samarium in Calcium Sulphate.—Eckstein. (*Nature*, 24th June 1939, Vol. 143, p. 1067.) Spectra showing effect referred to in 4100 of 1938.

3731. "Fluorescence and Phosphorescence" [Book Review].—Hirschlaff. (*Electronics*, May 1939, Vol. 12, No. 5, p. 34.)

3732. Luminiscence during Intermittent Optical Excitation.—Johnson & Davis. (*Journ. Opt. Soc. Am.*, July 1939, Vol. 29, No. 7, pp. 283–290.)

3733. LUMINISCENCE IN ELECTRIC FIELDS AND ELECTRONIC PHENOMENA IN SEMICONDUCTORS.—Destriau. (*Comptes Rendus*, 3rd July 1939, Vol. 209, No. 1, pp. 36–37.) *See* also 2500 of June.

3734. LUMINISCENCE AND PHOTOCONDUCTIVITY OF SOLIDS.—Randall & Wilkins. (*See* 3630.)

3735. APPLICATIONS OF SOME RESULTS RELATING TO THE LUMINESCENCE OF SOLID SUBSTANCES: I—PRODUCTION OF WHITE LIGHT: II—DETECTION OF RARE ELEMENTS.—Servigne. (*Journ. de Phys. et le Radium*, March 1939, Series 7, Vol. 10, No. 3, p. 37 S.)

3736. ULTRA-VIOLET CHEMI-LUMINESCENCE [Radiation occurring in Chemical Reactions may be a Kind of Sensitised Fluorescence: Presence of Other Substances introduces New Lines into the Spectrum].—Gurwitsch & Gurwitsch. (*Nature*, 17th June 1939, Vol. 143, pp. 1022–1023.)

3737. SENSITISED FLUORESCENCE OF LEAD [in Mercury Vapour], *and* ENERGY DISTRIBUTION OF OH MOLECULES IN SENSITISED FLUORESCENCE.—Winans & others: Lyman. (*Phys. Review*, 1st June 1939, Series 2, Vol. 55, No. 11, p. 1126: p. 1126: abstracts only.)

3738. ON THE INTERCHANGE OF ELECTRICITY BETWEEN SOLIDS, LIQUIDS, AND GASES IN MECHANICAL ACTIONS.—Banerji. (*See* 3492.)

3739. THE ATOMPHYSICAL INTERPRETATION OF "LICHTENBERG FIGURES" AND THEIR APPLICATION FOR STUDYING ELECTRIC DISCHARGE PHENOMENA.—Merrill & von Hippel. (*Phys. Review*, 1st June 1939, Series 2, Vol. 55, No. 11, p. 1122: abstract only.)

3740. CELLULAR AND BANDED ELECTROCONVECTIVE EDDIES IN GASES.—Luntz. (*See* 3491.)

3741. THE ELECTRIC STRENGTH OF AIR AT HIGH PRESSURE [Experimental Data show Increase of Strength until Critical Pressure is reached, after which Sparking Voltage fails to Rise and may even Fall: Dependence of Max. Voltage & Critical Pressure on Shape of Electrodes].—Skilling. (*Elec. Engineering*, April 1939, Vol. 58, No. 4, Transactions pp. 161–165.)

3742. BREAKDOWN STUDIES IN COMPRESSED GASES [Survey of Earlier Data and Theory, leading to New Experimental Investigation (under Practical Conditions, chiefly on Air: up to 600 lb/sq. inch, Direct Voltages up to 450 kV) and to Suggested Modifications in Theory].—Howell. (*Elec. Engineering*, May 1939, Vol. 58, No. 5, Transactions pp. 193–206.)

3743. PRESSURE CAPACITORS [Modern Development in Broadcast Equipment: Variable Condensers with Compressed Nitrogen: "H-K" and "Lapp" Units].—(*Electronics*, April 1939, Vol. 12, No. 4, pp. 16–19.)

3744. VARIABLE AIR CONDENSER [with High Reading Accuracy without Vernier, etc: Good Mechanical & Electrical Stability].—Muirhead & Company. (*Journ. Scient. Instr.*, July 1939, Vol. 16, No. 7, pp. 232–233.)

3745. A LOW-RANGE AIR CONDENSER.—Ward & Pratt. (*See* 3693.)

3746. ON INCREASING THE SPECIFIC CAPACITY OF ANODE FOIL FOR ELECTROLYTIC CONDENSERS.—Godes, Zakheim, & Novoselov. (*Izvestiya Elektroprom. Slab. Toka*, No. 4, 1939, pp. 52–56.)

Experiments on increasing the active surface of anode foil (with aluminium content of not less than 99.8%) by chemical etching. It is pointed out that as a result of this treatment tan δ of the condenser may also increase considerably, and that to reduce this effect the grooves produced on the foil surface should be free from overhanging edges (Fig. 1). Hydrochloric acid with a small addition of cupric chloride was tried for etching, but better results were obtained with a mixture of hydrochloric and nitric acids. Thus in the case of a 300 v condenser the specific capacity increased 2.5 to 3.5 times while tan δ did not exceed 4 to 5.5%. Various processes involved in this treatment are described in detail and the results obtained are tabulated.

3747. ELECTROLYTIC CONDENSERS [Lines of Development: Construction of Various Types: Critical Summary of Theories: Manufacturing Methods: Standardised Method of Test recommended: etc.].—Coursey & Ray. (*Journ. I.E.E.*, July 1939, Vol. 85, No. 511, pp. 107–128: Discussion pp. 128–132.) A summary was referred to in 2111 of May.

3748. WAX-MOULDED PAPER CONDENSERS [Probable Life claimed to be 2–5 Times Longer than Ordinary Tubular By-Pass Condensers].—Solar Company. (*Proc. Inst. Rad. Eng.*, July 1939, Vol. 27, No. 7, p. ii.)

3749. RUBBED FILMS OF BARIUM STEARATE AND STEARIC ACID.—Germer & Storks. (*Phys. Review*, 1st April 1939, Series 2, Vol. 55, pp. 648–654.) For the insulating properties of such films *see* 2971 of July. *Cf.* 3750.

3750. MOLECULAR FILMS FOUND TO POSSESS GOOD INSULATING VALUES.—Race. (*Gen. Elec. Review*, June 1939, Vol. 42, No. 6, pp. 280–281.) *See* also 2971 of July. *Cf.* 3749.

3751. LOSS MEASUREMENTS ON DIPOLE LIQUIDS AND SOLID COMMERCIAL INSULATING MATERIALS, ON CENTIMETRIC WAVES.—Bäz. (*See* 3695.)

3752. THE THERMAL METHOD OF MEASURING LOSSES IN SHEET DIELECTRICS AT RADIO FREQUENCIES AND HIGH ELECTRICAL STRESSES [and Some Results].—MacGregor-Morris & Grisdale. (*See* 3694.)

3753. EDGE CORRECTION IN THE DETERMINATION OF DIELECTRIC CONSTANT.—Scott & Curtis. (*See* 3692.)

3754. Temperature Limits and Characteristics of Mica as used in Conjunction with Class "B" Insulation.—Spry. (*Elec. Engineering*, June 1939. Vol. 58, No. 6, Transactions pp. 287–289.)

3755. Report on Recent Developments in Insulating Materials.—V.D.E. (*E.T.Z.*, 1st June 1939, Vol. 60, No. 22, pp. 656–657.)

3756. The "Galileo Ferraris" National Electrotechnical Institute: Researches on the Electrical Properties of Some Solid Dielectrics [Pyrex, Hypertrolitul, etc.].—(*La Ricerca Scientifica*, June 1939, 10th Year, No. 6, pp. 585–586.)

3757. Discussion on "Plastics and Electrical Insulation."—Hartshorn & others. (*Journ. I.E.E.*, July 1939, Vol. 85, No. 511, pp. 150–156.) *See* 760 of February.

3758. The Manufacture of Components from Pyrophillite [Natural Aluminium Silicate].—Spiridonov & Perlin. (*Izvestiya Elektroprom. Slab. Toka*, No. 3, 1939, pp. 46–52.)

A detailed description is given of methods for manufacturing various components from pyrophillite, which, it is stated, is eminently suitable for use at radio frequencies.

3759. Properties of Ceramic Materials [Porcelain, Steatite, Titania, Cordierite, & Lava Materials: Table of Typical Applications and Mechanical & Electrical Data].—Thurnauer. (*Electronics*, April 1939, Vol. 12, No. 4, p. 33.)

3760. A New Type of Glass [will stand Heating to Cherry Red and plunging into Ice Water: rivalling Quartz in Very Low Coefficient of Expansion].—Corning Glass Company. (*Science*, 23rd June 1939, Vol. 89, Supp. pp. 8–9: *Sci. News Letter*, 1st July 1939, Vol. 36, p. 3.)

3761. Fibre Glass—an Inorganic Insulation.—Atkinson. (*Elec. Engineering*, June 1939, Vol. 58, No. 6, Transactions pp. 277–286.)

3762. Asbestos and Glass-Fibre Magnet-Wire Insulation.—Mathes & Stewart. (*Elec. Engineering*, June 1939, Vol. 58, No. 6, Transactions pp. 290–294.)

3763. The Action of Solvents and Impregnating Varnishes on Enamelled Wires.—Greulich. (*E.T.Z.*, 27th April 1939, Vol. 60, No. 17, pp. 506–509.)

3764. On Electron Conductivity in Strong Fields.—Wolkenstein. (*Journ. of Tech. Phys.* [in Russian], No. 3, Vol. 9, 1939, pp. 171–187.)

The current in a dielectric is made up of an ionic and an electronic component. The relationship between the two is determined by the temperature of the dielectric and the intensity of the field. In this paper a detailed theoretical study is presented of the movements of electrons in a dielectric. The breaking-down of a dielectric is also discussed.

3765. Theory of Electrical Breakdown in Ionic Crystals: II [Formula for Breakdown Field Strength].—Fröhlich. (*Proc. Roy. Soc.*, Series A, 19th May 1939, Vol. 171, No. 945, p. S 50: abstract only.) For I *see* 3503 of 1937.

3766. The Evaluation of Transient Temperature Distribution in a Dielectric in an Alternating Field [Solution, for Transient Case, of Equation of Heat Conduction in One Dimension for the Many Solid Dielectrics wherein the Generation of Heat increases Exponentially with Temperature: Ultimate Catastrophic Rise of Temperature clearly shown by the Solutions: etc.].—Copple, Hartree, Porter, & Tyson. (*Journ. I.E.E.*, July 1939, Vol. 85, No. 511, pp. 56–66.)

3767. Technical Applications of Modern Electric-Discharge Lamps.—Harris. (*Journ. of Scient. Instr.*, June 1939, Vol. 16, No. 6, pp. 173–183.)

3768. New Stabilising Circuits with Glow-Discharge Lamps [where Currents are Too Small for Special Stabiliser Tubes (Minimum Current 5–10 mA): Special Circuits for Ordinary Midget Glow-Discharge Lamps, applicable also to Improve the Stabilisation given by the Special Tubes].—Boucke. (*Funktech. Monatshefte*, May 1939, No. 5, pp. 146–149.)

The basis of the special circuits is that part of the negative bias of the amplifier valve whose anode or screen-grid voltage it is desired to stabilise is tapped off the series resistance of the glow-discharge lamp.

3769. The Permatron—a Magnetically Controlled Industrial Tube [Construction & Characteristics: Advantages over Thyratron & Ignitron: Wide Field of Application].—Overbeck. (*Elec. Engineering*, May 1939, Vol. 58, No. 5, Transactions pp. 224–228.) *See* also 2785 of July and 3818, below.

3770. A Glow-Discharge Tube with a Cold Cathode and a Control Grid.—Parfent'ev. (*Journ. of Tech. Phys.* [in Russian], No. 3, Vol. 9, 1939, pp. 198–201.)

Glow-discharge tubes using cold cathodes and control grids have been developed by the author. The tubes are filled with neon and their striking voltage can be regulated by means of the control grid between cathode and anode. Results of tests with these tubes are discussed and various characteristics are plotted. It appears that this type of tube is extremely sensitive, so that a discharge of several tens or hundreds of watts can be produced by the application of 10^{-7} or 10^{-8} watt to the grid.

3771. Constant-Potential Battery-Charging Phanotron Rectifiers.—Ajer. (*Gen. Elec. Review*, May 1939, Vol. 42, No. 5, pp. 221–223.)

3772. A Portable High Voltage Supply [Valve-Controlled Induction Coil and Rectifier].—Huntoon. (*Review Scient. Instr.*, June 1939, Vol. 10, No. 6, pp. 176–178.)

3773. ELECTRON SCATTERING AND PLASMA OSCILLATIONS [studied in Mercury-Arc Discharge Tube: Scattering due to Plasma Oscillations receiving Energy from Fast Electrons].—Merrill & Webb. (*Phys. Review*, 15th June 1939, Series 2, Vol. 55, No. 12, pp. 1191–1198.)

3774. THE MAGNESIUM/COPPER-SULPHIDE RECTIFIER BATTERY CHARGER FOR RAILROAD PASSENGER CARS [Rectifier handling Large Currents per Unit Area].—Kotterman. (*Elec. Engineering*, June 1939, Vol. 58, No. 6, Transactions pp. 260–265.)

3775. STUDY OF SEMICONDUCTORS IN A VARIABLE RÉGIME.—Déchêne. (*See* 3649.)

3776. STUDIES ON THIN METALLIC FILMS: ELECTRICAL CONDUCTANCE.—Perucca. (*Bollettino del Centro Volpi di Elettrologia*, English Edition, Dec. 1938, Year 1, No. 4, p. 77d: summary only.)

3777. FIXED RESISTORS [Ceramite-Embedded].—Zenith Elec. Company. (*Journ. Scient. Instr.*, July 1939, Vol. 16, No. 7, pp. 234–235.)

3778. INVESTIGATION OF THE RESISTANCE MATERIAL "NOVOKONSTANT."—Schulze. (*See* 3699.)

3779. "ATMITE" [Silicon-Carbide Compound with Resistance an Inverse Function of Applied Voltage, Current increasing about as Fourth Power: Time Lag Immeasurably Small: Wide Field of Application], *and* THE PERFORMANCE OF "ATMITE" FOR SPARK QUENCHING.—Saville: Baker & Cannon. (*Strowger Journal*, May 1939, Vol. 5, No. 1, pp. 17–27: pp. 28–30.)

3780. DISAGREEMENT WITH "RELAY CONTACTS: THEIR AILMENTS" [Dissimilar Metals work Best: Tungsten is Suitable].—Clement. (*Electronics*, April 1939, Vol. 12, No. 4, p. 7.) *See* 1698 of April.

3781. PROGRESS IN THE DEVELOPMENT OF RELAYS [Survey].—Reche. (*E.T.Z.*, 22nd June 1939, Vol. 60, No. 25, pp. 753–761.)

3782. ADVANTAGES AND PROPERTIES OF THE VARIOUS CORE SHAPES FOR H.F. IRON-CORED COILS.—Henniger. (*Funktech. Monatshefte*, May 1939, No. 5, pp. 155–157.)

3783. ON THE PHYSICAL SIGNIFICANCE OF THE MAGNETISING PROCESSES IN FERROMAGNETIC MATERIALS.—Kersten. (*E.T.Z.*, 27th April & 4th May 1939, Vol. 60, Nos. 17 & 18, pp. 498–503 & 532–538.)

3784. ON SOME PHENOMENA OF WAVE PROPAGATION [with Application to Ferromagnetism]. Parodi. (*See* 3476.)

3785. MECHANICAL AFTER-EFFECT AND CHEMICAL CONSTITUTION.—Snoek. (*Physica*, July 1939, Vol. 6, No. 7, pp. 591–592.)

"We have shown [1726 of April] that small amounts of carbon or nitrogen, when introduced into a sample of iron which is otherwise very pure, are capable of producing a strong magnetic after-effect. In view of the intimate connection existing between magnetic and mechanical after-effect, we immediately set out to prove the same thing for the mechanical effect."

3786. A USEFUL WIND-DRIVEN DYNAMO [charging Two 6-Volt 130-Ampere-Hour Car Accumulators].—Phillips. (*Distribution of Electricity*, July 1939, Vol. 12, No. 134, pp. 296–297.)

3787. MODERN FASTENERS IN THE RADIO INDUSTRY. —Walsh. (*Electronics*, May 1939, Vol. 12, No. 5, pp. 27–29.)

STATIONS, DESIGN AND OPERATION

3788. FIELD TESTS OF FREQUENCY- AND AMPLITUDE-MODULATION WITH ULTRA-HIGH-FREQUENCY WAVES.—Weir. (*See* 3528.)

3789. REVISED ULTRA-HIGH-FREQUENCY ALLOCATIONS.—(*Electronics*, April 1939, Vol. 12, No. 4, p. 34.)

3790. RADIO OVER THE SUPPLY MAINS [Advantages over Distribution by Telephone Network].—Eckersley. (*Electrician*, 30th June 1939, Vol. 122, p. 842.) *See* also p. 820.

3791. AN EXPERIMENT IN PARALLEL OPERATION OF OSCILLATORS ON SHORT WAVES.—Nevyazhski. (*Izvestiya Elektroprom. Slab. Toka*, No. 3, 1939, pp. 13–21.)

Certain features of the new 120 kw short-wave radio transmitter [in Moscow ?] are discussed. The transmitter uses two separate channels with common anode modulation at the final stages. The two channels are each coupled to a separate mast carrying a number of horizontal half-wave radiators with reflectors, and are excited either from a common oscillator, in which case the radiated outputs are combined in the ether, or from two independent oscillators, in which case simultaneous transmissions of a programme on two wavelengths can be carried out (in the same or different directions). When the two channels are operating at the same frequency the direction of transmission can be varied by regulating the phase angle between the two aerials. This is effected by adjusting one of the two vernier condensers connected in the anode circuits of the first stages of the two channels. Another interesting feature of the transmitter is the extremely simple phase-monitoring device (using thermocouples in a bridge circuit) giving visual indication of the direction of transmission (Fig. 4).

Experience has shown that the transmitter operates entirely satisfactorily. Automatic phase-regulating devices have proved unnecessary, and the operation of a channel is very little affected if the other channel is switched on or off, or if it is operated on the same or on a different wavelength. When operating the two channels on the same wavelength, intermodulation in the ether between the two outputs was appreciable only outside the service angle of the transmitter.

3792. CONSIDERATIONS ON THE PROPAGATION OF SYNCHRONISED WAVES, AND ON THE RECEPTION OF COMMON-WAVE STATIONS [Examination of Field-Strength Ratio necessary for Good Reception: Influence of Synchronising Method: etc.].—Bernetti. (*U.R.S.I. Proc. of* 1938 *Gen. Assembly*, Vol. 5, Fasc. 1, 1938, pp. 236–242: in Italian.)

3793. A New "Deutschlandsender" [at Herzberg (Elster): Latest Improvements: 325 m Mast ("the First Long-Wave Mast-Radiator"): Intention to add Similar Masts to give, for First Time on Long Waves, an Anti-Fading Effect: 150 kW extensible to 200 kW: etc.].—(*Funktech. Monatshefte*, May 1939, No. 5, p. 150.)

3794. Rugby Radio Station [now including 13 Transmitters and over 40 Aerials: Possible Future Developments].—Gracie. (*P.O. Elec. Eng. Journ.*, April 1939, Vol. 32, Part 1, pp. 16–23.)

3795. Power Supply for Outside Broadcasts.—Cooper. (*World-Radio*, 23rd June 1939, Vol. 28, pp. 14–15.)

3796. Safety Interlocks at Transmitting Stations [*e.g.* Droitwich].—Hotine. (*World-Radio*, 7th July 1939, Vol. 29, pp. 12–13.)

3797. New Equipment for Outside Broadcasts [making use of Recent Types of Valve, particularly High-Slope Screened Pentodes].—Barrett, Mayo, & Ellis. (*World-Radio*, 21st & 28th July 1939, Vol. 29, pp. 12–13 & 10–11.) Also 4th August, pp. 12–13 (Petrie).

3798. The Cairo Radio-Communications Conference, 1938.—Picault. (*Rev. Gén. de l'Élec.*, 22nd April 1939, Vol. 45, No. 16, pp. 490–502.)

GENERAL PHYSICAL ARTICLES

3799. Ionisation by Collisions of Positive Ions [Considerations supporting This Hypothesis].—Townsend. (*Phil. Mag.*, July 1939, Series 7, Vol. 28, No. 186, pp. 111–117.)

3800. Remark on the Magnetic Properties of a Gas obeying the Bose-Einstein Statistics.—Néel. (*Journ. de Phys. et le Radium*, June 1939, Series 7, Vol. 10, No. 6, pp. 95 S–96 S.)

3801. On the Electromagnetic Field produced by an Electron [in Its Immediate Neighbourhood: Theory].—Weisskopf. (*Phys. Review*, 1st June 1939, Series 2, Vol. 55, No. 11, p. 1131: abstract only.)

3802. The Unification of the Equations of Laplace and Poisson.—Laboccetta. (*La Ricerca Scientifica*, June 1939, 10th Year, No. 6, pp. 563–566.)

3803. A Generalised Formula for the Doppler Effect.—Fleischmann. (*Journ. Opt. Soc. Am.*, July 1939, Vol. 29, No. 7, pp. 302–304.)

3804. Distribution of Charge and Potential in an Electrolyte bounded by Two Plane Infinite Parallel Plates [Theory: Variation of Electrokinetic Potential Difference with Concentration of Electrolyte].—Rosenhead. (*Proc. Roy. Soc.*, Series A, 19th May 1939, Vol. 171, No. 945, p. S 52: abstract only.)

MISCELLANEOUS

3805. Tensors and Electrical Networks [Correction of a "Widespread Misconception" as to what Tensors will do in the Theory of Electrical Networks].—Ingram. (*Elec. Engineering*, June 1939, Vol. 58, No. 6, pp. 274–275.)

3806. Fundamental Principles of Operational Calculus [and the Wide Applicability of Giorgi's Form].—Nucci. (*Radio e Televisione*, May 1939, Vol. 3, No. 6, pp. 360–373.)

3807. An Integraph for the Solution of Differential Equations of the Second Order [Portable, and Very Quick in Operation].—Myers. (*Journ. Scient. Instr.*, July 1939, Vol. 16, No. 7, pp. 209–222.)

"Particularly suitable for problems whose solution requires trial-and-error methods; as, for example, when the initial conditions are not completely specified."

3808. Mechanical Device for Smoothing Data.—Schumann. (*Nature*, 3rd June 1939, Vol. 143, pp. 937–938.) Development of idea referred to in 806 of February.

3809. A Method of Correlation Analysis [with Decomposition of Measured Characters into Linear Combination of General, Group, and Specific Factors].—Delaporte. (*Comptes Rendus*, 19th June 1939, Vol. 208, No. 25, pp. 1960–1963.)

3810. "The Nomogram—the Theory and Practical Construction of Computation Charts" [Book Review].—Allcock & Jones. (*P.O. Elec. Eng. Journ.*, April 1939, Vol. 32, Part 1, p. 55.)

3811. Nomograms [Alignment Charts] in *E.T.Z.*, Theory and Applications [with Publication Dates, from 1920 to 1937.]—Zimmermann. (*E.T.Z.*, 18th May 1939, Vol. 60, No. 20, pp. 585–589.)

3812. An Integrator for Polar, Rectangular, and Curvilinear Coordinates.—Lugeon. (*See* 3500.)

3813. The Work of A. Blondel in Wireless Technique.—Damyanovitch. (*Rev. Gén. de l'Élec.*, 3rd June 1939, Vol. 45, No. 22, pp. 715–720.)

3814. Elihu Thomson: Electrical Engineer.—Jackson. (*Elec. Engineering*, June 1939, Vol. 58, No. 6, pp. 251–255.)

3815. Patents for Acts of Nature.—Ruby. (*Science*, 28th April 1939, Vol. 89, pp. 387–389.)

3816. Foreign Patents and Currency Law: Important New Developments for Exporting Manufacturers of Telephone Apparatus.—(*T.F.T.*, March 1939, Vol. 28, No. 3, pp. 109–111.)

3817. Professional Status for the Radio Engineer: Activities of the Institute of Wireless Technology.—(*Wireless World*, 15th June 1939, Vol. 44, pp. 566–567.)

3818. The Permatron and Its Application in Industry [as Telegraph Relay, in Automatic Battery Charging, and as Automatic Fader for Neon Signs].—Overbeck : Spencer. (*Electronics*, April 1939, Vol. 12, No. 4, pp. 25–28.) *See* also 3769, above.

3819. Photo-Thermometry with Infra-Red Rays [for Photographic Measurement of Temperatures below Those at which Visible Rays are emitted].—Neubert & Henchy. (*La Ricerca Scientifica*, June 1939, 10th Year, No. 6, p. 601 : summary only.)

3820. New Apparatus for Photographic Reproduction [of Documents, etc.] : the "Omniphot-Microfilm."—Lézy. (*Recherches et Inventions*, April 1939, Vol. 19, No. 278, pp. 73–75.)

3821. The Universal Decimal Classification of Information.—Wright. (*P.O. Elec. Eng. Journ.*, April 1939, Vol. 32, Part 1, pp. 56–58.) Announcing the journal's decision to adopt the system.

3822. "Technical Dictionary in Four Languages : Vol. I—English, Polish, French, and German" [Book Review].—(*Rev. Gén. de l'Élec.*, 25th Feb. 1939, Vol. 45, No. 8, p. 226.) Published in Warsaw : obtainable in Paris.

3823. "International Electrotechnical Vocabulary" [Book Review].—French Electrotechnical Committee. (*Proc. Inst. Rad. Eng.*, June 1939, Vol. 27, No. 6, p. 419.) A French review was referred to in 405 of 1938.

3824. "Dictionnaire de Radioélectricité et de Radiovision" [Book Review].—Duval, Peychès, & Dorbec. (*Rev. Gén. de l'Élec.*, 24th June 1939, Vol. 45, No. 25, p. 818.)

3825. "I.E.E. Regulations—11th Edition" [Book Review].—(*Electrician*, 7th July 1939, Vol. 123, p. 11.)

3826. "Institute of Radio Engineers Standards, 1938 : Electronics" [Book Review].—I.R.E. (*Gen. Elec. Review*, June 1939, Vol. 42, No. 6, p. 285.)

3827. "Télégraphie et Téléphonie sans Fil" [Ninth Edition : Book Review].—Gutton. (*Rev. Gén. de l'Élec.*, 20th May 1939, Vol. 45, No. 20, p. 642.)

3828. "Radiotechnique" [Book Review].—von Ardenne, Fehr, & others. (*Génie Civil*, 22nd April 1939, Vol. 114, No. 16, p. 352.) Translated into French from the German.

3829. "The Elements of Radio Communication" [Book Review].—Brown & Gardiner. (*Electrician*, 14th April 1939, Vol. 122, p. 476.)

3830. "History of Radio to 1926" [Book Review].—Archer. (*Proc. Inst. Rad. Eng.*, March 1939, Vol. 27, No. 3, p. 233.)

3831. "The Radio Handbook, Fifth Edition" [Book Review].—Editors of *Radio*. (*Communications*, March 1939, Vol. 19, No. 3, p. 14.)

3832. "Fundamental Electronics and Vacuum Tubes" [Book Review].—Albert. (*Wireless Engineer*, May 1939, Vol. 16, No. 188, p. 230.)

3833. "Telephony : Vol. 2—Automatic Telephony" [Book Review].—Herbert & Procter. (*Wireless Engineer*, April 1939, Vol. 16, No. 187, p. 188.)

3834. "Educational Broadcasting, 1937" [Proceedings of Second National Conference : Book Review].—Marsh (Edited by). (*Proc. Inst. Rad. Eng.*, April 1939, Vol. 27, No. 4, pp. 296–297.)

3835. "Principles of Electricity and Electromagnetism" [Book Review].—Harnwell. (*Proc. Inst. Rad. Eng.*, April 1939, Vol. 27, No. 4, p. 296.) A book "such as many radio-physicists have probably often wished for."

3836. "High-Frequency Alternating Currents: Second Edition" [Book Review].—McIlwain & Brainerd. (*Proc. Inst. Rad. Eng.*, June 1939, Vol. 27, No. 6, p. 420.)

3837. "Reports on Progress in Physics : Vol. 5" [Book Review].—Ferguson (Edited by). (*Electrician*, 3rd March 1939, Vol. 122, p. 278.)

3838. History of the Radioelectric Industry. —Bethenod. (*Rev. Gén. de l'Élec.*, 28th Jan. 1939, Vol. 45, No. 4, pp. 99–102.)

3839. Abstracts of Some Recent Marconi Patents.—(*Marconi Review*, April/June 1939, No. 73, pp. 36–46.)

3840. "Mitteilungen aus der Forschungsanstalt der deutschen Reichspost (RDF) : Band II" [Book Review].—(*Rev. Gén. de l'Élec.*, 4th March 1939, Vol. 45, No. 9, p. 258.)

3841. A.E.G. Research [Future Publication of "Jahrbuch der A.E.G. Forschung" Three Times a Year].—(*Electrician*, 31st March 1939, Vol. 122, p. 412.)

3842. Report on the Work of the Physikalisch-Technische Reichsanstalt in the Year 1938 [with Notes on Quartz Clocks, Emission of Standard Frequencies, Field-Strength Measurements, Ultra-Short Waves, etc.].—(*Physik. Zeitschr.*, 1st April 1939, Vol. 40, No. 7, pp. 237–283.)

3843. The Activities of the National Electrotechnical Institute "Galileo Ferraris" in the Fourth Year of Its Existence—1937/8.—Vallauri. (*La Ricerca Scient.*, April 1939, 10th Year, No. 4, pp. 225–249.)

3844. History of the Engineering Department [of the G.P.O.].—Baker. (*P.O. Green Papers*, No. 46, May 1939, 44 pp.)

3845. The Design and Construction of Experimental and Research Apparatus.—Newman & Clay. (*Journ. Scient. Instr.*, April 1939, Vol. 16, No. 4, pp. 105–114.)

3846. THE WORK OF G. S. OHM IN THE LIGHT OF PRESENT-DAY TECHNIQUE.—Unger. (*E.N.T.*, March 1939, Vol. 16, No. 3, pp. 65–68.)

3847. THE PHYSICAL SOCIETY'S EXHIBITION, 1939.—(*Journ. of Television Soc.*, [dated] Dec. 1938, Series 2, Vol. 2, Part 12, pp. 498–499.)

3848. THE FEDERAL GOVERNMENT AND RESEARCH.—Potter. (*Elec. Engineering*, May 1939, Vol. 58, No. 5, pp. 205–207.) Mainly a review of the report " Research—a National Resource ", recently published by the National Resources Committee.

3849. ITALIAN CONTRIBUTION TO RESEARCHES IN PHYSICS FOR THE YEAR 1936/1937, *and* REPORT ON PHYSICAL STUDIES IN ITALY DURING 1938.—Dalla Noce: Dalla Noce. (*Atti della Soc. Italiana per il Progresso delle Scienze*, No. 2, Year 1, 1938, pp. 195–209: *Atti 27th Riunione S.I.P.S.* [these initials stand for the above-named Society].) The address is Rome, Piazzale delle Scienze, 7.

3850. COMITÉ CONSULTATIF INTERNATIONAL TÉLÉPHONIQUE: MEETING OF THE SUB-COMMITTEES [for the Specification of Quality of Transmission and for Wide-Band Transmission], LONDON, DEC. 1938.—(*P.O. Elec. Eng. Journ.*, April 1939, Vol. 32, Part 1, pp. 52–55.)

3851. WHY TELEMETERING? FIELDS OF SERVICE: TYPES OF EQUIPMENT & THEIR SELECTION: ETC.—Lunge. (*Gen. Elec. Review*, April 1939, Vol. 42, No. 4, pp. 150–159.)

3852. NOTE-FREQUENCY CHANNELS FOR TELEMETERING AND TELECONTROL INSTALLATIONS.—Kleinschnitz & Kummert. (*AEG-Mitteilungen*, April 1939, No. 4, pp. 229–232.)

3853. TELECOMMUNICATIONS AT THE WORLD ROME EXHIBITION OF 1942.—Ramasso. (*Radio e Televisione*, Jan. 1939, Vol. 3, No. 4, pp. 216–225: in Italian.)

3854. SALON OF " DETACHED PARTS " 1939.—(*L'Onde Élec.*, May 1939, Vol. 18, No. 209, pp. 229–233.)

3855. THE RADIOELECTRIC INDUSTRIES AT THE PARIS FAIR.—Adam. (*Génie Civil*, 10th June 1939, Vol. 114, No. 23, pp. 487–488.)

3856. THE SECOND NATIONAL CONGRESS OF RADIOPHONIC ART, PARIS, 15TH–17TH MAY 1939.—(*Génie Civil*, 8th July 1939, Vol. 115, No. 2, pp. 41–42.)

3857. I.R.E. PACIFIC COAST CONVENTION, SAN FRANCISCO, JUNE 1939: SUMMARIES.—(*Proc. Inst. Rad. Eng.*, June 1939, Vol. 27, No. 6, pp. 408–417: *Electronics*, June 1939, Vol. 12, No. 6, pp. 28–31 and 95, 96.)

3858. THE ART ADVANCES [Progress in Valves, Components, Equipment, Technique].—(*Electronics*, June 1939, Vol. 12, No. 6, pp. 20–27 and 92..95.)

3859. ON THE POSSIBILITY OF RECORDING IMAGES IN A SHORTER TIME THAN BY PHOTOGRAPHY.—Lallemand. (*See* 3644.)

3860. TELESURGERY [Television between Operating Table and Lecture Auditorium].—(*Electronics*, April 1939, Vol. 12, No. 4, p. 8: photographs & caption only.)

3861. ELECTROCARDIOGRAPH USING TELEVISION TECHNIQUE [No Waiting for Development of Film].—Walker. (*Sci. News Letter*, 3rd June 1939, Vol. 35, p. 340.)

3862. ULTRA-VIOLET CHEMI-LUMINESCENCE.—Gurwitsch & Gurwitsch. (*See* 3736.)

3863. INTEGRATING METERS FOR [Solar] ULTRA-VIOLET RADIATION, *and* OBSERVATIONS WITH A NEW RADIATION PYROMETER.—Kuper & Brackett: Strong. (*See* 3458 & 3470.)

3864. PROPERTIES OF TYPE II PHOTRONIC CELLS AFFECTING PHOTOMETRIC MEASUREMENT.—Stewart & O'Brien. (*Phys. Review*, 1st June 1939, Series 2, Vol. 55, No. 11, p. 1121: abstract only.)

3865. PHOTOELECTRICALLY RELEASED COUNTING EQUIPMENT FOR THE WATTMETRIC TESTING OF ELECTRICITY METERS.—Kuntze. (*E.T.Z.*, 18th May 1939, Vol. 60, No. 20, pp. 591–593.)

3866. ELECTRONIC CONTROL FOR SHIP STEERING [operated from Magnetic Compass by Photocells].—Chance. (*Electronics*, June 1939, Vol. 12, No. 6, pp. 41–44.)

3867. ELECTRONIC PERISCOPE FOR VISION IN FOG.—Del Vecchio. (*Radio e Televisione*, May 1939, Vol. 3, No. 6, pp. 347–349.)

A high-vacuum glass container encloses a photocathode *C* on which, through the wall of the bulb, the infra-red image is projected by a suitable lens. The photoelectrons emitted by *C* are accelerated by the ring anode *R* and by the positive potential applied to the fluorescent plate *A* at right angles to the plane of *C*, and are suitably deflected and concentrated onto *A* by a magnetic field (not indicated in the picture).

3868. AN AGRICULTURAL NOVELTY: CULTIVATOR WITH PHOTOELECTRIC CONTROL [Ground hoed only in Places where No Plants are growing].—Ferte. (*Electrician*, 19th May 1939, Vol. 122, p. 629.)

3869. PHOTOGRAPHIC REPRODUCTION: NEW USE FOR PHOTOELECTRIC CELLS IN MAKING OF GIANT POSTER [Air Brush, controlled by Photocell, enlarges from Original wrapped round Drum].—Frater. (*Electrician*, 14th July 1939, Vol. 123, p. 51.)

3870. A PHOTOELECTRIC NULL INDICATOR FOR MATCHING LIGHT INTENSITIES [with 2-Inch C-R Tube as Indicator].—Kniazuk. (*Journ. Opt. Soc. Am.*, June 1939, Vol. 29, No. 6, pp. 223–225.)

3871. A PHOTOELECTRIC INTEGRATING EXPOSURE METER.—Michaelson. (*Gen. Elec. Review*, Feb. 1939, Vol. 42, No. 2, pp. 92–93.)

Wireless Patents

A Summary of Recently Accepted Specifications

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

ACOUSTICS AND AUDIO-FREQUENCY CIRCUITS AND APPARATUS

504 960.—Audio-frequency amplifier of the para-phase push-pull type, designed to be inherently stable in operation without the use of a phase-reversing valve.

Ferranti; N. H. Searby; and G. I. Thomas. Application date 12th January, 1938.

505 030.—Regulating the H.T. supply to a high-powered audio-frequency amplifier, in order to increase its efficiency for a given content of harmonics.

Rediffusion and P. Adorjan. Application date 3rd November, 1937.

506 141.—Stereophonic recording and reproduction of sounds.

Philips' Lamp Co. Convention date (Germany) 4th October, 1937.

506 659.—Remote control of the volume or gain of a low-frequency amplifier by negative feed-back.

Marconi's W.T. Co. and A. L. Oliver. Application date 1st December, 1937.

DIRECTIONAL WIRELESS

504 744.—Preventing the misleading effect, on a pilot, of the rearwardly-projecting lobes of radiation from a navigational beam transmitter.

Marconi's W.T. Co.; C. S. Cockerell; and J. G. Robb. Application date 29th October, 1937.

505 405.—Direction-finding indicator with two opposed scales, each provided with automatic means for correcting "site error."

C. Lorenz Akt. Convention date (Germany) 2nd June, 1937.

505 547.—Automatic type of direction finder in which means are provided to make the receiver equally sensitive to signals, whether these come athwart the ship or from the fore-and-aft direction.

Telefunken Co. Convention date (Germany) 16th November, 1937.

505 910.—Segregating or separating-out undesired lobes of radiation from the main radiated beams of a radio navigational beacon.

Marconi's W.T. Co.; J. G. Robb; J. M. Furnival; and B. J. Witt. Application date 18th November, 1937.

505 913.—Transparent "templet" of field-strength curves which, when placed over a chart of the country, facilitates the navigation of an aeroplane by wireless.

Marconi's W.T. Co.; J. M. Furnival; and B. J. Witt. Application date 18th November, 1937.

RECEIVING CIRCUITS AND APPARATUS

(*See also under Television*)

505 124.—Variable thermionic impedance for automatic tuning-control in a superhet receiver.

E. K. Cole and G. Bradfield. Application date 9th November, 1937.

505 492.—Negative feed-back amplifier in which means are provided to control the effective impedance of the feed-back circuit and to reduce "longitudinal" currents in the system.

Standard Telephones and Cables (assignees of E. H. Perkins). Convention date (U.S.A.) 5th December, 1936.

505 528.—Automatic tuning arrangement designed to allow one of the usual valves to be dispensed with.

E. K. Cole. Convention date (Sweden) 18th June, 1937.

505 598.—Automatic tuning arrangements in which the frequency-control voltages are derived from opposed rectifiers, which also serve to demodulate the signals.

Telefunken Co. Convention date (Germany) 14th November, 1936.

505 820.—Remote tuning control for a wireless receiver in which the driving-motor moves at high speed "between stations" but at low speed near a tuning point.

Hazeltine Corporation (assignees of N. P. Case). Convention date (U.S.A.) 22nd October, 1937.

505 838.—Transformer-coupled, unscreened transmission line between an aerial and a receiving set, designed to eliminate local interference.

E. M. Lee; F. R. W. Strafford; H. G. Stedman; and Belling & Lee. Application date 10th November, 1937.

505 867.—Double rectifier arrangement for applying delayed A.V.C. without producing amplitude or other distortion.

Philips' Lamp Co. Convention date (Holland) 25th May, 1937.

505 878.—Wireless receiver in which the volume control automatically regulates the power consumption of the set.

C. Lorenz Akt. Convention date (Germany) 28th August, 1937.

505 896.—Tuning arrangement in which a control knob first serves to switch on a motor to effect coarse adjustment, and is then used for fine manual control near the critical tuning point.

Telefunken Co. Convention date (Germany) 16th October, 1936.

505 926.—"Mixing" circuit particularly suitable for restoring the carrier frequency to a signal from which it has been suppressed.

W. W. Triggs (communicated by Wired Radio Inc.). Application date 9th December, 1937.

505 986.—A.V.C. system in which a constant output is maintained at the stage from which the signal energy is taken off.

Marconi's W. T. Co. and G. P. Parker. Application date 18th November, 1937.

506 063.—Aerial coupling system arranged to balance-out local interference.

R. I. Kinross. Application date 23rd July, 1938.

506 085.—Circuit for receiving phase-modulated waves.

Marconi's W.T. Co. (assignees of M. G. Crosby). Convention date (U.S.A.) 10th February, 1937.

506 113.—Receiver on which the tuning-control knob is arranged to serve two or more different purposes, under the control of the incoming signals.

Philips' Lamp Co. Convention date (Germany) 26th July, 1937.

506 128.—Amplifier circuit in which the gain is varied automatically, with amplitude compression, to keep the output within predetermined limits.

Standard Telephones and Cables (assignees of N. C. Norman). Convention date (U.S.A.) 23rd September, 1937.

506 133.—Tuning arrangement for indicating on which wavelengths, within a given range, broadcast transmissions are taking place.

G. de Monge. Application date 1st September, 1938.

506 348.—Magnetron arrangement used as a mixing valve for receiving ultra-short-wave signals.

Marconi's W.T. Co. Convention date (U.S.A.) 25th November, 1936.

506 865.—Low-impedance electronic device, simulating a reactance and used for automatic frequency control, but arranged to avoid any considerable damping of the tuned circuit.

The British Thomson-Houston Co. Convention date (U.S.A.) 8th June, 1937.

TELEVISION CIRCUITS AND APPARATUS

For Transmission and Reception

504 898.—Rotating-lens scanning device for televising from a cinema film and simultaneously generating synchronising impulses.

Electrical Research Products Inc. Convention date (U.S.A.) 15th October, 1937.

505 022.—Pulse-controlled oscillation generator of the relaxation type, particularly for producing scanning voltages for television.

C. L. Faudell. Application date 3rd November, 1937.

505 026.—Cathode-ray tube with an additional plate electrode arranged between the deflecting plates in order to avoid " trapezium " distortion.

A. C. Cossor and B. C. Fleming-Williams. Application date 3rd November, 1937.

505 031.—Combined sound and picture receiver in which the picture signals do not become visible until the sound pictures have been accurately tuned in.

Telefunken Co. Convention date (Germany) 3rd November, 1936.

505 057.—Television transmitter designed to allow greater amplification of the picture signals without increasing the difficulty of separating them from the synchronising impulses at the receiving end.

Cie. des Compteurs &c. d'Usines à Gaz. Convention date (France) 8th February, 1937.

505 167.—Apertured diaphragm inserted in the path of the electron stream in a cathode-ray television transmitter for increasing the light "contrast" of the picture.

Radio-Akt. D. S. Loewe. Convention date (Germany) 2nd October, 1936.

505 252.—Saw-toothed " blocking " oscillator for producing scanning voltages for television.

W. S. Percival. Application date 4th November, 1937.

505 448.—Television amplifier with filter circuits and a compensator valve designed to eliminate interference.

Radio-Akt. D. S. Loewe. Convention date (Germany) 12th November, 1936.

505 453.—Scanning system for a cathode-ray television transmitter in which the scanning beam is periodically suppressed in order to allow the " space-charge " electrons to be collected.

G. Weiss. Convention date (Germany) 24th November, 1936.

505 480.—Means for stabilising a valve when the cathode is not earthed, particularly a " cathode-follower " valve used for scanning in television.

A. D. Blumlein and E. L. C. White. Application date 6th November, 1937.

505 490.—Cathode-ray tube in which means is provided to prevent the mosaic-cell electrode, or the fluorescent screen, from being damaged should the scanning voltages fail to function properly.

E. L. C. White and C. L. Faudell. Application dates 11th October, 1937, and 21st January, 1938.

505 686.—Cathode-ray television transmitter for use with infra-red rays to produce images of objects obscured by haze or fog.

Marconi's W.T. Co. (assignees of H. A. Iams). Convention date (U.S.A.) 30th December, 1936.

505 751.—Cathode-ray tube designed to allow the electron stream to be modulated at a " cross-over " point in order to avoid variation in the size of the scanning spot.

F. H. Nicoll and B. J. Mayo. Application date 13th September, 1937.

505 764.—Circuit for separating the frame and line synchronising impulses used in television, and for avoiding the effect of interaction between them.

E. L. C. White. Application date 15th October, 1937.

505 850.—" Mosaic " of small hemispherical lenses used to project the light from the fluorescent screen of a cathode-ray television receiver on to a viewing screen.

Fernseh Akt. Convention date (Germany) 17th November, 1936.

505 899.—Valve coupling for a television receiver, capable of carrying a D.C. signal-component and of attenuating it relatively to the A.C. signal components.

C. L. Faudell and N. Atkinson. Application date 13th November, 1937.

505 912.—" Adaptor " for allowing an existing television transmitter to radiate pictures in natural colour.

Marconi's W.T. Co. and D. L. Plaistowe. Application date 18th November, 1937.

506 081.—Constant-gain amplifier for handling a wide range of frequencies, particularly television signals.
The General Electric Co. and L. I. Farren. Application date 29th January, 1938.

506 112.—Television receiver in which the anode voltage of the cathode-ray tube is used to supply the charging potential for the time-base condenser.
R. J. Berry (communicated by C. Lorenz Akt.). Application date 19th July, 1938.

506 143.—Construction of mosaic-cell screen intended to receive light on one side, and to be scanned on the opposite side, to produce television signals.
Philips' Lamp Co. Convention date (Germany) 12th October, 1937.

506 237.—Cathode-ray television transmitter with an output circuit which is separated from the structure of the mosaic-cell screen.
Hazeltine Corporation (assignees of R. C. Hergenrother). Convention date (U.S.A.) 30th August, 1937.

TRANSMITTING CIRCUITS AND APPARATUS

(See also under Television)

505 036.—Tuning-dial and indicator for monitoring and correcting the frequency of a ship's transmitting set.
Marconi's W.T. Co. and T. D. Parkin. Application date 3rd November, 1937.

505 079.—Transmitting signals on the same carrier frequency, but on waves of different polarisation, so that they can be separately received.
A. D. Blumlein. Application date 4th October, 1937.

505 303.—Preventing "dead-end" effects in the coils used for tuning a short-wave wireless transmitter.
Telefunken Co. Convention date (Germany) 13th March, 1937.

506 096.—Method of modulation in which in-phase and out-of-phase periods of supply are used to ensure an economic power-consumption.
Telefunken Co. Convention date (Germany) 20th May, 1937.

506 109.—Distortionless method of modulation, applicable to suppressed carrier-wave systems.
Telefunken Co. Convention date (Germany) 3rd July, 1937.

506 306.—Eliminating or reducing one set of the side-band frequencies in carrier-wave signalling (addition to 472 214).
Marconi's W.T. Co. (assignees of J. Plebanski). Convention date (Poland) 8th March, 1938.

506 289.—High-frequency carrier-wave signalling on different frequencies over a network of wires.
C. Lorenz Akt. Convention date (Germany) 22nd December, 1936.

506 439.—Modulating circuit including a high-frequency magnetron tube with an anode divided into an even number of elements.
Siemens and Halske Akt. Convention date (Germany) 21st January, 1937.

CONSTRUCTION OF ELECTRONIC-DISCHARGE DEVICES

504 927.—Permeable secondary-emitting electrode, supported on a mesh structure, for use in an electron-multiplier.
J. D. McGee. Application dates 28th October and 7th December, 1937.

505 035.—Arrangement of apertured or slotted accelerator and control electrodes for a discharge-tube of the kind in which the electron stream is broken up into separate beams or jets.
Marconi's W.T. Co.; G. F. Brett; and E. O. Smith. Application date 3rd November, 1937.

505 556.—Coaxial electrode arrangement in an amplifier of the electron-multiplier type.
Radio-Akt. D. S. Loewe. Convention date (Germany) 8th October, 1936.

505 557.—Amplifying valve in which coaxial nets, acting as electron-multipliers, force the electrons to follow a curved path through slots in a pair of concentric diaphragms.
Radio-Akt. D. S. Loewe. Convention date (Germany) 14th October, 1936.

506 454.—Cathode-ray tube with a pair of target electrodes positioned to intercept the electron stream and so modulate it.
Farnsworth Television Inc. Convention date (U.S.A.) 27th April, 1937.

SUBSIDIARY APPARATUS AND MATERIALS

505 170.—Rotating mercury-switch for tuning the circuits of a wireless transmitter or receiver.
W. A. Beatty. Application date 4th September, 1937.

505 352.—Frequency-dividing circuit comprising two three-grid valves, each operating as a "blocking oscillator" for generating a different frequency.
Telefunken Co. Convention date (Germany) 23rd December, 1937.

505 500.—Method of "triggering" a valve of the non-linear type so as to ensure a clear-cut operation of an associated relay device.
B. M. Hadfield. Application date 11th November, 1937.

505 622.—"Stopper" circuit for preventing radio interference from the sparking-plugs of a motor-car engine.
Siemens Apparate und Maschinen Ges. Convention date (Germany) 14th November, 1936.

505 964.—Loud speaker intended to be used in the vertical position and provided with means to offset any resulting displacement of the speech-coil in the air gap of the magnetic system.
Telefunken Co. Convention date (Germany) 22nd October, 1937.